

Appendix 3 – Terrestrial Biodiversity

3.1 Description and Values

Biodiversity is life. More formally, the National Strategy for the Conservation of Australia's Biological Diversity (Commonwealth of Australia 1996) defines it as:

'the variety of all life forms, the different plants, animals and micro-organisms, the genes they contain, and the ecosystems of which they form a part'.

The biodiversity of the Territory includes terrestrial, freshwater, marine and coastal elements. This appendix supports Chapter 3 – 'Terrestrial biodiversity' of the INRM plan. Given the extensive inter-relationships between land, water, biodiversity and sustainable management, aspects of biodiversity are also discussed in other asset chapters and appendices.

The Northern Territory includes a rich mixture of environments, spanning a continental-scale climatic gradient from desert to monsoonal tropics (see Maps 1-2). There is a large rainfall gradient from some of the driest environments in the country (less than 200mm per year in the Simpson and Great Sandy Deserts) to some of the wettest (around 2000mm per year in the north of Bathurst Island). The frequency and timing of this rainfall is critical for the environments in the Top End, with its high rainfall in the short wet season, followed by a long dry season. These extremes greatly influence the species and habitats found in the northern parts of the Territory. In the central arid areas, variation in the timing and amount of rainfall between years is a major factor influencing habitats and species. During the extended periods of drought, the distribution of species contracts and many species become inactive for long periods.

In Central Australia, spinifex grasslands dominate large areas of sandy deserts, and acacias and desert oak frequently replace eucalypts as the dominant trees. Flood plains of the ephemeral inland rivers and saline lakes occur and are dominated by river gums and bluebush/saltbush, respectively. The ghosts of old rivers (palaeo-drainage lines) still cross the landscape and continue to provide a critical habitat for many species.

The clay soils of the Barkly Tablelands and Victoria River District support large areas of mitchell grasslands and large seasonal wetlands.

The sandstone ranges of the Top End, particularly that of western Arnhem Land, support distinctive vegetation types, including heathlands rich in plant species and a closed forest dominated by a primitive relative of eucalypts that is found only in the Territory. Eucalypt open forests dominate the vegetation of the Top End. Monsoonal rainforest, paperbark forests and swamps that are inundated in the wet season also occur in relatively small patches in the northern parts of the Territory. These vegetation communities support distinctive wildlife and contribute to biodiversity. Map 1 shows the distribution of vegetation types mapped at the 1:1,000,000 scale.

Each part of the Territory has been divided into areas of similar composition of wildlife and geology, with 12 bioregions wholly within the Territory, and another 13 shared with our neighbouring states. This Interim Biogeographic Regionalisation for the NT (Version 5.1) is a partition aimed to recognise the special biodiversity values and needs required by each part of the Territory. The boundaries of distinct bioregions have been mapped across Australia and those within the Territory are shown in Map 2 (IBRA 2005).

The Territory's habitats support a diverse array of plants and animals, with about 4200 native plant species recorded in the area to date. Vertebrate species in the Territory include more than 700 species of fish, about 50 species of frogs, more than 300 species of reptiles, more than 420 species of birds and about 150 species of mammals (Woinarski et al. 2001). The diversity of reptiles in tropical and desert areas is amongst the highest in the world. The freshwater fish fauna is also very rich. There is no comparable listing of Territory invertebrates, although it is possible to tally species numbers for a few conspicuous and easily recognised

groups, such as butterflies. The diversity of invertebrates in the Territory far exceeds that of vertebrates. The Territory ant fauna is perhaps the richest in the world. Many invertebrates play critical roles in maintaining the health and productivity of Territory environments (Woinarski et al. 2001).

Of the total number of species found in the Territory, about 550 plants, 40 reptiles, 3 birds, 6 mammals and 7 frogs are found nowhere else in the world (that is, they are endemic to the Territory) (Woinarski et al. 2001). Many of these endemic species are restricted to the rugged sandstone formations of western Arnhem Land. Map 3 illustrates the distribution of endemic plant species in the NT.

A high proportion of the Territory's animals such as magpie geese, shorebirds, flock pigeons, flying foxes, small insectivorous bats, some butterflies, fish, and marine turtles form large aggregations at feeding, breeding or roosting sites. Some of these aggregations are significant in that they may be the most spectacular and largest of their kind in the world.

The value of biodiversity in the Northern Territory may be more directly connected to people's day-to-day activities and well-being than in most other Australian regions. In much of the Northern Territory, Aboriginal people hold special relationships with plants, animals and the natural environment. Components of biodiversity are integral to the maintenance of Aboriginal culture as bush tucker, for ceremonial and artistic materials, or because of more deep-seated spiritual affiliations.

The Northern Territory's natural environment and biodiversity riches are also a major drawcard for one of its most important industries, tourism. Another major industry, pastoralism, remains sustained largely by the productivity of native grasses and the availability of water. Native fish are critical for recreational and commercial fishing industries. Other wildlife species, such as crocodiles, form the basis of sustainable industries for meat and other products; and many other plant and animal species have potential for commercial use. Such industries may be particularly important in the economically poorer regions of the Northern Territory. The Northern Territory's native plants also serve as important resources for traditional medicines and some offer potential for pharmaceutical development. The extensive forests and woodlands of northern Australia serve as a potentially important resource for global greenhouse gas accounting (Australian Greenhouse Office 2002).

Even beyond these commercial uses of and dependence on biodiversity, most Territorians appreciate biodiversity and the natural landscape as part of the essence and pleasure of the Territory landscape and lifestyle. The city of Darwin and other regional towns are framed by natural features, such as the harbour in Darwin, while the MacDonnell Ranges and Katherine Gorge form the backdrop to Alice Springs and Katherine respectively.

The outstanding natural values of the Northern Territory have been recognised through the listing of some sites of World Heritage status (Kakadu and Uluru-Kata Tjuta National Parks) and others as Ramsar wetlands of international significance. Some of the natural values which make these important sites are:

- Three wetlands in the Northern Territory have been recognised as being of International Significance under the Ramsar Convention on Wetlands - Cobourg Peninsula Aboriginal Land and Wildlife Sanctuary (the first wetland in the world to be listed under the Ramsar Convention in 1974); Kakadu National Park (Stage I and III); and Kakadu National Park (Stage II) The Cobourg Peninsula Ramsar site has a number of wetlands including freshwater and extensive intertidal areas. The peninsula is predominantly unmodified with numerous extensive tidal flats, estuaries, riverine wetlands and Melaleuca swamps. A number of rare or threatened plants are found on the Cobourg Peninsula Ramsar site as well as approximately 58 species of waterbirds and at least six seabird breeding rookeries occur on islands associated with the Peninsula. Other species found on the site are: at least 13 frog species, marine turtles including four rare sea turtles.
- Kakadu is located 120 kilometres east of Darwin, covering a total area of 19,804 square km. It contains features of great natural beauty and sweeping landscapes. Its focal points are the internationally important wetlands and the spectacular escarpment and outliers. The park contains important and significant habitats for a diverse range of flora and fauna, with more than 60 species of mammals, 289

species of birds, 132 species of reptiles, 25 species of frogs, 55 species of freshwater fish and over 10,000 species of insects.

The park is extremely important to Aboriginal people, and many communities still occupy the region. The Aboriginal art sites of Kakadu National Park are a unique artistic achievement that provides an outstanding record of human interaction with the environment over tens of thousands of years.

- Uluru-Kata Tjuta National Park covers an area of 132,566 hectares of arid ecosystems and is located close to the centre of Australia in the traditional lands of Pitjantjatjara and Yankunytjatjara Aboriginal people (locally known as Anangu). The huge rock formations of Uluru and Kata Tjuta are remarkable geological and landform features set in a contrasting, relatively flat, sand-plain environment. They are a part of an important cultural landscape and have special significance to Anangu.

Water holes and soaks provide restricted habitats for a number of rare and unique plant species. Larger stands of mulga and other acacias dominate the harder, wide, sand plain surrounding Uluru and Kata Tjuta. Over 150 species of birds, and many reptiles, amphibians and invertebrates adapted to arid environments have also been recorded. A number of rare mammals are also found in the park, including the hairy-footed dunnart, the sandhill dunnart and the mulgara. Reptile species are found in numbers unparalleled anywhere else in the world and are well adapted to the arid environment.

Nationally listed species that may occur in the NT are listed in attachment 3.3. Notable threatened species from this list include the Gouldian Finch, Bare-rumped Shearwater (critically endangered), Crested Shrike-tit (northern), Northern Shrike-tit, False Water Rat, Marsupial Mole and Central Rock Rat.

A number of habitats that support migratory species are of international conservation significance, with some Northern Territory sites supporting for part of the year much of the total world population of shorebirds that make annual migrations between Australia and the Northern Hemisphere. Migratory species likely to occur in the NT are included in the threatened species list in attachment 3.3.

3.1.1 Condition and Trends

Compared with most other parts of Australia, the Territory's environments are in good condition. There are few other areas in Australia, or indeed the world, where such vast natural landscapes from sandy deserts to monsoonal rainforests remain and where ecological processes are maintained much as they have been for tens of thousands of years. In the Northern Territory, this legacy is still largely intact.

Aboriginal people continue to be important managers and harvesters of the natural resources and their Indigenous Environmental Knowledge is critical to sustainably managing these resources. Activities associated with customary management of resources in the Territory's environments have been carried out by Aboriginal people for tens of thousands of years.

Largely because of the relative lack of intensive development and broad-scale clearing, the Territory has retained viable populations of many plants and animals that have declined across much of the rest of their range, notably:

- bilbies and rabbit-rats disappeared from southern Australia soon after European settlement, but these are still a part of the Northern Territory's fauna;
- the bush stone-curlew is still a common bird in Top End woodlands, whereas it has disappeared from much of southern Australia, largely because of the increasing intensity of land use and predation by foxes;
- large colonies of magpie geese were exterminated throughout southern Australia in the last two centuries, whereas immense magpie geese colonies remain an awe-inspiring spectacle in the wetlands of the Top End; and
- introduced sparrows, mynahs and starlings are the most common birds in most Australian towns, whereas native birds dominate in urban areas of the Northern Territory.

Notwithstanding this retention of many species that have disappeared or declined elsewhere, it is inevitable that as the Territory landscapes are increasingly used and developed, at least some components of biodiversity will decline. Currently, more than 70 species of plants and nearly 90 species of animals are listed as threatened in the Northern Territory (see Table 1). In addition, 14 native mammal species have become extinct in the Northern Territory over the last 200 years, all from desert areas. The extinction of these mammals represents one of the most extreme biodiversity losses recorded in the world in recent historic times.

Table 1 Number of threatened* species in the Northern Territory (listed as at 2004 under the Territory Parks & Wildlife Conservation Act 2000).

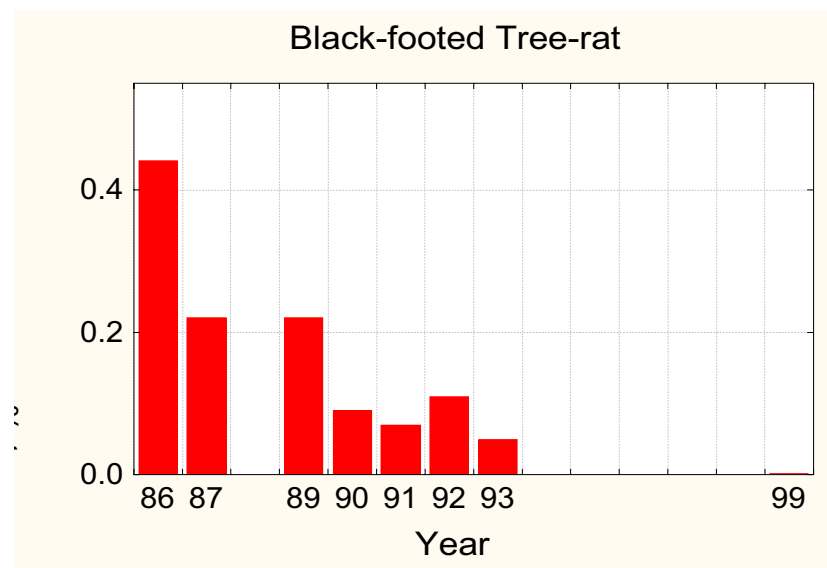
Taxonomic grouping	Critically endangered	Endangered	Vulnerable	TOTAL
Plants	1	20	51	72
Invertebrates	5	3	25	33
Fish	0	2	7	9
Frogs	0	0	1	1
Reptiles	0	3	5	8
Birds	3	6	6	15
Mammals	1	8	12	21

* The term 'threatened' includes critically endangered, endangered and vulnerable categories.

To date, there has been no comprehensive report card on condition and trends in Northern Territory environments and native species. However, the number of threatened species provides one measure of the condition and trend of the Northern Territory's biodiversity. For most of these threatened species, populations continue to decline, although in most cases there is only sketchy documentation of such trends (see Figure 1 below). The number of species listed as threatened in the Northern Territory increases at every revision of the list; and many currently unlisted plant and animal species continue to decline across much of their Northern Territory range.

Although an extensive monitoring program has been established to assess land condition for pastoral lands across the Northern Territory, there is no comparable broad-scale monitoring of biodiversity. One more narrowly focused study examined the condition of 1220 rainforest patches across the Top End (Russell-Smith and Bowman 1992). In that study, 34% of rainforest patches were scored as being 'severely disturbed' by fire, 20% as 'severely disturbed' by feral cattle and/or buffalo, 10% as 'severely disturbed' by pigs and 22% as infested with weeds. These figures are probably broadly representative of the condition of many other environments across the Northern Territory.

Figure 1 An example of declining trends for a species not currently listed as threatened, the black-footed tree-rat at Kapalga in the Top End of the Northern Territory (Woinarski et al. 2001). Note: trapping occurred only in 1986, 1987, 1989-93 and 1999.



Biodiversity decline and losses are not restricted to the more developed areas, but are also occurring in the most remote parts of the Northern Territory. Much of this decline is in response to threatening processes that occur widely across almost all landscapes and tenures.

The condition of the Territory's environments is also related to climatic events and the lack of active management of many parts of the land. Across much of the Northern Territory, the last decade has been generally characterised by higher than average rainfall and land condition is generally good. In the late 1950s and early 1960s much of central Australia was ravaged by drought, and in many cases impacts were compounded by unsustainably high stocking rates and high densities of rabbits. These events are reminders of the need to place condition assessment, land management, land use and conservation planning within a longer-term context and particularly considering the influence of climatic cycles. This is particularly so in the desert areas.

One measure of the intactness of the Territory's natural environment is the limited extent of vegetation clearing. The Territory currently has the lowest proportion of native vegetation cleared of all Australian jurisdictions (Table 2).

Table 2 Comparative extent of clearing for the Northern Territory and other Australian jurisdictions*.

Jurisdiction	Total area cleared (km ²)	Percent cleared	Clearing extent per person (ha)
Northern Territory	5,769	0.43	2.9
Western Australia	183,260	7.30	9.4
South Australia	99,384	10.10	6.5
Queensland	303,502	17.60	8.0
Tasmania	20,709	29.50	4.3
New South Wales	234,173	29.30	3.5
ACT	739	31.40	0.2
Victoria	142,353	62.70	2.9

* Data calculated from National Land & Water Resources Audit (2001) Australian Native Vegetation Assessment.

While the overall extent of clearing is relatively low for the Northern Territory, some regions have been more substantially modified, particularly (and unsurprisingly) in and around urban areas (Table 3).

Table 3 Summary of total extent of clearing for selected Territory regions to 2000*

Region	Total area cleared (km ²)	Total % cleared
Darwin	68	48.8
Palmerston	23	41
Port region	12	16.9
Litchfield	443	14.6
Coomalie Shire	171	11.6
Daly Basin	1936	8.6
Mary River	208	2.5
Tiwi Islands	112	1.5

* Hoskings 2002.

However, in 1999 the annual rate of clearing in the Northern Territory was the third highest in Australia – greater than that of all other States except Queensland and New South Wales (Table 4), both of which have since enacted far more proscriptive legislation to reduce/halt vegetation clearing.

Table 4 Estimates of annual clearing rates for Australian jurisdictions, in 1999*.

Jurisdiction	Annual clearing rate (km ²)
Queensland	4,000
New South Wales	328
Northern Territory	200
Tasmania	100
Western Australia	30
Victoria	20
South Australia	12
ACT	0

* Access Economics 2000.

In summary, the current condition and trends of terrestrial biodiversity in the Territory are characterised by:

- a unique and diverse range of ecosystems that generally remain intact and healthy due to the relative lack of intensive development and broad-scale clearing in the past;
- somewhat paradoxically, widespread indicators showing decline in biodiversity condition, largely due to the impacts of invasive plants, feral and domestic grazing animals, inappropriate fire regimes, climatic impacts and lack of people actively managing the land;
- the relatively high number of threatened species;
- a formal national park system that is far from comprehensive, adequate and representative of the Territory's biodiversity;
- the high proportion of land outside the formal existing reserve system that contains significant conservation values;
- the actual and potential significant role of Aboriginal people, pastoralists and other land managers in actively managing the land and contributing to the conservation of biodiversity values;
- localised issues relating to the increasing intensity of land use, particularly in the regions around Darwin and Alice Springs, and in the Daly Basin and Tiwi Islands; and
- the relatively few resources (sparse human populations and weak regional economies) to combat the environmental problems and enhance conservation management.

3.2 Issues and threats

Northern Territory environments, plants and animals are affected by a broad range of processes. Some, such as inappropriate fire regimes, the spread of weeds and impacts of feral and grazing animals, operate more pervasively across all landscapes and tenures and their impacts may be gradual and less immediately noticeable. Others, such as land clearing and mining, have impacts that are more obvious and localised.

Despite these clear dependencies upon the natural environments and biodiversity, there has been no comprehensive analysis of the economic value of biodiversity resources in the Territory, nor of the commercial value of the environmental services (such as pollination, maintenance of soil fertility, provision of clean air and water).

In some cases, site-specific measures are required. For example, many of the large aggregation sites for animals have been documented and mapped and fall outside conservation reserves. These aggregation sites are important for conservation management, because much or all of the total population of some species may be concentrated (in at least part of the year) in a relatively small area. If this area is inappropriately managed, there may be disproportionately large repercussions for the species and biodiversity generally.

Adverse impacts and threats to biodiversity can be roughly grouped as direct (eg. clearing vegetation) or indirect (inappropriate fire, weeds, feral animals and pastoralism) impacts. In the Territory direct impacts are generally intense but localised while indirect impacts occur over a vast scale and are usually less intense at any single location. Addressing these impacts is part of the solution to maintaining biodiversity along with conserving habitats and species both within formal conservation reserves and through off-reserve arrangements.

3.2.1 *Vegetation Clearance*¹

At a global level, vegetation clearance is widely recognised as one of the most important and direct factors affecting biodiversity (Dept. of the Environment, Sport and Territories 1995; Rankmore & Price 2004) and a core environmental attribute of today's landscape in the NT is the relative intactness of the vegetation (Table 3 and NLWRA 2001).

In the Northern Territory, there has been relatively little vegetation cleared, and its total impact has probably been less significant for biodiversity conservation than that of more extensive threatening factors such as inappropriate fire regimes and weed invasions (Parks and Wildlife Commission Northern Territory 1998). Less than 0.5% of the total area of the Northern Territory has been cleared, although this clearing is concentrated in a few key areas primarily used for urban growth, agriculture and horticulture (Table 4 and Hoskings 2002). The Daly Basin and the Darwin rural areas (Litchfield Shire) and Melville Island are where clearing is happening most intensively (Hoskings 2002, Rankmore & Price 2004).

As the Northern Territory's population and industrial base grows, pressure will increase to modify and clear lands, particularly in urban and outer urban areas and prime agricultural or horticultural lands as is currently occurring in the Darwin rural, Litchfield, Daly, Katherine and Ti Tree regions. This will inevitably result in some detrimental impacts. Currently impacts are regulated by clearing controls, although the current controls do not specify thresholds for acceptable limits of clearing at a regional level or for particular environments, so some vegetation types have been cleared to a greater extent because of the productivity of underlying soils or because they are close to urban and rural areas. Vegetation types that are being heavily affected by development need to be managed carefully so they can be represented in their natural environment in the future. Clearing also fragments vegetation and reduces habitats for species (Rankmore & Price 2004).

The 1:1,000,000 vegetation map of the Northern Territory (Wilson et al. 1990) has long been the core environmental descriptor for whole-of-Territory conservation planning. It is the only environmental classification and mapping that is consistent across the entire jurisdiction. It is used as the baseline for assessing the comprehensiveness of the Territory's conservation reserve system, for planning enhancements to that system, for national environment auditing and for describing and modelling the distribution of the Territory's biodiversity. At the 1:1,000,000 scale, 112 different vegetation types can be identified across the Territory. These have all been described and mapped (Map 1).

¹ This issue affects both biodiversity conservation and the sustainable use of land and readers should refer to Appendix 4 Land for further details.

Maintaining the integrity of native vegetation as required under the Commonwealth Matters for Target (Bilateral Agreement between the Commonwealth of Australia and the Northern Territory 2003) requires maintaining both the extent and the condition of this vegetation.

As it happens, there has been no previous analysis of the extent of clearing for the set of 112 vegetation types in the Territory. This baseline has now been calculated explicitly for the advice presented here (with each single percentage point of the NT landmass is equivalent to more than 1.3 million ha) (J. Woinarski, DIPE pers. comm.). In summary:

- 82 of the 112 (73%) vegetation types have had no (or negligible - $\leq 0.001\%$ 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 $> 5\%$ 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 tetradonta*-*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).

As of 2001, a total of 5769 km² (0.43%) of the NT has been cleared (Table 4 and NLWRA 2001).

For most of the 112 vegetation types, there is no current coherent baseline of condition assessment, and no established protocol for measuring this condition (J. Woinarski, DIPE pers. comm.). Nonetheless, there are existing elements that could contribute to such a system. The most substantial are the monitoring programs on pastoral lands that regularly report on land condition. If adaptable, this would provide a baseline of condition information for about half of the 112 vegetation types. Other existing elements that could contribute to a comprehensive condition monitoring program include the established fire monitoring programs on many national parks and broadly-scattered plot-based floristic survey sites sampled by DIPE.

Clearing vegetation also affects the sustainability of productive land as it greatly increases the area of soil surface exposed to raindrop impact. Sloping sites exposed to heavy rain will lose topsoil to run-off waters; on flatter sites, the soil can become compacted (Sedman 2000). Knowledge of soil and site drainage is critical for informed land use planning. Work on surface runoff and soil and nutrient loss from different farming systems in the Daly Basin (Dilshad, Motha and Peel 1994) has been applied across the Top End in an attempt to provide some quantitative data on the relationship between soil loss and vegetation cover. Sediment losses increase at an accelerated rate when cover is reduced to below 40% (Hill 2004) and runoff increases significantly when cover falls below 50%.

3.2.2 Inappropriate Fire Regimes

Northern Australia has the largest and most frequent fires on the continent (Dyer et al 2001). Fire is a major influence on the landscape. The Top End is characterised by frequent fires (typically any one area will burn once in every two years) and the Arid Centre by extensive fires in years following good rainfalls, but very limited burning occurs on most productive pastoral lands (Russell-Smith et al. 2003).

In 2002 the bush fire season in the Arid Centre was one of the worst in recorded history with approximately 133,000km² burnt. There were widespread extensive hot fires due to the accumulation of high fuel loads resulting from three consecutive wet years (Pastoral Land Board 2003).

Fire regimes have changed over the last two centuries, causing an alteration of ecosystems and their associated species (Williams et al. 2003). Fire is an important part of the landscape and, with Aboriginal people using it to manage the land for thousands of years, many ecosystems have consequently adapted to it (Whitehead et al. 2003). Indigenous mosaic burning involves relatively small fires. More recently fires have

become more extensive because they are less controlled and more intense due to burning being delayed until late in the Dry season (Russell-Smith et al. 2003). These changes have occurred because there are fewer Aboriginal people harvesting bush tucker, fewer people in remote regions and ecosystems are changing (J. Woinarski pers. comm. 2004).

Extensive fires are likely to cause widespread impacts through modifying native species assemblages. There are planned and unplanned fires started by humans, together with a high rate of ignitions from lightning strikes, across virtually all land tenures and landscape types (Williams et al. 2003). Repeated high intensity fires have caused increases in tree mortality, reduction in the shrubby understorey layer and declines in fire-sensitive species and environments like rainforests, riparian areas and sandstone heaths (Kakadu Board of Management 1998). Fire also helps compound pressures such as erosion and creates favourable conditions for weed species and exotic predators to thrive. The invasion of native vegetation by some exotic pasture grasses substantially increases fuel loads, leading to fires which are far more intense and therefore far more destructive and uncontrollable (Tiwi Land Council 2004). Minimising these intense fires can substantially reduce greenhouse gas emissions from savanna burning, which currently accounts for just less than half of all Northern Territory Greenhouse Gas emissions (Australian Greenhouse Office 2002). Fire management practices that reduce greenhouse gas emissions may also attract carbon credits should the Northern Territory participate in a greenhouse gas emissions trading scheme.

In other areas, typically on some pastoral properties, fires are less frequent, either because of deliberate exclusion or because grazing has reduced the fuel load. Such reduced fire frequencies can cause encroachment (or ‘thickening’) of woody shrubs and trees (eg. VRDCA 2004, Roper River Landcare Group 2004 Dyer & Stafford Smith 2003) and many fire-sensitive plants and animals are in decline across their whole range (Williams et al. 2003).

When fire is used appropriately it can be an important tool for land managers to mould and maintain the landscape for both conservation and production (Dyer & Stafford Smith 2003). The habitat has become less suitable for many native plants and animals as well as impacting on pastoral land capability. There are a variety of views in the community about both the use of fire and the ideal mix of landscape conditions we should be managing to achieve sustainability.

Managing fire is important for regional economies. Uncontrolled fire threatens potential production of farming lands and can put important infrastructure at risk (Tiwi Land Council 2004). Fire management can potentially create regional employment and sustain Indigenous fire management knowledge.

Approaches to fire management are likely to vary considerably between the Top End, the Savanna Rangelands and the Arid Centre, with their different vegetation and land uses. No single fire regime applied at landscape scales can meet the needs of any one major land management objective (eg. pastoral production), let alone multiple land management objectives (Tropical Savanna CRC 2004). Fire managers require a clear understanding of the purpose of fire and how this may vary within their region and they particularly need to be aware of environmentally and culturally sensitive habitats. One of the most significant challenges, particularly in remote regions, is developing and coordinating this capacity throughout the Territory.

3.2.3 Declared Weeds and Ecologically Invasive Plant Species ²

The Northern Territory remains largely dominated by native plants, but some exotic plant species are now a major component of some environments and provide a significant challenge for managers of all land types.

² Declared Weeds are invasive plant species listed under the Weeds of National Significance or declared under the NT *Weeds Management Act 2001*

Ecologically Invasive Plants are “...weeds that have less direct impacts on humans but are detrimental to the conservation of natural resources. ...They include plants that adversely affect the integrity, conservation value or biodiversity of natural systems.” (ANZECC & ARMCANZ 1999, p.7) (includes species on the National Environmental Alert List see Attachment 3.2 at the end of this Appendix).

Declared weeds threaten the sustainability of rural primary industries through increased costs, reduced efficiency and limitations on marketing (Pastoral Land Board 2003). Declared weeds are introduced plant species listed under National or Territory legislation and/or policy, while 'ecologically invasive plants' is a broader term encompassing other, non-listed introduced plant species that need to be managed in some areas as they may have adverse impacts on some natural resource assets. The declared weeds and ecologically invasive plants of major concern in the Northern Territory are those that impact on the natural environment, industries and/or community. Some declared weeds and ecologically invasive plants markedly affect fire regimes by increasing fire intensity (Smith 2001), while others choke waterways. They can affect the productive capacity of pastoral lands by displacing native vegetation, reducing accessibility and creating better conditions for feral animals (eg Roper River Landcare Group Inc 2004). Some declared weeds and ecologically invasive plants were introduced to improve pastoral productivity and for use as ornamentals whilst others arrived inadvertently.

Although native plants dominate most of the landscape, exotic plants are now a major component of some environments, with 13 of the 20 Weeds of National Significance (WONS) either already found in the NT or representing a serious threat (S. Wingrave pers. comm. 2004). These species include Alligator Weed, Athel Pine, Cabomba, Olive Hymenachne, Lantana, Mesquite, Mimosa, Parkinsonia, Parthenium Weed, Pond Apple, Prickly Acacia, Rubber Vine and Salvinia (see Maps 4-16). Regional Weed Advisory Committees comprised of a range of land users/managers have identified other priority species for the Northern Territory including Bellyache Bush, Chinese Apple, Gamba Grass (ecologically invasive plant but not a declared weed), Mission Grasses, Baleria, Rubberbush, Devils Claw, Grader Grass and Noogoora Burr (S. Wingrave pers. comm. 2004). Most of these declared weeds and ecologically invasive plants occur either in the Top End or Savanna Rangelands, whilst the Arid Centre suffers mainly from infestations of Athel Pine, Parkinsonia, Rubberbush and Buffel Grass (an ecologically invasive plant) (see Maps 4-21). Specific weed and invasive plant issues across the NT are outlined in Table 10.

In some cases ecologically invasive plants may be viewed favourably by some landholders. Introduced exotic pastures are used by the pastoral industry to increase productivity and combat the domestic stock production problems associated with the use of native pastures. However experience has shown that many introduced pastures have become serious environmental weeds, or have the potential to do so, and pose significant threats to biodiversity and other land users (Parks and Wildlife Service 2004). Thus, many species introduced deliberately to the Territory for use in pastoral areas (Buffel Grass, Gamba Grass, Para Grass, Olive Hymenachne, and Mission Grass) have significantly spread outside their original area of use.

Lonsdale (1994) estimated that between 1947 and 1985, 463 exotic grasses and legumes were intentionally introduced to northern Australia to support the pastoral industry. Of these introductions, only 21 species (5%) were later recommended as useful, while 60 (13%) became listed as weeds. Seventeen of the useful species are also recognised as weeds, leaving a mere four species (<1%) that were useful without being weeds. Low (1997) has subsequently suggested that there is evidence that three of these four useful, but not weedy species are at least ecologically invasive plants in Queensland. The single remaining useful species, *Centrosema pascuorum* (the centro cultivars), has also been recorded spreading into native bushland from areas of cultivation (C. Wilson DIPE pers. comm.).

Weeds affect biodiversity values in many ways: they may out-compete native plants; they may reduce or alter the resources available to native animals; and they may markedly affect fire regimes. Weeds do not respect property, tenure or regional boundaries, and the only effective way of dealing with them is through collaborative management across tenures and across jurisdictions.

The threat of introducing new exotic invasive species either into the Territory or to new areas within the Territory remains, and the Territory needs to minimise the risk of introduction and to be able to respond quickly to new outbreaks. This is important for primary industries as the cost of new weeds can impact heavily on the production value of produce. It is also a particularly important issue for several of the NT's islands, which often provide critical refuges for threatened or endemic plants and animals (Northern Land Council 2004). Keeping these islands free of invasive species (weeds and feral animals) should allow these

plants and animals to survive. Research into eradicating and managing current infestations must also continue.

Specific issues relating to some of the Declared Weeds and ecologically invasive plants are summarised in Table 5 below, while more information on the weeds and invasive plant species affecting inland waters can be found in Appendix 5 – Inland Waters.

A major challenge is developing sufficient weed management capacity in remote and regional areas. Mechanisms such as training and financial incentives are needed to allow for effective coordinated management of weeds across tenures. Table 10 identifies the specific weed issues effecting land resources and production values across the NT.

Table 5 Specific issues associated with declared weeds and ecologically invasive plant species.

Issue	Extent	Impact	Causes	Current Management
Weeds of National Significance				
Athel pine <i>Tamarix aphylla</i> (also a Declared Weed)	Found in the Alice Springs Region Has infested along the banks of the Finke River and extends for over 700km along the river	Displaces Eucalypts and other vegetation Reduces the diversity of flora and fauna	Deliberately introduced to central Australia as a shade and ornamental tree	Subject to national WONS strategy All known infestations subject to active management programs across the spp range in the NT
Olive Hymenachne <i>Hymenachne amplexicaulis</i>	Major infestations limited to floodplains with pastoral region in Darwin area. Minor outbreaks in Arnhem land and Katherine region	Fast growing, semi aquatic grass Invades permanent waters and seasonally flooded wetlands Reduces plant diversity and habitats for native species	Deliberately introduced as an improved pasture in the Top End. Useful plant in reclaiming land after mimosa management program	Subject to WONS strategy. all outlying infestations currently under active management programs
Lantana <i>Lantana camara</i> (also a Declared Weed)	Top End – Generally small infestations Isolated plants in Katherine region.	Reduces plant diversity and habitats for native species Reduces human access to land	Deliberately introduced to Australia as an ornamental plant	Subject to national WONS strategy DIPE Weeds Branch currently developing management strategy.
Mesquite <i>Prosopis limensis</i> (also a Declared Weed)	Small infestations in the Barkly and the Victoria River District.	Fast growing, thorny thickets that replace native vegetation Restricts movement of native animals Reduce production value and increase production costs	Deliberately introduced to Australia as a shade tree Seed easily spread through livestock movements Aggressive invader of native pastures	Subject to national WONS strategy All known infestations subject to active management programs across the spp range in the NT
Mimosa <i>Mimosa pigra</i> (also a Declared Weed)	15 catchments affected in Darwin and Katherine regions currently affects approximately 100,000 ha of floodplain and associated riparian zones	Harbours feral animals Changes in vegetation type and structure Production value decrease Production cost increase Access to land reduced	Deliberately introduced as an ornamental plant. Quick growing aggressive invader preferring disturbed landscapes	Subject to WONS strategy Active eradication programs in all strategic infestations. Impact reduction programs active across all significant infestations. Extensive management program on Aboriginal land Biological control program.

Maps and Appendices for the Integrated Natural Resource Management Plan for the Northern Territory

Issue	Extent	Impact	Causes	Current Management
Parkinsonia <i>Parkinsonia aculeate</i> (also a Declared Weed)	Found in Alice springs, Tennant Creek, Katherine and Darwin regions	Forms impenetrable thorny thickets that competes with and excludes native species Reduction in production values and increase in production costs	Deliberately introduced as a shade tree in the 20th century Seed spread easily along watercourses	Subject to national WONS strategy Significant number of active management programs across the spp range in the NT
Pond Apple <i>Annona glabra</i>	No known infestations currently exist	Reduces plant diversity and habitats for native species particularly in mangrove ecosystems.	Deliberately introduced to Australia as a rootstock in horticulture. Seed spread via seawater movement.	Subject to WONS strategy Subject to surveillance in the NT/QLD border area.
Parthenium <i>Parthenium hysterophorus</i> (also a Declared Weed)	Small outbreaks have occurred in the Gulf and Katherine region. No known current infestations.	Invades disturbed area quickly eg degraded pastures, along roadsides etc. Can cause allergic reactions Seeds contaminate harvesting material, vehicles and machinery – difficult to notice due to small nature of seed	Accidentally introduced to Australia as a contaminant of pasture seed.	Subject to national WONS strategy Successful eradication and monitoring program in place. On going Education and Monitoring program
Prickly Acacia <i>Acacia nilotica</i> (also a Declared Weed)	Small infestations in the Barkly and the Victoria River District. Seedlings occur on roadsides.	Fast growing, thorny thickets that replace native vegetation Restricts movement of native animals Reduce production value and increase production costs	Deliberately introduced to Australia as a shade tree Seed easily spread through livestock movements Aggressive invader of native pastures	Subject to national WONS strategy All known infestations subject to active management programs across the spp range in the NT
Rubber Vine <i>Cryptostegia grandiflora</i> (also a Declared Weed)	<i>C. grandiflora</i> not established as a weed in the Northern Territory. Ornamental rubbervine widespread in urban areas and some remote small communities	Smother vegetation Forms dense impenetrable thickets poisonous	Deliberately introduced to Australia as an ornamental plant.	Subject to national WONS strategy Regular surveillance of NT/QLD border region in order to detect early introduction
Declared Weeds				
Bellyache bush <i>Jatropha gossypifolia</i>	Darwin, Katherine, Daly and Gulf regions	negative impact on biodiversity and pasture production values increases production costs poisonous	Deliberate introduction to Australia as an ornamental plant.	subject to active management programs in most locations biological control agent recently released by DIPE Weeds Branch
Chinee Apple <i>Ziziphus mauritiana</i>	A number of scattered infestations in the Katherine, Gulf and Darwin regions	Fast growing, thorny thickets that replace native vegetation	Deliberately introduced to Australia as an ornamental and food plant	A number of localised management programs mainly in the Katherine and Gulf region.

Maps and Appendices for the Integrated Natural Resource Management Plan for the Northern Territory

Issue	Extent	Impact	Causes	Current Management
Mission grasses <i>Pennisetum</i> spp.	Distribution centred on Darwin and Katherine region	replaces native grasses, changes fire regimes. Massive increase in the intensity of fire	Appears to have been accidentally introduced as an impurity in pasture seed	Extensive management on roadsides in Top End. NT strategy currently being developed.
Grader Grass <i>Themeda quadrivalvis</i>	Darwin and Katherine Region	Invades degraded native and improved pastures	Accidental introduction to Australia	localised management programs throughout NT
Hyptis <i>Hyptis suaveolens</i>	Widespread in Gulf, Katherine, VRD and Darwin regions	Invades disturbed sites further reducing production and environmental values.	Disturbed and/or degraded ecosystem	Localised management programs across distribution.
Noogoora burr <i>Xanthium occidentale</i>	Established on several of the major river systems in the Barkly, Gulf, Katherine, Victoria River and Darwin districts.	Is toxic to stock when young Seed easily spread Establishes easily in disturbed areas	Accidental introduction to Australia in 19th century. easily spread through movement of humans, livestock, native animals and equipment.	localised management programs throughout NT
Rubberbush <i>Calotropis procera</i>	Widely distributed across NT	negative impact on biodiversity and pasture production values	Deliberate introduction as an ornamental plant	management programs active in Katherine, Gulf, Tennant creek and Alice Springs regions
Senna species <i>Senna</i> spp.	Widely distributed across northern half of NT	negative impact on biodiversity and pasture production values	Some species deliberately introduced, other accidentally introduced	some localised management programs
Sida species <i>Sida</i> spp.	Widely distributed across northern half of NT	negative impact on biodiversity and pasture production values	Some species deliberately introduced, other accidentally introduced	some localised management programs
Ecologically Invasive Plants				
Baleria <i>Baleria prioritis</i>	A number of scattered infestations in the Katherine, Gulf and Darwin regions	Fast growing thorny plant that replaces native plants and reduces access to land	Deliberately introduced to Australia as an ornamental plant	A number of localised management programs mainly in the Katherine/ VRD region
Buffel Grass <i>(Cenchrus ciliaris)</i>	Areas around Alice Springs, especially along river systems, floodplains and roadsides. Introduced pasture species in parts of Barkly and Katherine regions	Replacing native plants Increases fire fuel loads and is threatening River Red Gums as they have a low tolerance of hot fires	Deliberately introduced as a major pasture species and for dust suppression in Central Australia	Localised management programs in areas of conservation
Devils claw <i>Martynia annua</i>	Darwin, Katherine, Daly and Gulf regions	negative impact on biodiversity and pasture production values	Deliberate introduction as an ornamental plant	localised management programs in the Katherine region

Issue	Extent	Impact	Causes	Current Management
Gamba grass <i>Andropogon gayanus</i>	Distribution centred on Darwin region with few plants in Katherine district	replaces native grasses, changes fire regimes. Massive increase in the intensity of fire	Deliberately introduced as an improved pasture spp.	Extensive management on roadsides in Top End NT strategy currently being developed

3.2.4 Feral Animals³

Buffalo, deer and horses were released when Port Essington (one of the Territory's first European settlements) was abandoned in 1849. Feral cats may have entered the NT even earlier. They, and many other exotic animals, have prospered since and now represent serious threats to our biodiversity. Feral animals can:

- out-compete native animals;
- spread or harbour diseases new to native wildlife;
- consume native plants and animals; poison native animals; and
- change our environments.

The current complement of feral animals detrimentally affecting biodiversity in the Northern Territory includes the water buffalo, camel, horse, donkey, pig, cat, European fox, black rat, cattle, rabbit, goat, house mouse, cane toad, feral doves, crazy ant and big-headed ant (see Attachment to this appendix for a full list of declared feral animals in the NT). Other non-native grazing animals, such as domestic stock, can have similar impacts on biodiversity to feral animals, in particular in competing for food and water with native animals and contributing to changes in the environments.

Foxes (in central Australia) and cats (across almost of the Northern Territory) are major predators of native animals; they contributed substantially to the extinction of central Australian mammals; and they are implicated in the ongoing decline in other mammals, some ground-nesting birds and some reptiles. Map 22 identifies the known distribution of some important feral animals. More information on feral animals and aquatic pests can be found in Appendix 5 – Inland Waters.

The recent spread of cane toads appears to have led to local extinctions of the northern quoll and substantial declines (possibly only temporary) in a number of goannas and snakes. Crazy ants and big-headed ants are recognised as amongst the world's worst invasive pests and cause significant reduction in invertebrate biodiversity and then consequently to vegetation dynamics. They may also detrimentally affect ground-dwelling vertebrates. Infestations of crazy ants are currently restricted to parts of north-east Arnhem Land, while big-headed ants are established in the Darwin region and have recently arrived in Alice Springs, parts of the Tiwi Islands and Kakadu National Park.

Feral camels, donkeys, horses, buffalo and cattle may foul waterholes, reduce the abundance of favoured plant species, spread weeds, trample the nests of ground-dwelling animals and, in high densities, cause erosion to stream banks and other susceptible habitats (eg Roper River Landcare Group Inc 2004, Edwards et al. 2004). High densities of buffalo in the northern floodplains from the 1950s led to damage to water channels and are believed to have caused breaches in coastal chenier ridges, causing or exacerbating subsequent saltwater intrusions into these important freshwater environments. Selective browsing by feral pigs is a major threat to some rainforest and wetland plants and pigs may also consume eggs and young of many ground-nesting vertebrates.

Donkeys and horses are the predominant feral animals in the Savanna Rangelands and house sparrows, which compete with native seed eating birds and may carry exotic diseases, are common in the Barkly districts.

Camels, rabbits and foxes are common in the Arid Central region of the Northern Territory. Camels graze on most plant species but are suspected of preferring some rare plant species. Like

³ Feral animals are those listed as such under the *Territory Parks and Conservation Act 2001*. they are animals that have established themselves in the Territory, despite not being indigenous and whose presence cannot be easily controlled.

other hoofed animals camels foul waterholes and they can affect fragile areas like salt lakes, destabilise dune crests and increase erosion. Camel populations are estimated to be doubling every eight years (G. Edwards, DIPE, pers. comm.). Rabbits out-compete a range of native animals, overgraze pasture plants, kill mature plants and stop new seedlings from growing.

Exotic animals occur across most Northern Territory lands. The major exceptions are some islands, and these now represent very significant refuges for plants and animals that are elsewhere disadvantaged by the spread of weeds and pests. The values and issues surrounding feral animals are not always simple.

The introduction of new animals that may thrive in the Northern Territory is a constant threat so there is a continuing need for a rigorous system of border control. The Northern Territory's proximity to Asia increases the possibility of introduced animals bringing in diseases such as foot and mouth disease. Such diseases have the potential to devastate the pastoral industry (Northern Territory Government 2004). Preventing the introduction of new exotic animals and other primary industries and their diseases is extremely important to the continuing health of primary industries.

Feral animals are a threat not only to biodiversity, but also to many land users. On pastoral lands, large populations of feral donkeys and horses reduce carrying capacity and create permanent structural changes to vegetation communities and habitats (eg Roper River Landcare Group Inc 2004). Pastoral profitability can be further limited by the cumulative impacts of feral animals: erosion, decreases in water quality, the transport of weeds, damage to fences (Roper River Landcare Group Inc 2004) and electrical circuits (Hoffman 2004) and the distribution of exotic livestock diseases (VRDCA 2004).

On Aboriginal lands, feral pigs, rabbits, buffalo and camels may reduce the abundance of bush tucker (particularly yams and quandongs) (VRDCA 2004). Feral animals constitute a significant alternative food source to Indigenous people and are also valued for their contribution to tourism through trophy hunting (Tiwi Land Council 2004, NLC 2004).

Developing and maintaining sufficient capacity to manage the impacts of feral animals is a key challenge in remote regions. Table 6 lists feral animals which impact on land use in the NT.

Table 6 Northern Territory feral animals that impact on land use.

Issue	Extent & Numbers	Impact	Current Management
African Big-headed Ants, Yellow Crazy Ants and Tropical Fire Ants	All NT	Superior competitor, exclude native ants affects localised invertebrate numbers threatens traditional food resources of Aboriginal people damages infrastructure	Successfully eradicated from Kakadu (African Big headed Ants, Tropical Fire Ants) Being mapped in Arnhem Land (Yellow Crazy Ant) and an eradication program is beginning (ABC Online 2004).
Rabbits	Arid Zone	Overgraze pasture plants and reduce trees and shrubs by killing mature plants and suppressing the recruitment of seedlings Compete with native fauna Soil erosion	Introduction of Rabbit Haemorrhagic disease has reduced numbers by 80%. Warren ripping on some pastoral leases.

Issue	Extent & Numbers	Impact	Current Management
Camels	Arid Zone Minimum 80, 533 and increasing by 10% a year, or doubling in population every 8 years.	Eat most plants available but are selectively eating some rare plant species Food harvested by Aboriginal people is affected by camel browsing Impact on fragile areas such as salt lakes Foul waterholes Destabilise dune crests and increase erosion Damage stock fences and infrastructure.	Management is limited to live muster of wild animals and culling on some pastoral leases and national park.
Donkeys & Horses	All NT Horses 265,000	Avid Grazers Compete with native herbivores and stock for forage and water Change composition of plants in an area due to selective foraging Soil erosion and compaction Spread weeds Foul water Damage infrastructure	Culling operations in regions such as the Victoria River District (VRD) – User pays with assistance from PWS NT Long-term effective management in Alice region.
Pigs	Top End and VRD	Loss of biodiversity Damage to water points Over grazing Soil compaction Soil erosion Spread of weeds Competition with native fauna Destruction of seedlings	On Melville Island there is a planned eradication program for feral pigs.
Buffalo	Top End & VRD	Foul water Impact wetlands and riparian zones Spread weeds	Extent not as great due to BTEC, but significant numbers in some areas (eg Arnhem Land).

A key challenge for sustaining terrestrial biodiversity lies in leaving enough ungrazed or lightly-grazed landscapes to maintain the viability of species that are disadvantaged by pastoral land use. This challenge is particularly difficult in those environments now given over almost exclusively to the pastoral industry. The extensive research into appropriate land management practices for sustainable grazing is showing that sustainable grazing is primarily dependent on the management of pasture use, especially in relation to the level of use and timing (Tropical Savannas CRC 2004).

3.2.5 Lack of Conservation of Habitats and Species

As mentioned earlier, addressing the impacts above is major part of the solution to maintaining biodiversity along with conserving habitats and species both within formal conservation reserves and through off-reserve arrangements.

National parks and other conservation reserves are widely recognised as the cornerstone of biodiversity conservation. The Northern Territory's national park system includes some outstanding areas of international and national significance (Map 23). However, the percentage of land area formally devoted to conservation and national parks in the Territory is the least of any Australian jurisdiction (Table 7). It also falls well below generally agreed national and international recommendations, which typically set a benchmark of at least 10-15% of lands devoted to conservation.

Table 7 Relative area of terrestrial park systems in Australian jurisdictions.

Jurisdiction	Area of terrestrial reserves (km ²)	% area reserved: total land area
Northern Territory	50,434*	3.7
Queensland	71,202	4.1
New South Wales	53,363	6.7
Western Australia	271,688	10.8
Victoria	34,243	15.1
South Australia	252,439**	25.7
Tasmania	25,499	37.3
ACT	1,282	54.4
Australia	760,150	10.1

Data from Collaborative Australian Protected Areas Database 2002

* includes Kakadu and Uluru-Kata Tjuta National Parks and Indigenous Protected Areas; but does not include the as yet undesignated Limmen Park and extension to Keep River (with a total area of 14,467 km²)

** includes 106,017 km² of "regional parks"

The NT Government and the Council of Australian Governments (COAG) have agreed to develop a Comprehensive, Adequate and Representative (CAR) reserve system that should include at least 10-15% of the jurisdiction through endorsing agreements and strategies such as the National Strategy for Ecologically Sustainable Development (1992), the National Forest Policy Statement (1992) and the National Strategy for the Conservation of Australia's Biological Diversity (1995). They also agreed that the conservation reserves and National Parks system will include representation of all natural environments, at a scale sufficient to capture the diversity within those environments and large enough to provide for their long-term conservation security.

The Northern Territory conservation reserve system currently falls well short of this goal. Of the 112 vegetation types described for the Northern Territory at 1:1,000,000 scale, 49 (44%) are not included within any conservation reserve and a further 29 are represented by less than 5% of their extent (Table 8). Across all vegetation types, the median proportion of area reserved is only 0.13 percent. The current system is characterised by unusually extensive reservation of a few environments and poor or no representation of most others.

Table 8 Summary of the reservation status (% total area included within conservation reserves) for the 112 vegetation types represented in the Territory*.

Broad vegetation group	# types	Extent of reservation (%)				
		0	0+ - 1	1+ - 5	5+ - 10	> 10
Chenopod shrubland	6	4	2	0	0	0
Miscellaneous shrubland	2	1	1	0	0	0
Acacia woodland	20	10	6	2	2	0
Mixed species low woodland	3	2	0	0	0	1
Tussock grassland	7	3	2	1	0	1
Eucalypt low woodland with tussock grass	9	3	4	1	0	1
Littoral complex	5	2	1	0	1	1
Rainforest	2	0	0	0	1	1
Floodplains	2	0	0	0	0	2
Melaleuca forests and shrubland	4	2	0	0	0	2
Hummock grassland ("spinifex")	20	10	4	2	1	3
Eucalypt low woodland with hummock grass	15	7	0	0	4	4
Eucalypt forest	17	5	2	1	2	7
Total	112	49	22	7	11	23

*Data from J. Woinarski DIPE, 2004, unpublished.

The lack of formal conservation of the more fertile environments, especially tussock grasslands and chenopod shrublands, is a major impediment to achieving a comprehensive terrestrial reserve network in the Northern Territory. The relatively small proportion of lands devoted to formal conservation reserves means that biodiversity conservation in the Northern Territory is unusually reliant on lands outside the protected area system being well managed for biodiversity. For some species, such as the critically endangered Carpentarian rock-rat, all of the few locations in which they are found are outside the formal reserve system.

While existing national parks are managed primarily for biodiversity conservation, this alone is not sufficient to conserve viable examples of all of the Northern Territory's biodiversity. The reality of current land tenure in the NT suggests that most additions to the CAR system will be less conventional than elsewhere and would require successful negotiation with relevant land managers. The data on areas protected within formal park systems highlights how important off-park conservation measures are in the Territory. All landholders and the general community have a role and obligation to help maintain biodiversity.

As major landholders, Aboriginal people are directly responsible for managing approximately 44% of the Northern Territory's landmass. Community-based ranger programs are active in improving NRM by getting people back on country, surveillance of remote areas, on-ground works and interpreting the natural and cultural values of the landscapes and biodiversity for visitors.

Most of the rest of the Territory is primarily managed for cattle production by pastoral leaseholders. As well as individual activities on individual leases, local Landcare groups such as Centralian Land Management Association, Victoria River District Conservation Association, Roper River Landcare Group and Barkly Landcare Group collectively undertake NRM projects for their local region. Many of these projects positively help maintain biodiversity in these areas by directly targeting issues such as fire, weeds and feral animals.

3.2.6 Knowledge and Management Gaps

Until recently, on a national scale, the environments of the Northern Territory were largely viewed as pristine, few environmental problems were identified and there was little perceived need to address these problems urgently.

Given its population base, there has been a surprisingly large amount of scientific research into the NT's biodiversity. Data sets of vegetation types, plants, animals, weeds and feral animals for NT are listed in Woinarski et al. (2002). However, the Territory is large and has a relatively small human population (and pool of biodiversity scientists). Moreover, resource levels for environmental issues have generally been less than those in more densely populated parts of Australia. Additionally, while Indigenous peoples' knowledge of Northern Territory environments and biota is extensive, this information has rarely been incorporated into government or industry-led land management decisions.

As a result, there remain major deficiencies in the knowledge needed to maintain biodiversity as well as issues relating to the way decisions regarding biodiversity management reflect the range of values of different peoples of the NT. The major gaps in knowledge and data can be summarised as needing:

- adequate baseline data for monitoring changes and effective management;
- strategic, detailed knowledge on threatened species and ecosystems; and
- strategic, detailed knowledge on feral animals and the interaction between fire, weeds and feral animals.

In addition:

- collaboration is needed to make sure Indigenous Ecological Knowledge is incorporated into biodiversity management;
- much of the knowledge that exists does not yet easily translate to on-ground managers or the broader community; and
- current institutional arrangements often preclude on-ground workers, both within and external to government and research institutions from accessing this information.

3.2.7 Climate Change

The degree and nature of changes in climate due to increased concentrations of greenhouse gases in the atmosphere remains uncertain, yet it is now clear that some increases in temperature are inevitable. Global greenhouse gas emissions must be reduced within a reasonable timeframe to avoid substantial relatively abrupt changes to the earth's systems..

The long term implications of climate change for biodiversity may be very serious. Thomas et al. (2004) predict on the basis of a mid-range climate warming scenario for 2050 that 15-37% of species in the regions and taxa sampled, would be 'committed to extinction'. The extent of cascading species extinction due to dependency of one organism on another and changes in ecological balance are largely unknown.

In the Territory, current projections include increases in temperature (especially minimum temperatures); increases in the frequency of extremely hot periods; decreases in rainfall; increases in evaporation; increases in the intensity of cyclones and associated storm surge; and sea level rise. The impacts of these changes are likely to be diverse but are at this stage, largely unexplored. Many species may not be able to adapt at a rate matching the anticipated unprecedented environmental change. Changes in temperature and moisture regimes may result in a reduced capacity of many plants and animals to feed or reproduce and cyclones, storm surge and sea level rise could result in the extensive destruction of habitat. The consequences of these changes are also likely to have significant implications for industries dependent on natural systems. Adaptive strategies such as the maintaining wildlife corridors and translocating species need to be explored and considered in policies and planning.

The impacts of climate change are also discussed in Chapter 4 – Land; Chapter 5 – Inland Waters; Chapter 6 – Coastal and Marine; and Appendix 6 – Coastal and Marine.

3.2.8 Other Threats

There are numerous other threats to Terrestrial Biodiversity such as unsustainable land practices, mining, hunting and harvesting and tourism and recreation. These threats have been considered in more detail in Appendix 4 – Land or Appendix 5 – Inland Waters.

3.3 Current Management Responses

3.3.1 Northern Territory Government Agencies

The Department of Infrastructure, Planning and Environment is the lead agency dealing with biodiversity issues on behalf of the NT Government. The core business of the Department of Business, Industry and Resource Development also has a critical impact on biodiversity through their focus on fisheries, pastoralism, agriculture, horticulture, mining, exploration and regional development.

3.3.2 Northern Territory Government Initiatives

As could be expected for an issue of this importance, a large number of NT Government documents that deal with managing and conserving biodiversity have been developed or are in the process of being developed, including:

- Conservation Plans, particularly the Conservation Master Plan currently being developed
- Threatened species recovery, action and management plans;
- Policies and strategies for particular geographical areas (eg. Daly Basin) and biodiversity issues (eg. sustainable wildlife use);
- Weed management strategies for weeds of national significance (13) and for sub-regions of the Territory;
- Fire management plans and strategies;
- National park management plans and associated documents;
- Vegetation retention strategies (greater Darwin Region); and
- Pest declaration areas (currently restricted to the Victoria River District).

Documents such as legislation, plans, policies and strategies form a necessary supporting framework for practical, on-ground management (See Appendix 9). Day-to-day management and actions by government, landholders and the general community are an important component of biodiversity management.

3.3.3 Off-Park Conservation Measures

Given the paucity of the formal reserve system in NT, there is a high reliance on off-park measures. Important examples in the NT include:

- formal agreements on Aboriginal lands and other private lands eg. Dhimurru Land Management Aboriginal Corporation in East Arnhem Land, Manangoora pastoral lease agreement regarding protection of a significant stand of cycads from grazing and Caranbirini Conservation Reserve within the McArthur River Pastoral Lease;
- purchase of land for conservation purposes by non-government conservation groups eg. Birds Australia;
- increasing community participation and capacity in collaborative land management with explicit outcomes for biodiversity conservation including initiatives eg. Landcare groups;
- on Aboriginal lands, community ranger schemes delivering strategic management programs eg. threatened species initiatives (NLC 2002); and
- national funding programs that support community groups to deliver biodiversity outcomes as part of a broader focus on sustainable natural resource management eg. National Landcare Program, Envirofund.

3.3.4 Action on Key Threats

Weeds

Nationally, the Territory is helping develop and carry out weed management strategies for 13 of the 20 Weeds of National Significance: Alligator Weed, Athel Pine, Cabomba, Olive Hymenachne, Lantana, Mesquite, Mimosa, Parkinsonia, Parthenium weed, Pond Apple, Prickly Acacia, Rubbervine and Salvinia. These plans coordinate management programs across borders and clearly identify strategically important issues and areas for managing each species

The NT *Weeds Management Act 2001* describes the level of management required for each declared weed species. The current list of declared weeds in the NT is being reviewed in line with the introduction of the new Act (see Appendix 9). A number of NT specific weed management plans and an NT wide weed management strategy have been developed.

Feral Animals

Managing feral animals is an important aspect of effective NRM, as these species amplify the effects of other threatening processes by spreading weeds, degrading soil and over-grazing. Under the *Territory Parks and Wildlife Conservation Act*, areas threatened by feral animals can be declared a Feral Animal Control Area thus authorising any necessary action; the Victoria River District is the only such area declared to date. Inside municipal boundaries, feral animal control is the responsibility of the relevant councils.

The National Feral Animal Control Program (NFACP) provides financial support to remedy deficiencies in information, management and extension. Although NFACP has granted some funds to NT feral animal management programs, its priorities are determined on a national basis and often differ from those of the Northern Territory.

DIPE is primarily responsible for coordinating feral animal management outside town boundaries and is currently drafting a Territory Management Plan for feral animals. The Department already has management programs for feral horses, donkeys, wild dogs and rabbits, running cooperatively with landholders and their representative organisations (eg. Landcare groups and Land Councils). DIPE research continues to investigate the basic biology of a number of feral animal species and options for their control. There are numerous feral management programs which necessarily vary substantially between regions. Most of these programs aim to reduce the number of feral animals rather than eradicate the species or minimise its impacts.

Fire

Better understanding of appropriate fire management has resulted from extensive research programs and this research now forms the basic philosophy for fire management in the NT. Within the boundaries of the *Bushfires Act 1980* individual land managers on most land tenures generally have discretion as to how they use fire to manage their land. The Bushfires Council coordinates pre-suppression work to achieve consistent levels of management that will be most suited to the differing areas of the Northern Territory.

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Attachment 3.1: Feral Animals of the Northern Territory

Following is the official list of feral animals for the Northern Territory as listed under the Territory Parks and Conservation Act 2001.

Mammals

Bos javanicus Bali Cattle
Bos taurus Cattle
Bos indicus Cattle
Bubalus bubalis Buffalo
Camelus dromedarius Camel
Canis familiaris Dog
Capra hircus Goat
Cervus sp. Deer
Equus asinus Donkey
Equus caballus Horse
Felis catus Cat
Mus musculus Mouse
Mustela putorius Ferret
Oryctolagus cuniculus Rabbit
Ovis aries Sheep
Rattus rattus Rat
Sus scrofa Pig
Vulpes vulpes Fox

Birds

Agapornis spp. Lovebirds
Alisterus scapularis King Parrot
Amadina fasciata Cut-throat Finch
Amandava subflava Orange-breasted Waxbill
Anas platyrhynchos Domestic Duck
Anser anser Domestic (Grey-lag) Goose
Anser cygnoides Goose
Cacatua tenuirostris Long-billed Corella
Cairina moschata Muscovy Duck
Carduelis carduelis European Goldfinch
Carduelis chloris Greenfinch
Catreus wallichii Cheer Pheasant
Chrysolophus amherstiae Lady Amherst Pheasant
Chrysolophus pictus Golden Pheasant
Columba livia Domestic Pigeon
Coturnix coturnix Domestic Quail
Coturnix chinensis Chinese Quail
Cyanoramphus novaezelandiae Kakariki (Red-fronted Parakeet)
Eclectus roratus Eclectus Parrot
Erythrura trichroa Blue-faced Parrot-finch
Estrilda astrilda Saint Helena Waxbill
Estrilda melpoda Orange-cheeked Waxbill
Gallus gallus Domestic Fowl
Glossopsitta concinna Musk Lorikeet
Glossopsitta porphyrocephala Purple-crowned Lorikeet
Glossopsitta pusilla Little Lorikeet
Lagonosticta senegala African Firefinch

Lophura nycthemera Silver Pheasant
Meleagris gallopavo Turkey
Neophema elegans Elegant Parrot
Neophema pulchella Turquoise Parrot
Numidia meleagris Guineafowl
Passer domesticus House Sparrow
Passer montanus Tree Sparrow
Pavo cristatus Common Peafowl
Platycercus adscitus Pale-headed Rosella
Platycercus elegans Crimson Rosella
Platycercus eximius Eastern Rosella
Platycercus icterotis Western Rosella
Polytelis anthopeplus Regent Parrot
Polytelis swainsonii Superb Parrot
Psephotus chrysopterygius Golden-shouldered Parrot
Psephotus haematonotus Red-rumped Parrot
Psittacula cyanocephala Plum-headed Parakeet
Serinus canaria Canary
Stagonopleura guttata Diamond Firetail
Streptopelia chinensis Turtle Dove
Streptopelia risoria Barbary Dove
Tiaris canora Cuban Finch
Trichoglossus chlorolepidotus Scaly-breasted Lorikeet
Uraeginthus spp. Cordon Bleu Finches

Attachment 3.2: Weeds on the national environmental alert list

SCIENTIFIC NAME	COMMON NAME	EXTENT IN AUSTRALIA	POTENTIAL DISTRIBUTION
<i>Acacia catechu</i> var. <i>sundra</i>	Cutch Tree	NT	QLD, WA
<i>Acacia karroo</i>	Karoo Thorn	QLD, NSW, SA, WA	
<i>Asystasia gangetica</i> ssp. <i>micrantha</i>	Chinese Violet	NSW	QLD, NT, WA
<i>Barleria prionitis</i>	Barleria	QLD, NT	WA
<i>Bassia scoparia</i> (weedy form)	Kochia	Tas, WA	NSW, Vic, SA
<i>Calluna vulgaris</i>	Heather	Tas	NSW, Vic
<i>Chromolaena odorata</i> (weedy form)	Siam Weed	QLD	NT, WA
<i>Cynoglossum creticum</i>	Blue Hound's Tongue	NSW	Vic, Tas, SA, WA
<i>Cyperus teneristolon</i>	Cyperus	NSW	QLD, Vic, SA, WA
<i>Cytisus multiflorus</i>	White Spanish Broom	Vic	NSW, Tas, WA
<i>Dittrichia viscosa</i>	False Yellowhead	WA	NSW, Vic, Tas, SA
<i>Equisetum</i> spp.	Horsetail	NSW, Tas, Vic	
<i>Gymnocoronis spilanthoides</i>	Senegal Tea Plant	QLD, NSW	
<i>Hieracium aurantiacum</i>	Orange Hawkweed	Tas, Vic	NSW, SA
<i>Koelreuteria elegans</i> ssp. <i>formosana</i>	Chinese Rain Tree	QLD	NSW, NT, WA
<i>Lachenalia reflexa</i>	Yellow Soldier	WA	NSW, Vic, Tas, SA
<i>Lagarosiphon major</i>	Lagarosiphon	Tas, NSW	Vic, SA, WA
<i>Nassella charruana</i>	Lobed Needle Grass	Vic	NSW, SA, WA
<i>Nassella hyalina</i>	Cane Needle Grass	NSW, Vic	
<i>Pelargonium alchemilloides</i>	Garden Geranium	WA	NSW, Vic, Tas, SA
<i>Pereskia aculeata</i>	Leaf Cactus	QLD, NSW	WA
<i>Piptochaetium montevidense</i>	Uruguayan Rice Grass	Vic	NSW, SA, WA
<i>Praxelis clematidea</i>	Praxelis	QLD	NT, WA
<i>Retama raetam</i>	White Weeping Broom	SA, WA	NSW, Vic, Tas
<i>Senecio glastifolius</i>	Holly Leaf Senecio	NSW, WA	Vic, Tas, SA
<i>Thunbergia laurifolia</i>	Laurel Clock Vine	QLD	NT, WA
<i>Tipuana tipu</i>	Rosewood	QLD	NT, WA
<i>Trianoptiles solitaria</i>	Subterranean Cape Sedge	Vic	NSW, Tas, SA, WA

Attachment 3.3: Species of National Significance in the Territory

Nationally Listed Species for Region Northern Territory

Total Area of Northern Territory = 134778759 Ha

Scientific Name	Common Name	EPBC STATUS	Range of Taxa (ha) Nationally	Range of Taxa within a region (ha)	Proportion of Taxa's range within a region (%)	Porportion of region containing taxa (%)	MIGRATORY	MARINE
<i>Boronia xanthastrum</i>	-	Vulnerable	31,512	31,514	100.01	0.02		
<i>Polytelis alexandrae</i>	Princess Parrot, Alexandra's Parrot	Vulnerable	13,571,156	13,571,403	100.00	10.07		
<i>Macrozamia macdonnellii</i>	MacDonnell Ranges Cycad	Vulnerable	1,709,261	1,709,270	100.00	1.27		
<i>Ptychosperma bleeseri</i>	-	Endangered	5,431	5,431	100.00	0.00		
<i>Lagorchestes hirsutus</i> unnamed subsp.	Mala, Rufous Hare-Wallaby (central mainland form)	Endangered	86,245	86,245	100.00	0.06		
<i>Actinotus schwarzii</i>	Desert Flannel-flower	Vulnerable	35,516	35,516	100.00	0.03		
<i>Solanum carduiforme</i>	-	Vulnerable	9,303	9,303	100.00	0.01		
<i>Burmannia</i> sp. Melville Island (R.Fensham 1021)	-	Endangered	169,383	169,383	100.00	0.13		
<i>Boronia suberosa</i>	-	Vulnerable	6,143	6,143	100.00	0.00		
<i>Boronia viridiflora</i>	-	Vulnerable	48,648	48,648	100.00	0.04		
<i>Isodon auratus auratus</i>	Golden Bandicoot (mainland)	Vulnerable	20,860	20,860	100.00	0.02		
<i>Acacia undoolyana</i>	Undoolya Wattle, Sickle-leaf Wattle	Vulnerable	2,037	2,037	100.00	0.00		
<i>Pseudantechinus mimulus</i>	Carpentarian Antechinus	Vulnerable	23,274	23,274	100.00	0.02		

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<i>Zyomys palatalis</i>	Carpentarian Rock-rat	Endangered	13,181	13,181	100.00	0.01		
<i>Egernia slateri slateri</i>	Slater's Skink, Floodplain Skink	Endangered	3,969,933	3,969,933	100.00	2.95		
<i>Tyto novaehollandiae melvillensis</i>	Masked Owl (Tiwi Islands)	Vulnerable	747,895	747,895	100.00	0.55		
<i>Sminthopsis butleri</i>	Carpentarian Dunnart	Vulnerable	747,895	747,895	100.00	0.55		
<i>Ipomoea</i> sp. Stirling (P.K.Latz 10408)	-	Vulnerable	1,910	1,910	100.00	0.00		
<i>Boronia tolerans</i>	-	Vulnerable	11,572	11,572	100.00	0.01		
<i>Helicteres</i> sp. Glenluckie Creek (N.Byrnes 1280)	-	Vulnerable	14,175	14,175	100.00	0.01		
<i>Wrixonia schultzei</i>	-	Vulnerable	72,538	72,538	100.00	0.05		
<i>Acacia pickardii</i>	-	Vulnerable	220,273	220,273	100.00	0.16		
<i>Olearia macdonnellensis</i>	-	Vulnerable	88,502	88,502	100.00	0.07		
<i>Boronia quadrilata</i> Duretto ms.	shrub	Vulnerable	6,095	6,095	100.00	0.00		
<i>Arenga australasica</i>	Australian Arenga Palm	Vulnerable	2,193,321	2,193,320	100.00	1.63		
<i>Xeromys myoides</i>	Water Mouse, False Water Rat	Vulnerable	919,704	919,703	100.00	0.68		
<i>Sauropus filicinus</i>	-	Vulnerable	19,172	19,172	100.00	0.01		
<i>Ectrosia blakei</i>	-	Vulnerable	36,400	36,400	100.00	0.03		
<i>Eremophila</i> sp. Rainbow Valley (Henshall 1181)	-	Vulnerable	52,412	52,412	100.00	0.04		
<i>Boronia verecunda</i>	-	Vulnerable	126,370	126,370	100.00	0.09		
<i>Goodenia quadrifida</i>	-	Vulnerable	68,346	68,346	100.00	0.05		
<i>Mesembriomys macrurus</i>	Golden-backed Tree-rat	Vulnerable	1,895,824	1,895,819	100.00	1.41		
<i>Boronia laxa</i> Duretto ms.	shrub	Vulnerable	151,282	151,281	100.00	0.11		
<i>Ricinocarpos gloria-medii</i>	-	Vulnerable	9,846	9,846	100.00	0.01		
<i>Boronia rupicola</i>	-	Vulnerable	62,137	62,136	100.00	0.05		
<i>Thryptomene wittweri</i>	Mountain Thryptomene	Vulnerable	22,605	22,605	100.00	0.02		
<i>Minuria tridens</i>	-	Vulnerable	711,675	711,666	100.00	0.53		
<i>Geophaps smithii smithii</i>	Partridge Pigeon (eastern)	Vulnerable	8,011,890	8,011,416	99.99	5.94		

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<i>Zyomys pedunculatus</i>	Central Rock-rat	Endangered	11,874,334	11,873,191	99.99	8.81		
<i>Saccolaimus saccolaimus mudiclimiatus</i>	Bare-rumped Sheath-tail Bat	Critically Endangered	9,578,280	9,576,958	99.99	7.11		
<i>Notomys aquilo</i>	Northern Hopping-mouse	Vulnerable	6,527,657	6,526,631	99.98	4.84		
<i>Egernia kintorei</i>	Great Desert Skink	Vulnerable	43,542,991	43,531,555	99.97	32.30		
<i>Livistona mariae</i> subsp. <i>mariae</i>	Central Australian Cabbage Palm	Vulnerable	15,124	15,120	99.97	0.01		
<i>Dasyercus cristicauda</i>	Mulgara	Vulnerable	69,545,173	69,516,275	99.96	51.58		
<i>Tyto novaehollandiae kimberli</i>	Masked Owl (northern)	Vulnerable	11,753,224	11,570,170	98.44	8.58		
<i>Erythrotriorchis radiatus</i>	Red Goshawk	Vulnerable	28,940,663	27,087,737	93.60	20.10		
<i>Acacia latzii</i>	Latz's Wattle	Vulnerable	665,895	611,911	91.89	0.45		
<i>Falcunculus frontatus whitei</i>	Crested Shrike-tit (northern), Northern Shrike-tit	Vulnerable	5,365,254	4,766,960	88.85	3.54	Migratory	
<i>Petrogale lateralis</i> MacDonnell Ranges race	Warru, Black-footed Rock-wallaby (MacDonnell Ranges race)	Vulnerable	38,859,959	32,177,617	82.80	23.87		
<i>Pristis microdon</i>	Freshwater Sawfish	Vulnerable	54,802,548	45,053,171	82.21	33.43		
<i>Elusor lavarackorum</i>	Gulf Snapping Turtle	Endangered	21,567,204	16,799,709	77.89	12.46		
<i>Notoryctes typhlops</i>	Yitjarritjarri, Southern Marsupial Mole	Endangered	55,234,457	39,376,990	71.29	29.22		
<i>Erythrura gouldiae</i>	Gouldian Finch	Endangered	47,906,513	27,790,308	58.01	20.62	Migratory	
<i>Malurus coronatus coronatus</i>	Purple-crowned Fairy-wren (western)	Vulnerable	26,158,966	10,602,589	40.53	7.87		
<i>Macrotis lagotis</i>	Greater Bilby	Vulnerable	99,234,960	29,536,753	29.76	21.91		
<i>Pseudomys australis</i>	Plain's Rat	Vulnerable	15,339,741	3,070,821	20.02	2.28		
<i>Amytornis textilis modestus</i>	Thick-billed Grasswren (eastern)	Vulnerable	46,129,888	7,242,125	15.70	5.37		
<i>Glyphis</i> sp. C	Northern River Shark	Endangered	160,369	21,275	13.27	0.02		

<i>Glyphis sp. A</i>	Speartooth Shark	Critically Endangered	131,883	14,774	11.20	0.01		
<i>Natator depressus</i>	Flatback Turtle	Vulnerable	19,128,171	1,404,066	7.34	1.04	Migratory	Listed
<i>Carcharodon carcharias</i>	Great White Shark	Vulnerable	66,919,153	2,541,282	3.80	1.89	Migratory	
<i>Rhincodon typus</i>	Whale Shark	Vulnerable	66,919,153	2,541,282	3.80	1.89	Migratory	
<i>Notoryctes caurinus</i>	Karkarratul, Northern Marsupial Mole	Endangered	43,809,799	966,219	2.21	0.72		
<i>Lepidochelys olivacea</i>	Pacific Ridley, Olive Ridley	Endangered	17,828,463	104,386	0.59	0.08	Migratory	Listed
<i>Dermochelys coriacea</i>	Leathery Turtle, Leatherback Turtle, Luth	Vulnerable	17,797,967	73,891	0.42	0.05	Migratory	Listed
<i>Chelonia mydas</i>	Green Turtle	Vulnerable	17,786,289	62,212	0.35	0.05	Migratory	Listed
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	Vulnerable	17,786,094	62,017	0.35	0.05	Migratory	Listed
<i>Balaenoptera musculus</i>	Blue Whale	Endangered	6,745,735	12,949	0.19	0.01	Migratory	
<i>Caretta caretta</i>	Loggerhead Turtle	Endangered	17,749,850	25,773	0.15	0.02	Migratory	Listed
<i>Ophidiocephalus taeniatus</i>	Bronzeback Snake-lizard	Vulnerable	777,001	2	0.00	0.00		
<i>Leipoa ocellata</i>	Malleefowl	Vulnerable	2,476,258	0	0.00	0.00	Migratory	