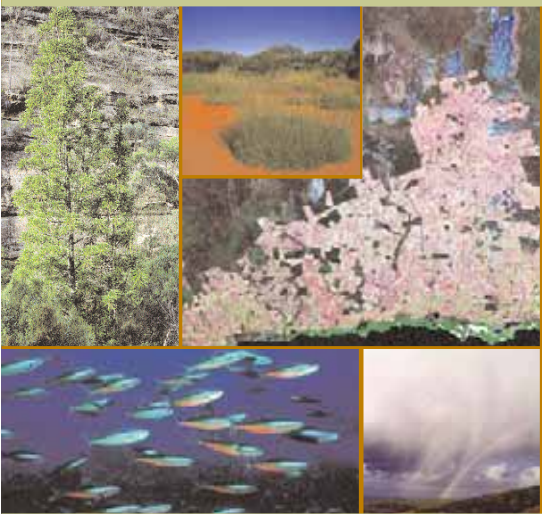


# 2004–2007



## National Biodiversity and Climate Change Action Plan

Natural Resource Management Ministerial Council

Australia is one of the most biologically diverse countries in the world, with many species that are found nowhere else on the planet. This biological diversity (biodiversity) is largely as a result of the diversity in Australia's climate. Consequently, any changes to Australia's climate resulting from human-induced climate change will affect Australia's biodiversity in a substantial way over the coming century.

While many of the changes are already occurring, there are actions we can take to reduce the negative impacts on biodiversity from human induced climate change.

Australia's federal and state governments have developed a National Biodiversity and Climate Change Action Plan to address this issue (see website <http://www.deh.gov.au/biodiversity/publications/nbccap/index.html> for more information). This brochure explains how Australia could be affected by climate change and what we might do to help our species and ecosystems adapt to the impacts of climate change.

### Everyone's responsibility

The National Biodiversity and Climate Change Action Plan has been developed

to help coordinate the efforts of the nation's different groups.

Land and water managers, planners and policy makers at national, state and territory, and local level will need to work together to deal with the impacts of climate change on biodiversity. They will need to integrate the strategies and actions outlined in the action plan with broader biodiversity policies and programs including on-the-ground conservation activities.



Pearson's tree frog, Moon River, Queensland (Picture: HB Hines).



Everyone will need to pitch in to protect Australia's biodiversity from climate change. Snowgum regeneration in the ACT (Picture: Joseph Lafferty) and taking morphological measurements on Heard Island (Picture: Kate Kiefer Australian Antarctic Division)

## How do humans contribute to climate change?

Many human activities produce gases (called greenhouse gases) that can reduce the amount of infrared radiation from the sun (ie heat) that can escape from our atmosphere. This effect can increase temperatures and produce an enhanced 'greenhouse' effect (ie the earth's atmosphere traps the heat just like the glass in a greenhouse).

Because the earth's climate system is finely balanced, increased temperatures in the lower atmosphere can cause changes to the weather and climate worldwide. Consequently, the enhanced greenhouse effect is often referred to as global warming.

But climate change is more than a warming trend. Increasing temperatures will lead to changes in many aspects of weather and can cause changes in the amount, type, and seasonal patterns of rain, and the types and frequency of severe weather events such as droughts and floods.

## How has the climate changed?

### Globally

The climate worldwide has changed over the last century. For example, since

1900, the average surface temperature of the earth has risen by about 0.6°C, there have been more heat waves and heavy rainfalls, there have been fewer frosts, glaciers and sea-ice have retreated as the oceans have warmed and sea levels have risen by 10–20 cm. The last ten years formed the warmest decade globally, and 1998 was the warmest year since temperature records with adequate global coverage began in 1861.

### In Australia

Over the last 100 years, there have been changes in Australia's rainfall and temperature.

Over the country as a whole, the average annual rainfall has increased slightly, but this disguises regional differences. For example, rainfall has increased in tropical parts of Australia and in eastern New South Wales, but has declined in parts of eastern Queensland, the South-West region of Western Australia and isolated parts of the southern fringe of Australia.

Much of Australia has seen an increase in both maximum and minimum temperatures over the last 100 years, particularly since the mid-1900s. As with rainfall, there are regional differences in temperature, although overall the direction of temperature trends is more stable than for rainfall. Western areas of Australia have experienced the stron-

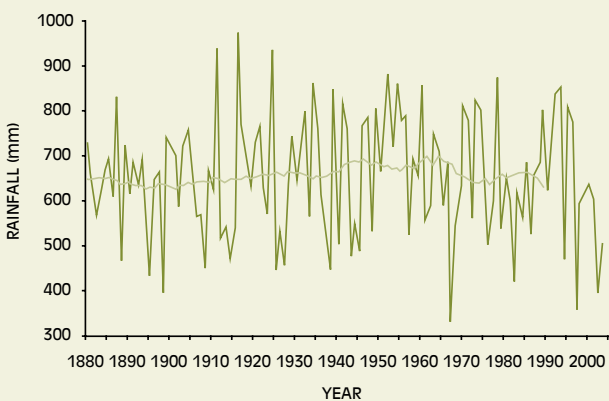
gest increases in daytime maximum temperatures, while parts of central and eastern New South Wales, and southern Queensland have recorded weak daytime cooling trends. Overnight temperatures have increased throughout Australia, with minimum overnight temperatures increasing by a greater amount than daytime temperatures.

## What might we expect in the future?

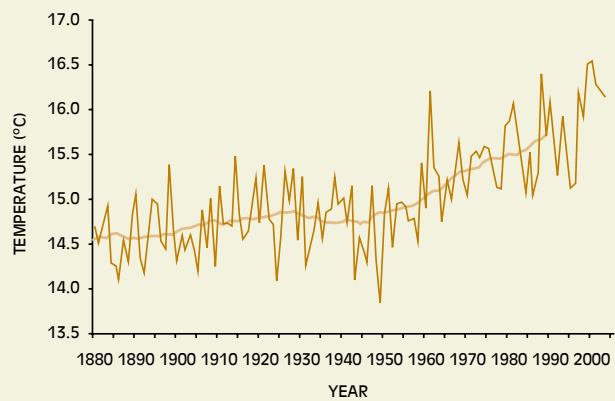
The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has used computer modelling to project climate changes for the Australian region. The latest projections, relative to the average climate of 1990, can be summarised as follows (see also CSIRO website <http://www.dar.csiro.au/publications/projections2001.pdf>):

- most of Australia could warm by 0.4–2.0°C by 2030 and by 1–6°C by 2070
- annual rainfall could decrease in the south and east (mainly in winter and spring), but summers may be wetter in some inland and eastern coastal areas
- evaporation could increase, during all seasons, by up to 8% annually for each degree of global warming over most of Australia
- extreme rainfall and tropical cyclones could become more intense.

Melbourne annual rainfall



Melbourne annual mean temperature



Historical record of annual rainfall and mean temperature for Melbourne. It is evident that while there appears to be no significant long-term trend in rainfall, there has been a significant warming trend since the 1950s. Some of this warming is due to the so-called 'urban heat-island' effect (*Bureau of Meteorology*).

# Australia's biodiversity

## What is biodiversity?

Biodiversity is the abundance of all life forms, that is, the different plants, animals and microorganisms, their genes and the terrestrial and aquatic communities (called ecosystems) in which they live.

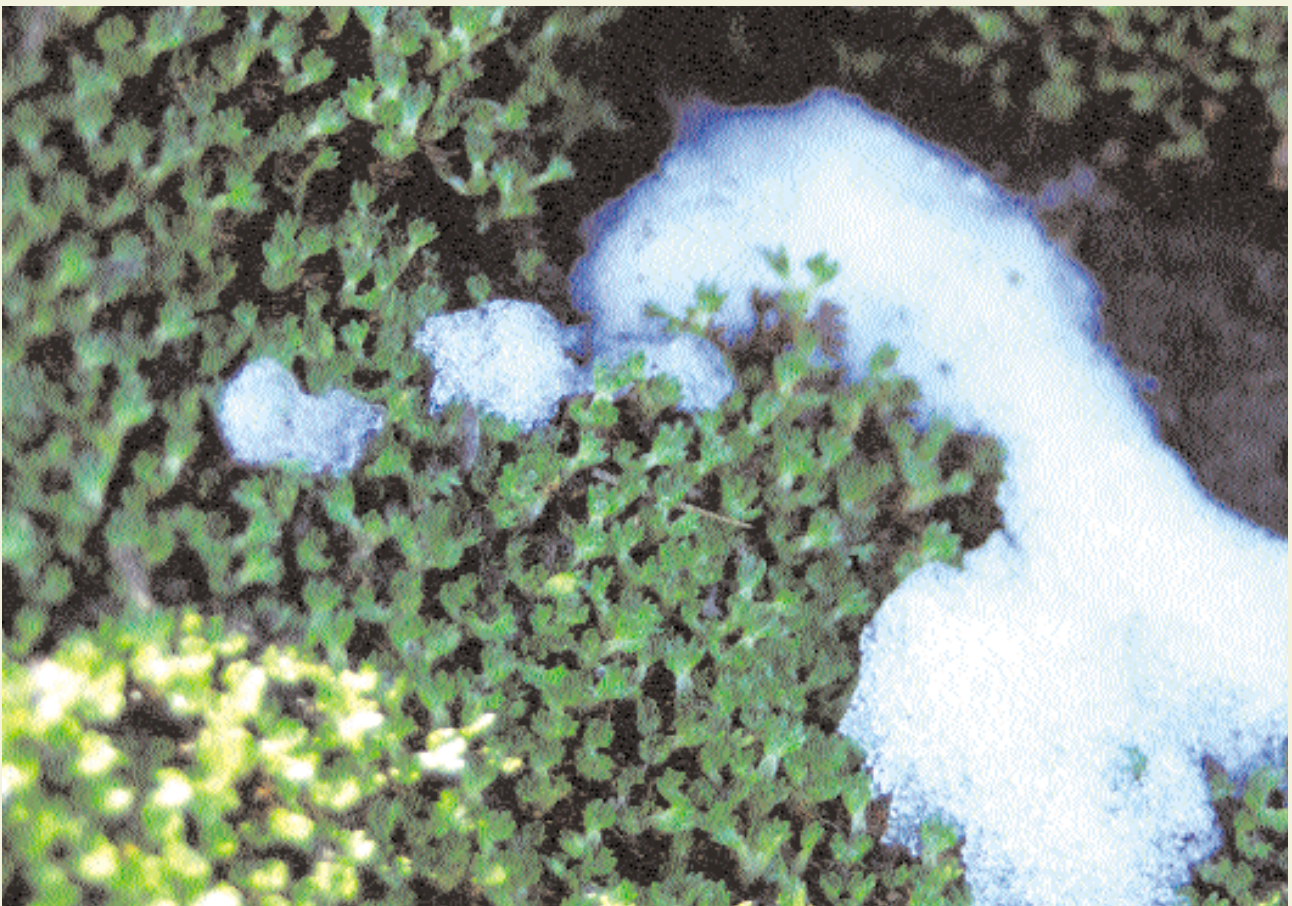
Biodiversity is vital to all Australians — it defines our ecological systems and landscapes, and is a fundamental part of Australia's identity. Ecosystems process our air and water and contribute to our national economic wealth through agriculture, forestry, fisheries, biodiversity and tourism. Biodiversity has immeasurable social, cultural and aesthetic values.

## How might climate change affect our biodiversity?

There is reasonable agreement among scientists that climate change is already affecting species and ecosystems, and will continue to do so. However, there is much uncertainty about how individual species and ecosystems might respond to climate change in the future. Some studies suggest even moderate climate change will cause substantial changes in species distribution, reproduction, growth and interactions. Furthermore, the impact of other stresses (habitat clearing, grazing, water extraction) will greatly reduce the ability of biodiversity to adapt to climate change naturally.

The 2001 report of the United Nation's Intergovernmental Panel on Climate Change concluded that Australia's biodiversity is highly vulnerable to the changes in temperature and rainfall that are projected to occur over the next 100 years. This is partly because many Australian species have quite a limited range of climate in which they can survive.

Climate change would pose a threat to any species found in areas that are near the upper limit of their temperature range or in areas from which they cannot migrate. Especially vulnerable areas are the Australian Alps (see Box 1), coral reefs (see Box 2), South-West Western Australia (see Box 3), upland tropical rainforests (see Box 4), arid and semi-arid habitats, freshwater wetlands and riverine environments.



Native cushion-forming plant, *Azorella selago*, partially covered by a recent fall of snow on Heard Island (Picture: Kate Kiefer, Australian Antarctic Division).

### Box 1: The Australian Alps

Species most at risk from climate change are those with a limited ability to disperse, specialised habitat requirements, small populations and low genetic diversity. The ecosystems of the Australian Alps are considered to be some of the most vulnerable to climatic warming because their species are isolated and cannot move beyond the edge of their range.

For example, the 'climatic envelope' of the mountain pygmy possum, which hibernates under snow in winter, is likely to disappear if the average annual temperature increases by about 1°C. Predicted decreases in the amount and duration of snow cover in the future may affect the possum's metabolic rate, behaviour and foraging activities. The population dynamics and survival of this vulnerable species may also be affected by changes in the behaviour of predators, increased competition with other small mammals, and the potential impacts of warming on the bogong moths, the pygmy possum's major food source.

The 'climatic envelope' of many endemic alpine plant species could also disappear with a 1°C increase in average annual temperature.

#### What we can do

Management that reduces threatening processes, such as invasive predators and inappropriate fire regimes, will increase the resilience of species such as the mountain pygmy possum to climate change (see also 'What can we do to protect our biodiversity?' page 5).



Mount Hotham (Victoria) is part of the south-eastern Australian alpine area that extends from New South Wales to Victoria (Picture: Trevor J Ierino).



Mountain pygmy possum (Picture: K Stepnell, © Department of Environment and Conservation, NSW).

## What can we do to protect our biodiversity?

Under climate change, the distribution of many species and ecosystems is likely to change. Existing communities may dissolve, while new ones may form. Patterns of biodiversity in the landscape may change over timeframes as short as decades, and species that are currently 'protected' in reserves may therefore not be adequately conserved in the future.

We therefore need to:

- help the natural adaptation of species to climate change
- protect species that are particularly vulnerable to climate change.



Protected Areas need to reflect the different climatic gradients (eg in higher-relief landscapes) in order to assist adaptation to climate change. Yathong Nature Reserve, New South Wales (© Department of Environment and Conservation, NSW).



Even small patches of vegetation can, if networked, provide critical habitat for vulnerable species (Picture: © CSIRO Land and Water).

## Helping species adapt to climate change

We can take some actions that may make species and ecosystems respond better to climate change. Such 'adaptations to climate change' could include planning and management interventions that would better protect our biodiversity and help build its resilience (ability to cope) to climate change.

### Create networks of protected areas

Australia has a well-established National Reserve System that uses protected areas (such as national parks and other types of conservation areas) to conserve our biodiversity. These protected areas are formally managed for this purpose, and are particularly effective where they can reduce threatening processes.

Protected areas can also be used to facilitate natural adaptation of biodiversity to climate change. Protected areas can be networked and linked within regions and over the whole country. In order to help adaptation to climate change, such networks would need to incorporate the different climatic gradients (eg in higher-relief landscapes) and increase the number of species that are represented in the protected areas.

## Build resilience to climate change

The resilience of an ecosystem is a measure of its ability to withstand and recover from environmental stresses and disturbances. The healthier an ecosystem is, the greater its resilience. Because climate change will cause species distributions to shift, resilience also includes the capacity of a species to move to other localities. To improve the resilience of ecosystems we need to reduce the pressures on them. This could include reducing weed incursions or fragmentation of vegetation by land clearing. An improved resilience will increase the likelihood that species living in the area will survive climate change.



Large degraded areas are being replanted with up to 100 different native species of trees, shrubs and grasses after removal of environmental weeds. Tallebudgera Estuary, Elanora Wetlands, Queensland (Picture: Ryan Photography).

## Protecting species that are particularly vulnerable to climate change

We can take several actions that can be included in the design, planning and establishment of protected areas to help biodiversity adapt better to climate change. To do this, we will need special tools (eg models and computer programs) to help predict the impact of climate change on our ecosystems and species. Such tools can also help us identify the areas that need to be protected and the species that will be most vulnerable to climate change.

### Create refuges

Refuges are natural areas where species may survive the immediate impacts of climate change and from which they may disperse to colonise new locations as environmental conditions allow. Refuges can protect small populations, geographically restricted populations, or remnant populations. They may act as sources from where species can expand again in new climatic conditions. When planning and designing protected areas, we need to identify the refuges that need to be managed.



Small pockets of remnant vegetation can act as refuges for species vulnerable to climate change. Protecting and enhancing these critical habitats is a key aim of the action plan. Wongarbone Nature Reserve, New South Wales (Picture: A Fox, © Department of Environment and Conservation, NSW).



The nationally endangered southern corroboree frog has an extremely limited distribution, restricted to subalpine areas in the Australian Capital Territory and Kosciuszko National Park in the south of New South Wales (Picture: D Hunter, © Department of Environment and Conservation, NSW).

### Create buffer zones

Buffer zones are areas around key habitats that provide a transition from the outside of the reserve to the unmodified natural habitat in the core reserve where no human disturbance is allowed. These zones provide a degree of protection from threatening processes and impacts.

Buffer zones may significantly increase the ecological resilience of a protected area, and are especially important for protected areas that are small and vulnerable. To maximise future conser-

vation of biodiversity we need to identify locations that need buffer zones.

### Find the best management techniques

To identify the best technique to protect each of our most vulnerable species (eg in cases like fire management, grazing, regeneration of habitats) we will need to conduct experiments of different management techniques. To do this well, we need long-term monitoring and evaluation programs.



Revegetation at Toolibin Lake in Western Australia (Picture: Dept of Conservation and Land Management, WA, 1995–96).

## Box 2: The Great Barrier Reef

Climate change poses particular risks to species that are already vulnerable, such as those that are restricted to islands, peninsulas, small reserves or coastal areas.

Reef corals are one group of organisms that are very sensitive to changes in sea temperatures outside their normal range. Temperatures of 1–2°C above the long-term average summer maximum are enough to cause coral bleaching in many of the dominant coral species.

The Great Barrier Reef experienced major coral bleaching in 1998 and 2002 (see below for more information on coral bleaching). In the summer of 2001–2002, 60–95% of the reef was affected. Bleaching events are likely to become more frequent and more severe under predicted climate change scenarios. Other possible climate-related effects include increased wave energy and changes in the frequency and intensity of tropical cyclones and pest outbreaks.

The reef may also be affected by the changing atmosphere; for example, increased carbon dioxide levels affect seawater chemistry, reducing rates of coral calcification.

### What is coral bleaching?

Algae that live within the coral tissue provide food for the coral to grow; it is these algae that give the coral its normal healthy colour. When the water temperature increases above normal levels, the algae are expelled from the coral, which causes the coral tissue to gradually lose colour, revealing the bright white skeleton.

If stressful conditions prevail for long enough, these bleached corals will die. However, if stressful conditions abate, then the bleached corals can recover their algae and return to their normal, healthy colour. The severity of bleaching can vary substantially, depending on water depth, location and species of coral.

Coral bleaching is one of the most significant threats to the Great Barrier Reef and to the regional communities, industries and economies that depend on the reef's health.

### What we can do

Chronic environmental stresses, such as pressures from terrestrial run-off, over-fishing and losses in biodiversity, already affect the GBR. These stresses compromise the reef's resilience (its general ability to withstand and recover from environmental stresses). When the reef is weakened by chronic stresses, its ability to cope with additional climate-related stresses such as coral bleaching is also reduced.

By minimising the occurrence of chronic stresses on the reef, we can aim to ensure that coral reefs are more resilient when exposed to extra stresses associated with climate change, and have a better chance to survive and recover from events such as coral bleaching.

### What has been done

The Great Barrier Reef Marine Park Authority (GBRMPA) has established a comprehensive Coral Bleaching Response Program (2003) that is being implemented in response to the threat of climate change.

While the GBRMPA cannot directly address global climate change, it is taking action to increase the reef's chances of survival under future climate scenarios. Actions include supporting and improving the reef's natural resilience through the Reef Water Quality Protection Plan, various fisheries plans and the new GBR Zoning Plan.



Colourful night shot of a mixed community of reef organisms, including red, white, yellow and green feather stars, red-and-white gorgonians, and pink *Tubastraea* corals (Picture: V Taylor, © GBRMPA).



Coastal pollution is an indirect environmental stress on the Great Barrier Reef. Black molasses spill at the port of Townsville, Queensland (Picture: A Elliott © GBRMPA).

# What is the National Biodiversity and Climate Change Action Plan?

The National Biodiversity and Climate Change Action Plan is the first document that provides a broad framework to support adaptation to climate change across Australia, and one of the first biodiversity adaptation plans in the world. The action plan will help coordinate the activities of different Australian governments to address the impacts of climate change on biodiversity and will be an important step in coordinating national, state and territory government's climate change impact and adaptation programs.

## Objectives of the action plan

The action plan sets seven specific objectives to help our biodiversity adapt to the impacts of climate change, and specifies the actions we need to take to reach these objectives. The objectives focus on gathering knowledge (see 1 and 2), minimising impact on biodiversity (see 3, 4, 5 and 6) and incorporating knowledge and harm-minimisation strategies into the management of natural resources and land-use (see 7).

To the right and in the following pages are examples of actions that will be taken by Australian governments to address the impacts of climate change on biodiversity. The full list of actions can be found in the *National Biodiversity and Climate Change Action Plan* publication, which is available from the <http://www.deh.gov.au/biodiversity/publications/nbccap/index.html> website.

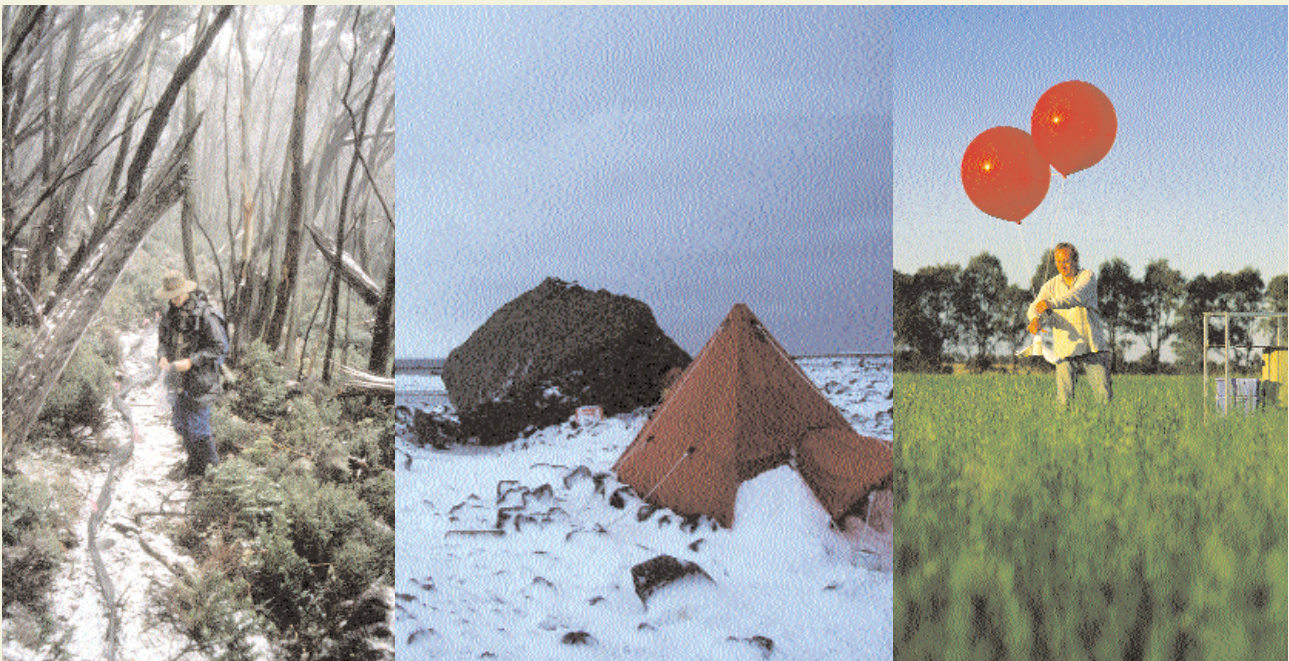
## 1. To improve our understanding of the impacts of climate change on biodiversity

We must improve our understanding of the potential effects of climate change and climate variability on biodiversity. This will require research that can fill gaps in our current knowledge. For example, we need data and models that will allow us to predict the impacts of climate change on biodiversity, and the potential effects of different adaptation strategies.

### Actions

Over the next three years all governments will:

- identify the gaps in our knowledge about climate change impacts on biodiversity and work out how these can be addressed
- refine tools to predict the impacts of climate change on biodiversity
- improve our ability to measure the economic costs of climate change impacts on biodiversity.



Research in the mountain areas of Victoria (Picture: Gregory Hollis) and on Heard Island in the Antarctic region (Picture: Kate Kiefer, AAD). A CSIRO scientist launches a weather balloon (Picture: © CSIRO Land and Water).

## 2. To increase awareness of climate change impacts and our capacity to respond

We need to increase awareness of the climate change that is already happening in Australia, its potential impacts and actions we can take to respond to climate change. This could be achieved using existing education and public awareness programs.

### Actions

Over the next few years all governments will:

- raise awareness in the community about climate change impacts on biodiversity
- develop information packages for schools about climate change impacts on biodiversity.



Cambridge Primary School at Waverley Flora Park, Tasmania (Picture: Anne Gates, 1998).

## 3. To minimise the impacts of climate change on inland aquatic and semi-aquatic ecosystems

Climate change may alter water cycles, thus affecting species and ecosystems that are dependent on inland rivers, wetlands and groundwater systems. For example, a reduction in rain may lead to reduced flows in many rivers and inland wetlands, which could threaten the reproduction of migratory birds that depend on wetlands for their breeding cycle.

### Actions

Over the next three years all governments will:

- identify the impacts of climate change on species using inland lakes, rivers and streams
- work out what actions can be taken to protect and restore inland lakes, rivers and streams to ensure the survival of species and ecosystems vulnerable to climate change.



Even small wetlands could provide important habitat in future climates. Wetlands with paperbarks and water lilies, Yellow Water Lagoon, Northern Territory (Picture: John Baker).

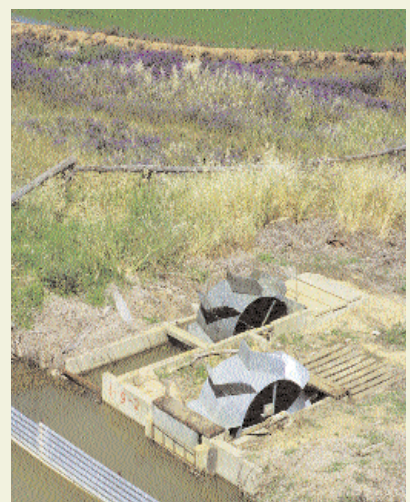
## 4. To minimise the impacts of climate change on marine, estuarine and coastal ecosystems

Climate change will lead to changes in water temperatures in the oceans, coastal seas and estuaries. Changes in water temperatures could also cause changes to water currents and circulation. These changes could significantly alter deep-ocean chemistry and dynamics, ultimately changing the distribution of many marine species. These changes will also affect the Great Barrier Reef (see Box 2) and other coral reefs globally.

### Actions

Over the next three years, all governments will:

- work out what marine, coastal and estuarine species and ecosystems are vulnerable to climate change
- consider ways to protect these species and ecosystems by, for example, reducing the impacts of other threatening processes such as water pollution.



The management of water use will be an important component of all Australian, state and territory government actions to adapt to climate change. Dethridge wheels measuring water consumption in the Murrumbidgee irrigation area, New South Wales (Picture: © CSIRO Land and Water).

**5. To minimise the impacts of climate change on native terrestrial species, communities and ecosystems**

Climate change could alter the abundance and distribution of species and the distribution and composition of terrestrial ecosystems. Indeed, the survival of some species may depend on changes to their distribution. The likelihood that these shifts will occur will be determined by the rate and degree of warming, the ability of species to disperse, and the existence of suitable alternative habitats within modified landscapes.

**Actions**

Over the next three years, all governments will use the best available research to:

- design programs to protect species vulnerable to climate change
- build on existing programs to re-establish native vegetation as habitat for species vulnerable to climate change.



National, state and territory programs to restore native vegetation provide an important mechanism to protect vulnerable species from the effects of climate change (Picture: Paul Stevenson).

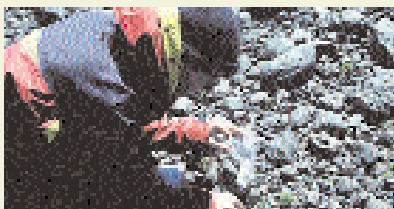
**6. To minimise the impact of invasive organisms on biodiversity in future climates**

Climate change is expected to increase the risk of invasion by alien organisms, including pests, weeds and diseases from neighbouring territories. Climate change may also favour some established alien and native organisms that are currently restricted in range, causing them to become invasive.

**Actions**

Over the next three years, all governments will use the best available research to:

- work with regions to improve their understanding of weeds, feral animals and exotic diseases, and their potential to spread under climate change
- prevent the establishment of new invasive organisms that may thrive under climate change



A biologist collects alien introduced plants (*Poa annua*) on the sub Antarctic Heard Island, 2001 (Picture: K Kiefer, © Australian Antarctic Division).



Dozing lantana with a stick rake, Clairview, Queensland (Picture: Mike Richards, courtesy of Queensland Government, Natural Resource Mines and Energy).

**7. To factor the impacts of climate change on biodiversity into natural resource management and land-use planning**

To be effective, all biodiversity conservation initiatives will need to address the future impacts of climate change. As a starting point, biodiversity programs (and natural resource programs generally) need to be reviewed to ensure they incorporate the action plan's goals of preserving vulnerable species and ecosystems, in the short term, and assist the adaptation of biodiversity to climate change, in the long term.

**Actions**

Over the next three years, all governments will:

- incorporate the monitoring and evaluation of the impacts of climate change on biodiversity into the natural resource management frameworks
- work with planners and managers to ensure that suitable strategies to minimise the negative impacts of climate change on biodiversity are incorporated into regional plans and other biodiversity programs.



Research field assistant extracting soil samples on the sub Antarctic Heard Island (Picture: K Kiefer, Australian Antarctic Division).

### Box 3: South-West Western Australia

Many plant and animal species are only found in nature in extremely narrow climatic ranges. Such species are highly vulnerable to relatively small increases in temperatures, whereas species with larger climatic ranges are likely to be more tolerant.

Plant species of the genus *Dryandra* (related to grevilleas and hakeas) are limited to very specific soil types that are only found within a restricted area of South-West Western Australia. Bioclimatic modelling suggests that many of the 92 species of *Dryandra* could be seriously threatened with a global temperature rise of as little as 1 °C.

Many species of Western Australian frogs, mammals and plants could become restricted to small areas, or could disappear altogether, with a warming of only 0.5 °C.

#### What we can do

One way to protect species from the impacts of climate change is to reduce the effects of other threatening processes particularly those that may be exacerbated by climate change, such as invasive species.

For example, Phytophthora root rot is a disease that is caused by the soil fungus *Phytophthora cinnamomi*. This invasive pathogen could potentially expand in South-West Western Australia as a result of climate change and could have a devastating impact on species such as *Dryandra* that are already vulnerable to climate change.

It will therefore be important to be vigilant to any potential expansion of *Phytophthora cinnamomi* in South-West Western Australia.



Plant species of *Dryandra* (related to grevilleas and hakeas) have specific soil requirements and occur on soils that are only found within a restricted area of South-West Western Australia (Photo: A Cochrane).

### Box 4: North Queensland rainforests

The green ringtail possum, is found in a small altitudinal range in the rainforests of north Queensland. Its habitat may be limited because of the possum's sensitivity to temperature. Above 30 °C, the body temperature of the green ringtail possum rises out of control, and prolonged exposures to high temperature can cause death.

As models of climate change predict not only rising temperatures, but also more frequent extreme climatic events, the green ringtail possum is likely to be heavily affected by climate change. In addition, as a leaf feeder, the possum may also be affected by future reductions in leaf quality, because plants that grow in increased concentrations of carbon dioxide contain less nitrogen.

#### What we can do

To provide protection to temperature-sensitive species such as the green ringtail possum we need to identify and preserve natural areas where such species may survive. These areas are called refuges. A suitable refuge for the green ringtail possum should have the potential to maintain temperature gradients during climate change and should be within the range of the species so that it can successfully adjust its distribution over time.



The wet tropics are one of the most biodiverse areas in the world (Picture: M. Mulvaney, © Australian Heritage Commission).

## Further information about the action plan

The full action plan is available from the <http://www.deh.gov.au/biodiversity/publications/nbccap/index.html> website. For further information about the plan, please contact:

Contact area	Department	Postal details	Email
Land Water and Coasts Division	Australian Government, Department of the Environment and Heritage	GPO Box 787, Canberra, ACT 2601	ciu@deh.gov.au
Greenhouse Policy Unit	Victorian Department of Sustainability and Environment	PO Box 500, East Melbourne, VIC 3002	climate.change@dse.vic.gov.au
Biodiversity Policy Section	New South Wales Department of the Environment and Conservation.	PO Box 1967, Hurstville, NSW 2220	info@epa.nsw.gov.au
Science Division	Western Australia Department of Conservation and Land Management	Locked Bag 104, Bentley Delivery Centre 6983, Perth, WA 6000	info@calm.wa.gov.au
Planning Division	Queensland Environmental Protection Agency	PO Box 155, Brisbane Albert Street, QLD 4002	biodiversity.planning@epa.qld.gov.au
Ecological Restoration Science and Conservation Directorate	South Australian Department for Environment and Heritage	GPO Box 1047, Adelaide, SA 5001	parkinfo@saugov.sa.gov.au
Nature Conservation	Tasmanian Department of Primary Industries, Water and Environment	GPO Box 44, Hobart, TAS 7001	NatureConservationInquiries@dpiwe.tas.gov.au
Biodiversity Conservation	Northern Territory Department of Infrastructure, Planning and Environment	PO Box 2130, Alice Springs, NT 0871	biodiversityconservation.dipe@nt.gov.au
Environment, Planning and Legislation	Environment ACT	PO Box 144, Lyneham, ACT 2602	EnvironmentACT@act.gov.au

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