Submission 033
Date received: 29/07/2011

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Mr Tony Zappia MP
Chair
House of Representatives Standing Committee
on Climate Change, Environment and the Arts
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Via email: ccea.reps@aph.gov.au

Dear Mr Zappia

I am pleased to provide the Northern Territory Government's Submission to the House of Representatives Standing Committee on Climate Change, Environment and the Arts' *Inquiry into Australia's biodiversity in a Changing Climate*.

The Northern Territory's biodiversity and natural environments form an integral part of our lifestyle, industry and culture and so for the Territory in particular, the impacts of climate change on biodiversity are significant.

The 2009 *Northern Territory Climate Change Policy* recognises the importance of protecting the Northern Territory's unique natural environment and building resilience to climate change, particularly through improved land management and water strategies. These include the 1600km conservation corridor, the Northern Territory Eco-Link, and the protection of the priceless Mary River wetlands at risk from rising sea levels. Further adaptation strategies for the Northern Territory's communities, natural environment, and infrastructure will be developed under the Northern Territory Adaptation Action Plan, due for completion by the end of 2011.

Thank you for the opportunity to contribute to this important Inquiry. The contact in relation to this matter is Dr Alaric Fisher, A/Director, Biodiversity Conservation Division, Department of Natural Resources, Environment, the Arts and Sport, phone: and email:

Yours sincerely

PAUL HENDERSON

29 JUL 2011

Northern Territory Government

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House of Representatives
Standing Committee on Climate Change, Environment and the Arts

Inquiry into Australia's biodiversity in a changing climate

Submission by the Northern Territory Government

July 2011

The response of the Northern Territory Government to the global challenge of climate change is detailed in the *Northern Territory Climate Change Policy 2009*[1] (the policy) which was developed in consultation with the Territory community. The Policy sets out an action plan that emphasises the leadership of government, but recognises that meeting the challenges of climate change is a partnership between government, business and the whole community. Headline actions under the plan are:

1. By 2018, the Territory Government will be carbon neutral.
2. By 2020, at least four million tonnes of carbon per year will be removed from the atmosphere through better land management. Working with business, landholders and the community the Territory can become a major player in the emerging carbon economy, assisted by the establishment of new Carbon Fund arrangements.
3. The Territory will be a low land-clearing jurisdiction, protecting the 'carbon bank' in our landscape. The rate of clearing will be contained. The government will introduce native vegetation legislation to protect Territory vegetation.
4. By 2020, the Territory will be a world leading generator of renewable and low emissions power in remote communities.
5. The Territory will be at the forefront of efforts to save the best of our priceless coastal wetlands, at risk from rising sea levels – through specific interventions aimed to reduce salt water intrusion, protect fishing and save biodiversity.

The policy details a total of 40 actions. While progress on each of these actions will likely ameliorate the potential impact of climate change on the biodiversity of the Northern Territory, targets of particular relevance are those relating to land management and to building ecosystem resilience to climate change:

Target 14: By 2020, the Territory Government will work with business and the community to establish a carbon offset industry in the Northern Territory, removing four million tonnes of carbon per year from the atmosphere through land management based carbon offsets.

Target 15: Establish new carbon fund arrangements to provide financing for investment in land management, renewable energy technology and other sustainability programs in the Territory.

Target 16: Territory land managers will be at the forefront of sustainable land management, running economically and environmentally sustainable businesses that are ready to grasp opportunities from carbon storage in the land.

[1] Available at www.greeningnt.nt.gov.au/climate/policy.html

Target 18: Support landholders to use carbon offset markets to reduce the emissions from savanna burning by 500 000 tonnes per year by 2030.

Target 20: Immediately reduce the impact of feral camels on vegetation in arid environments and, by 2015, achieve measurable improvements in carbon sequestration.

Target 35: By 2011, develop a Territory Climate Change Adaptation Action Plan.

Target 36: Take conservation efforts into the 21st century by partnering with landholders to create Territory Eco-link, a 1600 km conservation corridor from the tropics to the desert that will link our national parks and provide the buffer that species need as they adapt to the changing climate.

Target 37: The Territory will be a low land-clearing jurisdiction, protecting the 'carbon bank' in our landscape. The rate of clearing will be contained. The government will introduce native vegetation management legislation to protect Territory vegetation.

Target 40: By 2013, develop, test and select new methods to rehabilitate damaged wetlands and protect the Mary River freshwater wetlands and their carbon stores from the risks of rising sea levels.

Actions and outcomes under each of these targets are described in more detail in the policy.

As indicated by Target 35, a *Territory Climate Change Adaptation Action Plan* (the plan) is currently under development. The goal of this strategic adaptation planning is to build the Territory's resilience to climate change, protecting communities, our economy and our unique natural environment. The plan will include a synthesis of the latest climate science as it relates to the Northern Territory, and will identify and assess risks from climate change to various sectors, including biodiversity and habitats.

As the plan is still under development, it is not possible to provide detail of potential adaptation strategies. However, background information about the potential impacts of climate change on biodiversity in the Northern Territory, which has been compiled for the draft plan, is included in this submission (**Attachment 1**), as it may be of assistance to the Inquiry.

One issue of importance for the Inquiry is 'nationally important ecosystems'. While all Territory ecosystems and many species will potentially suffer some negative impacts from climate change, the attached review identifies the following as likely to be particularly at risk:

- Coastal floodplains (these ecosystems are of particular significance, due to the high cultural and economic value, as well as the rich biota associated with them);
- Sandy beaches and dunes (particularly as nesting habitat for threatened marine turtles and seabirds);
- Mangrove communities and near-coastal forest (if there is an increase in the frequency and intensity of cyclones)
- Seagrass meadows ;
- Fire-sensitive communities;
- Water-dependent ecosystems in central Australia; and
- Relictual communities associated with mountain ranges in central Australia.

ATTACHMENT 1

Background Information – Climate Change and Biodiversity in the Northern Territory[2]

1. Introduction

The Territory's biodiversity and natural environments form the foundation for much of our lifestyle, industry and culture. To a large extent, they define the "feel" and image of the Territory, what makes the Territory distinct. The Territory's nature is indissolubly part of the essence of Indigenous culture. The integrity of our natural environments is essential for the health, productivity and flows of our water resources, the health of our soils, and the quality of the air that we breathe.

Climate dictates much of the character of the Territory's natural landscape. The Territory's terrestrial environments form a long but shallow gradient in species composition and vegetation structure, driven principally by latitudinal variation in the amount of annual rainfall. In the tropical north, the extreme wet-dry (monsoonal-driven) seasonality exposes floodplains to regular drying and flooding cycles, and the nesting of magpie geese, freshwater turtles and crocodiles is tightly synchronized to this periodicity. Watercourses flood and dry in routine annual cycles. Plant communities in the Top End comprise species that can withstand the annual droughts and flooding rains, and the frequent fires that are inevitable under a regime of high incidence of lightning strike, high temperatures, and long rain-free periods. In the low rainfall areas of central Australia, plants and animals may be exposed to recurring periods of multi-year drought, with adaptation traits including the capacity to respond to and recruit rapidly in occasional intermittent high rainfall years or events. Superimposed on the broad latitudinal trend in climate, local topographic variation may also strongly influence micro-climate and hence the distribution and persistence of individual species (although the Territory's topographic variation is relatively subdued compared with alpine environments that are the focus of much climate change considerations elsewhere). So, sheltered gullies and springs in the rocky ranges of central Australia may provide moderating refugial areas in an otherwise climatically harsh landscape; the peaks of those ranges may have unusually cool night-time temperatures, providing conditions suitable for species more typical of less arid climates; and the rugged and deeply dissected topography of the sandstone plateau of western Arnhem Land can offer both some protection from fire and an extraordinary local variety of micro-climates. The Territory's marine ecology is also linked to climate-driven annual cycles (that mediate freshwater inflows in the wet season, and annual changes in coastal water temperatures), less regular fluctuations (notably the regional and global scale oscillations in sea surface temperatures associated with El Nino Southern Oscillation events and oceanic current processes), and episodic disturbances (such as cyclones).

The Territory's present-day biodiversity and natural environment is a legacy shaped by a long history over which monsoon-driven seasonality has dominated the climate, nuanced by past climatic variation. Changes in rainfall and fire regimes, in association with the arrival of

[2] This is an edited extract of material prepared for the draft *Territory Climate Change Adaptation Action Plan*

Aboriginal people, led to the destruction of a rich megafauna (large birds, reptiles and mammals) across the Territory over the last 50,000 years. Fluctuations in rainfall over the last 20,000 or so years have driven extensive ebbs and flows in the spatial patterning of vegetation, with lower more open woodlands extending to the northern coastline 10,000 to 20,000 years ago. Changes in sea level have dramatically altered the Territory's ocean dynamics and coastline: most notably, the "land-bridge" connection from Arnhem Land to New Guinea, and a vast freshwater system in the centre of the Gulf of Carpentaria, have been repeatedly exposed (most recently about 12,000 to 8,000 years ago) and flooded. The distinctive and biodiversity-rich floodplains of the Top End are a very recent phenomenon (about 8,000 to 5,000 years old). These past climatic changes have shaped and winnowed the Territory's biota, leaving now a relatively robust and resilient set. And across this turbulent history, many terrestrial plant and animal species have found refuge in the most rugged landscapes, where climatic extremes can be moderated or species can make localized shifts to exploit the diverse range of local micro-climates. These refugial areas are now home to many of the Territory's most distinctive, endemic and "old" species.

Major threats to biodiversity in the Northern Territory include fire, weeds, feral animals, intensive land use and disease. The extent, incidence and impacts of some of these factors may be exacerbated (or ameliorated) by climate change. Conversely, the resilience of ecological systems to climate change impacts may be more readily moderated or constrained if other threats are controlled.

Current climate change is probably implicated to some extent in the "thickening-up" of vegetation in parts of the Top End (such as the Victoria River District), and recent increase in atmospheric CO_2 concentration is implicated in the localised expansion of rainforest patches (and other denser vegetation types) in the Top End over recent decades. Recent incremental sea level rises are largely responsible for the continuing up-river expansion of some mangrove communities; and have contributed to the saltwater intrusion of some floodplain communities, leading to significant mortality for freshwater-associated plant species. Recent incidences of coral bleaching in Territory seas have been caused by episodes of unusually high sea temperatures.

Predicting impacts of climate change on natural environments is particularly challenging. Natural systems work as complex interconnected webs, with many interdependencies. Species vary individually in their preferred range and tolerance limits to any or all of the individual components that together make up climate. And species may respond to climate changes in very many ways, including in behaviour, physiological adaptation, growth rates, diet, breeding seasonality and reproductive output, susceptibility to disease, and distributional range. Inevitably, any climate change will benefit some species, but disadvantage others. Advantage may be more likely in species with greater genetic heterogeneity, because it offers more scope for evolutionary adaptation. A species' response may be direct (to one of the constituent climatic variables, such as length of dry season) or indirect (such as through changed competitive advantage with another species, or alterations in the key phenological (e.g. flowering or seeding) patterns of a plant that forms a pivotal resource for consumer species, such as butterflies or honeyeaters). For some migratory species (such as the shorebirds which visit our coastlines and wetlands), climate changes in the Territory may be inconsequential, yet we may lose these species if more

severe climate change elsewhere in their migratory range is intolerable. Furthermore, climate change will affect not only individual species, but also the ecological processes (such as hydrological flows, and fire) that structure and determine how environments work.

Weeds, pests and diseases may also be affected by climate change, with potential for changed climatic conditions to increase for some species the likelihood of their arrival to the Territory, their spread or their impact.

2. Future climate change impacts

2. 1 Risks from increased temperature and extreme events

Temperature increases will affect biodiversity, but the impacts may vary depending upon whether such increase occurs in particular seasons or is year-round, whether it relates to increases in day-time maxima or night-time minima, whether it reflects a few instances of extreme heat events, or whether it involves sustained periods of marginally hotter weather. Increases in temperature may affect biodiversity through increased incidence of extremely hot days (where ambient temperatures may surpass the physiological tolerance of individual species), through raised sea surface temperatures (notably driving coral bleaching), increased length of hot spells, warmer night-time temperatures (and reduced incidences of frost), changes in birth sex ratios for some reptile species (such as crocodiles and turtles) with temperature-dependent sex determination, increases in evaporation rates (and hence more rapid rates of desiccation in temporary water sources), and increases in fire intensity. For many components of biodiversity, there is insufficient information available to predict responses to increased temperatures.

2.1.1 Northern Region

In the Top End, annual average temperatures are expected to rise by 1°C by 2030, and 1.5-2.5°C in by 2070[3]. The major impact of such change is likely to be an increased incidence and severity of fire, with reduced controllability and increased impacts on fire-sensitive species and environments. Such increase will occur because the vegetation will be more desiccated (and for longer), and because fire intensity is influenced in part by ambient temperature.

Change in sea surface temperature are not necessarily closely linked to air temperature, but it is likely that there will be increases in the incidence of very warm waters, with consequential increases in coral bleaching and hence reduction in the biodiversity of the Territory's significant coral reef environments. It is possible that some corals may be able to moderate impacts through gradual movement to deeper (and hence cooler) waters, but there is little certainty about such responses.

Increases in temperature around egg clutches may lead to dramatic changes in sex ratio for nestling marine turtles and some other reptiles (and hence eventually to overall decline for

[3] Climate change projections used in this report are from Hennessy *et al.* (2011). *Climate Change in the Northern Territory*. The Centre for Australian Weather and Climate Research.

such species). However, it is possible that nesting reptiles may be able to moderate temperatures around nest sites through behavioural changes (e.g. digging deeper nest cavities) or changing nesting periods. Increased air temperatures may also lead to increased water temperatures in swamps, lakes and other water bodies, with potential changes in aquatic vegetation composition and condition, and changed reproductive success in breeding invertebrates and fish.

Increases in temperature may cause increases in direct mortality for some species for which current temperatures are already near a critical physiological threshold. Elsewhere in Australia, there is much anecdotal evidence of high levels of mortality of some bird and other animal species associated with bouts of unusually hot weather, but there is no substantial record from the Top End.

2.1.2 Southern Region

In central Australia, annual average temperatures are expected to rise by 1.2°C by 2030, and at least 3°C in by 2070. In an area where the climate is already marked by long periods of extreme heat, such further increase will place very significant stress on many species, environments and ecological processes. It is likely that such increases (especially if they relate mainly to increases in day-time maxima) will exceed critical physiological thresholds for many species, rendering central Australia uninhabitable for some species currently existing there. The impacts may be particularly on diurnal species and those with high water use or metabolic rates.

As in the Top End, higher temperatures are also likely to lead to more intense and frequent fires, with increased impacts on fire-sensitive species and ecological communities. For example, recent modelling has indicated that plausible increases in fire frequency associated with predicted increased temperature will lead to significantly greater risk of extinction for the threatened waddy-wood *Acacia peuce*, a distinctive tree endemic to the north Simpson Desert region. The current fire regime is considered to be a major threatening factor for a high proportion of central Australia's threatened species; so any increase in fire intensity or frequency is likely to magnify detrimental impacts on these species.

Notwithstanding the relatively low altitudinal range, the mountains of central Australia support some (largely relictual) species restricted to the highest zones or most sheltered sites. The mechanism determining this altitudinal restriction is generally uncertain, but is likely to be related at least in part to temperature regimes; and such montane species may be unable to tolerate temperature increases, or may become competitively inferior under such changes.

SUMMARY: BIODIVERSITY AND ENVIRONMENTAL IMPACTS DUE TO TEMPERATURE CHANGES

- Increased incidence (and impacts) of fires
- Reduction or loss of coral reefs, through bleaching
- Decline through altered sex ratios for reptile species with temperature-driven sex determination
- Increased direct mortality for species currently close to thermodynamic thresholds
- Decline or loss of relictual montane species in central Australia

2.2 Risks from precipitation changes and extreme events

The ecology of the Territory's natural environments is largely driven by rainfall, typically through within-year regular cycles of wet and dry in the Top End, and longer rhythms of drought and wet years in central Australia. Average annual rainfall is a blunt descriptor of the complex ecological determinant of rainfall: many species and environments respond to, or are dictated by, the intensity of rainfall events, the timing of onset and finish of the wet season, the intensity and duration of drought, the extent of inter-year variability in rainfall patterning, or the spatial occurrence of rainfall events. For example, the date of onset and pattern of subsequent rain events determines the starting date of nesting in magpie geese and crocodiles, and whether nests are subsequently destroyed by floodwaters or are successful. The timing of early wet season rains may also determine whether the regular lightning storms of the build-up season cause widespread fire or are rapidly extinguished. Particular rainfall events may trigger widespread ecological shifts, such as the episodic invasion of grasslands by cohorts of paperbarks (*Melaleuca* species). Coastal and marine environments may also be affected by changes in rainfall amount and patterning: for example increased intensity of flooding may cause sea grass meadows near river mouths to be buried under sediments, with consequent reduction in habitat suitability for dugongs and some marine turtle species.

2.2.1 Northern Region

The projections indicate relatively small shifts in rainfall in the Top End, albeit with considerable uncertainty. Rainfall is likely to reduce by a small percentage in "winter" (by about 4% in 2030 and 7-13% in 2070) and "spring" (by about 5% in 2030 and 8-15% in 2070) (more familiarly, the mid-late dry season), and the incidence of extreme rain events is likely to increase. The impacts on biodiversity and natural environments are difficult to predict, particularly so given that many factors make up the rainfall "package". However, the dry season in the Top End is a time of considerable stress for many plant and animal species, and any reduction in rainfall over that period is likely to lead to reductions in survivorship. This may reduce continuity and persistence in some water courses, and affect particularly species that aestivate (such as some freshwater turtles), plants with relatively high water demands (e.g. evergreen trees rather than dry-season deciduous trees), and species that are dependent upon semi-permanent water sources, but many other plant and animal species (feasibly, such as cane toads) may also suffer from reductions in moisture availability over the mid-late dry season.

Reduced rainfall in this time may also contribute to more intense, extensive and frequent fires, because vegetation fuel will be more desiccated and there will be a landscape-wide reduction in watercourses which may otherwise form natural fire breaks.

An increased incidence of extreme rainfall events (and associated increased incidence of severe flooding) may lead to degradation of some river systems (and their associated riparian vegetation), and increased levels of sediment deposition in some estuaries and coastal waters.

2.2.2 Southern Region

The predicted reduced rainfall in central Australia will have significant detrimental consequences for biodiversity and natural systems. Reduced rainfall will further stress the refugial waterbodies and aquifers that are the lynchpin for much of central Australia's ecology. Rainfall reduction will decrease the number of such water sources, and reduce their persistence time. It will lengthen the time between, and reduce the intensity of, the floods that episodically renew ecological processes in central Australia, and trigger major recruitment events.

In central Australia, the length of drought is critical; if longer than the aestivation time for burrowing frogs or land-snails, the duration of seed dormancy of plants, or the longevity of species (such as the banded stilt) that breed only in the very irregularly-filled inland lake systems, these species may be lost from the system. If droughts are spatially extensive, there may be diminishingly few options for central Australian species that seek to disperse from drought-affected to more favourable areas.

In central Australia, reduced rainfall may lead to a reduction in fire frequency, but occasional high rainfall years are likely to still occur and will trigger unusually productive plant growth; and such episodic high fuel loads will lead to lead to intense fires in the following dry periods.

SUMMARY: BIODIVERSITY AND ENVIRONMENTAL IMPACTS DUE TO RAINFALL CHANGES

- Increased incidence (and impacts) of fires
- Increased stress on Top End species over the dry season
- Reduced continuity and persistence in water courses
- Increased degradation of rivers and riparian systems
- Sediment deposition on sea grass meadows
- Decline of water sources in central Australia, and the many species that are dependent upon them

2.3 Risks from sea level rise

The Territory's coastal ecological communities are by definition frontier environments, which have long been dynamic, responding to changes in sea level and other climatic factors. Nonetheless the likely pace of future change may outstrip much of the historical bounds of

that dynamism and de-couple many of the strongly interactive ecological connections that characterise the land-sea interface.

The natural value at most risk is the coastal floodplain environment, because of its proximity to the sea, because it is of low elevation, because it is of very limited topographic relief, and because the underlying black-soil plains can't readily move or reconstitute themselves in the steeper terrain of the mid-catchment of coastal rivers. Even very small rises in sea level may lead to broad-scale saltwater intrusion across much of this floodplain environment. This is of considerable concern, given that the floodplains are extraordinarily productive, and provide the key habitat for much of the Top End's iconic wildlife, including magpie geese, saltwater crocodiles, freshwater turtles, and barramundi.

Sea level rise may also threaten some of the Territory's islands. As elsewhere in Australia, many of these islands currently provide a very significant conservation haven, particularly for species threatened by factors that are pervasive across mainland areas (such as predation by feral cats). With sea level rises, some low-lying islands will disappear, and the area of some other islands will decrease.

Rapid sea level rise may also reduce or degrade sandy beach environments. Currently, many Territory beaches are of international significance for conservation, because they support large populations of breeding seabirds and/or important breeding sites for threatened species of marine turtles.

Some marine environments themselves may be detrimentally affected by sea level rise. The most notable such case may be coral reefs, whose occurrence in Territory waters is determined by the spatial distribution of appropriate substrates, tidal range, water depth and turbidity. The ability of coral reefs to move to track suitable water depths is uncertain, particularly if constrained by the patchy occurrence of suitable substrates.

SUMMARY: BIODIVERSITY AND ENVIRONMENTAL IMPACTS DUE TO SEA LEVEL RISE

- Decline or loss of floodplain environments, and their iconic biota
- Diminution or loss of islands, and their associated conservation values
- Decline or loss of sandy beaches and dunes, and their associated values as nesting sites for threatened marine turtles and seabirds
- Decline or loss of coral reefs

2.4 Risks from other factors associated with climate change

Cyclones are a major disturbance event in coastal northern Australia; and their subsequent inland traces may provide drenching rains across central Australia. There is little certainty about future trends in their frequency and intensity. The most plausible prediction is for little or no change in frequency but possible increases in intensity. Cyclones have major impacts on ecological systems, with the impacts broadly proportional to cyclone intensity and frequency. If the future holds more intense cyclones, then Top End eucalypt forests may become reduced in structure, and mangrove communities may be more extensively degraded. High intensity cyclones may also damage marine systems: for example, cyclones

over the last few decades in the Gulf of Carpentaria have caused mass strandings and deaths for dugongs and marine turtles, and damaged sea grass beds.

A major driver of global climate change is increased CO_2 in the atmosphere. This itself has direct impacts on biodiversity. Much is absorbed in the ocean, and has led to (and will continue to lead to) increased acidification of oceans. This increased acidification has direct detrimental impacts on much marine life, particularly through reducing growth rates in corals, and reducing viability in some shell-building molluscs.

Increased CO_2 in the atmosphere also affects the growth rates in terrestrial plants, with this increase (and hence competitive advantage) variable across different species. A major dichotomy amongst plants relates to their photosynthetic pathways, with one group ("C3 plants", which tend to be more temperate and cooler-adapted) likely to gain a competitive edge with increasing atmospheric CO_2 concentration over the remainder ("C4 plants"). This could prompt broad-scale shifts in plant communities, especially for grass species. Increased atmospheric CO_2 levels may already be driving some vegetation changes in the Top End, particularly expansion of rainforest and increases in woody biomass in eucalypt forests and woodlands.

SUMMARY: BIODIVERSITY AND ENVIRONMENTAL IMPACTS DUE TO CHANGE IN CYCLONE ACTIVITY, AND CO_2 CONCENTRATION

- Degradation of coastal and near-coastal mangrove and eucalypt forest communities
- Decline or loss of coral reefs
- Changes in plant species composition (mostly at the expense of "C4" plant species)
- Increase in some vegetation communities (including rainforest)

3. Summary of risks

Much of the Territory is already an extreme environment, controlled by long drought and episodic floods in central Australia, and extreme intra-year seasonality in the Top End. While evolution has long filtered the biota to a relatively robust set that is capable of dealing with these conditions, it is difficult to predict how much more stressed these systems will become, or whether future climate change will push some species beyond their physiological tolerances, behavioural capability or other adaptive responses. It is likely that the rate and extent of climate change will outstrip the response capability of some species.

In addition to risks associated with the individual climate change parameters described above, it is almost certain that any changes in climate will increase climatic suitability for some weed, pest or disease species (and conversely may decrease suitability for other weed, pest or disease species). This may mean that some existing "sleeper" non-native species (those currently with little or no rate of spread or impact) may rapidly become highly invasive. Furthermore, climate change in the regional neighbourhood (particularly in south-eastern Asia), coupled with increased incidence of extreme climatic events, may mean that new pest, weed and disease species are likely to arrive in the Territory in the future.

The major risks to biodiversity and natural environments are summarized in the following table.

Risk	Driver	Notes
Increased impact (particularly on fire-sensitive species and environments) from increased frequency, intensity and extent of fire	Increased temperature; reduced rainfall (central australia); reduced late dry season rainfall (top end)	Already a major threatening factor for many species
Reduction or loss of coral reefs, and their associated diverse communities	Increased sea temperatures; ocean acidification	Some possibility of natural adaptation response
Reduction or loss of reptile species with temperature-controlled sex determination	Increased temperature	Considerable uncertainty about capability for natural adaptation response
Decline or loss of species already close to thermodynamic thresholds	Increased temperature	Very little existing knowledge of such thresholds
Decline or loss of relictual montane species in central Australia	Increased temperature (directly); changed fire regimes (indirect); reduced rainfall	Little existing knowledge of determinants of range
Decline or loss of water-dependent species and ecosystems in central Australia	Increased temperature (directly); reduced rainfall	
Decline or loss of continuity and persistence in river systems (including riparian vegetation) and other water sources	Reduced rainfall; increased temperature; increased incidence of extreme floods	
Decline or loss of sea grass meadows, and the species associated with them	Increased incidence of extreme floods	
Decline or loss of coastal floodplain environments	Sea level rise	
Diminution or loss of islands, and their associated conservation values	Sea level rise	Most of the high conservation value islands are large and have moderate altitudinal range
Decline of sandy beaches used for nesting by turtles and seabirds	Sea level rise	
Degradation of mangrove communities and near-coastal forest	Increased intensity of cyclones	
Change in vegetation communities, particularly decline or loss of "C4" plants	Increased atmospheric CO_2	Relatively little existing information to predict changes and consequences in this region
Invasion of "new" pest, weed and disease species; or increased incidence, range and impacts of existing such species	Changes in rainfall, temperature; increased stress on native species and environments; increased incidence of extreme events	Currently, uncertain what unwanted species will prosper, but undoubtedly new pest threats will emerge