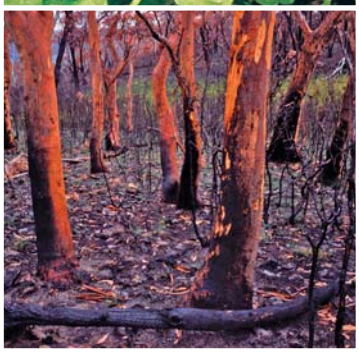
2007–2008

NSW Biodiversity and Climate Change Adaptation Framework

Prepared by the NSW Inter-agency Biodiversity and Climate Change Impacts and Adaptation Working Group




New South Wales Government

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This document was prepared by the NSW Inter-agency Biodiversity and Climate Change Impacts and Adaptation Working Group. This group consists of representatives from the Department of Environment and Climate Change NSW (DECC), the NSW Department of Primary Industries (DPI), the NSW Department of Planning (DoP), the Australian Museum and the Botanic Gardens Trust.

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Ministers' foreword

Climate change caused by human actions is already affecting NSW's biodiversity and ecosystems. With broad scientific agreement that further major impacts are likely, finding ways to adapt to future climate change is a vital part of protecting NSW's precious plants and animals.

The NSW Government has established a new climate change, environment and water portfolio to address the challenges posed by climate change. The new Department of Environment and Climate Change will assist NSW to adapt to predicted changes in climate and to protect our environment and social and economic interests, in partnership with the community and stakeholders.

This document identifies ways in which NSW public sector agencies will tackle climate change and its effect on biodiversity. Agencies will be taking various actions over the next two years including:

- undertaking targeted climate change adaptation awareness raising activities
- promoting ecological corridors of natural bushland that link national parks with other areas populated by native species, to make it easier for plants and animals to move as climate change alters habitat distribution
- identifying which plants and animals are at risk from climate change, examining ways in which climate change will affect them, developing options to conserve them and establishing monitoring programs in several national parks
- increasing knowledge of ways in which climate change will affect factors like bushfires and pests, which already have an impact on wildlife and natural areas, as well as on rural and urban areas, and incorporating this knowledge into management strategies.

The actions outlined in this document will complement NSW's strong commitment to reducing greenhouse gas emissions as outlined in the *NSW Greenhouse Plan* and *The State Plan, A New Direction for NSW*. The NSW Government has also announced plans to set renewable energy targets which are that 10% of energy used in the State must be sourced from renewable sources such as the Sun and the wind by 2010, and 15% by 2020.

Finding ways of adapting to climate change will be a very difficult challenge. A long-term program and sustained effort by our generation as well as future generations will be needed. This document is the first state plan developed specifically to help biodiversity adapt to climate change. It is therefore an important contribution to NSW's overall adaptation planning for dealing with climate change.

Hon. Phil Koperberg

Minister for Climate Change Environment and Water

Hon. Verity Firth

Minister Assisting the Minister for Climate Change Environment and Water

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Executive summary

The health and diversity of our native plants, animals and ecosystems are important in their own right but also for the benefits they give us in protecting our water sources, improving the productivity of our forests and soils and for our wellbeing and enjoyment. Human-induced climate change is now predicted to be the greatest threat to biodiversity in many regions of the world. Its threat is increased by accelerated increases in carbon dioxide levels in the atmosphere and oceans and rises in temperature, and because the Earth's ecosystems are already stressed by other human impacts.

NSW is committed to a significant effort to minimise the impacts of climate change under the *NSW Greenhouse Plan, The State Plan, A New Direction for NSW* and the *National Biodiversity and Climate Change Action Plan*. NSW was the first state or territory in Australia to introduce ambitious long-term emissions reduction targets – a return to year 2000 levels of greenhouse gas emissions by 2025, and a cut of 60% by 2050. However, some climate change will still occur because past and future emissions will contribute to warming for centuries to come, due to the timescales required for removal of these emissions from the atmosphere. Adaptation is therefore essential to reduce the severity of the effects of climate change and complement climate change mitigation strategies. Adaptation involves adjusting our management of the environment to reduce vulnerability to the impacts of climate change and implementing actions that build resilience, reduce other pressures and deal with fragmentation.

This *NSW Biodiversity and Climate Change Adaptation Framework* identifies six key action areas:

1. Share knowledge about biodiversity and climate change, and raise awareness of adaptation actions.
2. Research and monitor impacts of, and adaptation to, climate change.
3. Incorporate adaptation strategies that deal with the impacts of climate change on biodiversity into policy and operations.
4. Provide adaptation planning methods and tools to deal with climate change impacts on biodiversity.
5. Minimise the impacts of climate change on key ecosystems and species.
6. Minimise the increased threat of invasive species on native species that comes with climate change.

Within each of these key action areas, specific actions and commitments are outlined.

This Framework is the starting point for raising awareness, undertaking vital research and monitoring projects, and implementing strategies to maintain biodiversity and protect threatened plants and animals. Although it focuses on biodiversity and climate change, much of the information it contains also applies to broader natural resource management and land use planning, and will complement activities of agencies such as the Australian Greenhouse Office.

1 Introduction

The importance of biodiversity

Healthy ecosystems help to provide the air we breathe, the water we drink and the ability of our land to sustain production from agriculture, fisheries and forestry (Natural Resource Management Ministerial Council 2004). Biodiversity is a vital component of healthy ecosystems. Biodiversity is the variety of life, measurable as the variety within and between species, and the variety of ecosystems.

Biodiversity will be greatly threatened under projected human-induced climate change, the greatest threat to biodiversity in many regions of the world (Thomas et al 2004). Climate change is listed as a key threatening process under both the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).

Climate change is a serious threat to biodiversity due to the unprecedented rates of change in carbon dioxide levels and temperatures, and because the Earth's ecosystems are already stressed by other human impacts.

Biodiversity will be affected by climate change through:

- changing weather such as higher temperatures and changes in rainfall frequency and levels, and chemical changes such as increased carbon dioxide in the air and increased acidification of oceans
- changes in coastal and estuarine habitat due to rising sea levels
- disturbance due to increased fire, invasive species, grazing and extreme climatic events
- impacts on species, such as range shifts and movement towards cooler latitudes or higher elevations, and an increased risk of extinction
- changes to flowering and fruiting times
- changes to species interactions (for example between plants and their pollinators).

Evidence of climate change

The global climate has changed significantly during the last 100 years, with the average surface temperature of the Earth increasing by 0.74 ± 0.18°C (Intergovernmental Panel on Climate Change 2007). There is a 'very high confidence' that the globally averaged net effect of human activities since 1750 has been one of warming, with palaeoclimatic information supporting the interpretation that the warmth of the last half century is unusual compared with at least the previous 1300 years (Intergovernmental Panel on Climate Change 2007). It is 'very likely' (>90% certain) that greenhouse gas increases have caused most of the warming since the mid-20th century (Intergovernmental Panel on Climate Change 2007).

Greenhouse gases are gaseous constituents of the atmosphere that absorb and emit radiation from the Earth's surface, the atmosphere, and clouds. This action causes the greenhouse effect. Water vapour, carbon dioxide, nitrous oxide, methane and ozone are the primary greenhouse gases in Earth's atmosphere. There are also human-made greenhouse gases in the atmosphere, such as halocarbons and other chlorine- and bromine-containing substances, sulphur hexafluoride, hydrofluorocarbons, and perfluorocarbons (Intergovernmental Panel on Climate Change 2001b).

Since worldwide temperature recording began in 1861, nine of the ten warmest years were in the last decade (Steffen 2006). In Australia, 2005 was the warmest year on record (Australian Bureau of Meteorology 2006). This is particularly significant as many of Australia's warmest years (such as 1988, 1998 and 2002) had temperatures boosted by major El Niño events, but no such event occurred in 2005. The 2005 record continued the trend in which all but four years since 1979 have been warmer than average (Steffen 2006).

Much supporting evidence collected over the last few years indicates that the relatively modest warming that has already occurred has affected a range of plants and animals (Hughes et al 2003). For example, the migration patterns and seasonal cycles of species have changed in accordance with the warmer weather, so migrating birds arrive earlier than they used to, and native trees and shrubs flower and bear fruit earlier than they used to. Additionally, some species of birds, mammals and insects have moved towards cooler latitudes or upwards in altitude in response to shifting climatic zones (Hughes et al 2003).

The CSIRO (Hennessy et al 2004) has projected that without action to limit greenhouse gas emissions, climate change in NSW will result in:

- increased annual average temperatures
- the risk of increased frequency or intensity of extreme weather such as floods, and droughts that could increase the frequency of bushfires
- the possibility of a decrease in annual average rainfall
- decreased streamflow throughout the Murray–Darling Basin.

The effects of future climate change on species and ecosystems could be extensive. A warming of 1°C would threaten the survival of species currently living near the upper limit of their temperature range, such as the mountain pygmy possum which lives near its limits in alpine regions (Brereton et al 1995). Other species that have restricted climatic niches and cannot migrate could become endangered or extinct (Pittock 2003). In NSW, ecosystems that are particularly vulnerable to the effects of climate change include freshwater wetlands, coral and coastal ecosystems, rainforests and alpine regions.

About mitigation and adaptation planning

The impacts of climate change can be reduced through mitigation and adaptation. Mitigation measures attempt to limit further changes in the global climate by reducing greenhouse gas emissions. Mitigation globally can slow the rate of climate change and may eventually limit future change if greenhouse gas concentrations are stabilised. However, very large emission reductions are required if stabilisation is to be achieved within the next century, as carbon dioxide and other greenhouse gases have long atmospheric lifetimes (Whetton 2003). Accordingly, adaptation is necessary to complement mitigation (Intergovernmental Panel on Climate Change 2001a).

Adaptation measures reduce the vulnerability of species and ecosystems to the impacts of climate change by strengthening their resilience, reducing other pressures such as the impact of invasive species, and reducing and repairing habitat fragmentation. Adaptation can expand the range of climate variability with which a system can cope, while mitigation reduces the extent of climate change to which a system will be exposed. The combination of these approaches minimises the risk of adverse consequences (Preston and Jones 2006).

About the *National Biodiversity and Climate Change Action Plan* and the *NSW Greenhouse Plan*

NSW is committed to dealing with the impacts of climate change under the *National Biodiversity and Climate Change Action Plan* (National Action Plan) (Natural Resource Management Ministerial Council 2004) and the *NSW Greenhouse Plan* (NSW Greenhouse Office 2005).

The National Action Plan was released in October 2004 and is available at www.environment.gov.au/biodiversity/publications/nbccap/index.html. This plan is the first national natural resource management and climate change adaptation strategy in Australia. It aims to guide agencies that manage natural resources in dealing with the inevitable impacts of climate change on biodiversity.

The National Action Plan sets out objectives and actions to gather knowledge; minimise impacts on freshwater, marine and terrestrial biodiversity; and incorporate adaptation actions into protected area establishment, natural resource management and land-use planning. Key strategies include research, awareness raising, promoting the creation of links to aid migration and dispersal of species, protecting climatic refuges and preserving important habitats.

The *NSW Greenhouse Plan* was released in late 2005. On 11 June 2005, NSW became the first state or territory in Australia to commit to ambitious long-term emissions reduction targets – a return to year 2000 levels of greenhouse gas emissions by 2025, and a cut of 60% by 2050. These targets are also committed to in *The State Plan, A New Direction for NSW* (NSW Government 2006).

About this framework document

The *NSW Greenhouse Plan* also commits NSW to developing this framework document, which in turn outlines ways in which NSW will implement actions committed to in the National Action Plan.

This framework document supports:

- a coordinated statewide response to implement the objectives and actions set out in the National Action Plan
- initial priority biodiversity and climate change adaptation planning actions for NSW agencies to undertake over the next two years to reduce risks to biodiversity
- procedures for NSW government agencies to work together to reduce the vulnerability and increase the capacity of the biodiversity of NSW to adapt to climate change
- appropriate coordination, linkages and information transfer between agencies
- collaboration between agencies to raise awareness, promote research and develop tools to implement the above adaptation actions.

Content of this document

This framework document contains six key action areas:

- Action area 1: Share knowledge about biodiversity and climate change, and raise awareness of adaptation actions.
- Action area 2: Research and monitor impacts of, and adaptation to, climate change.
- Action area 3: Incorporate adaptation strategies that deal with the impacts of climate change on biodiversity into policy and operations.
- Action area 4: Provide adaptation planning methods and tools to deal with climate change impacts on biodiversity.
- Action area 5: Minimise the impacts of climate change on key ecosystems and species.
- Action area 6: Minimise the increased threat of invasive species on native species that comes with climate change.

Each action area includes:

- background information
- objectives and immediate priorities
- recommended actions to achieve the objectives and deal with the priorities
- examples of actions already being undertaken by NSW agencies
- lead agencies and, where relevant, funding agencies.

This document outlines actions that NSW public sector agencies will undertake over the next two years to help protect and maintain biodiversity in an era of climate change. It is intended to be the starting point for building awareness and understanding of the impacts of climate change, and increasing agencies' capacity to implement adaptation planning. Actions in this document will be integrated with existing broader natural resource management initiatives, and will complement current and ongoing activities being undertaken under the *NSW Greenhouse Plan, The State Plan, A New Direction for NSW* and by the Australian Greenhouse Office.
For further information on these activities, see www.greenhouse.nsw.gov.au and www.greenhouse.gov.au.

2 Key action areas

Action area 1: Share knowledge about biodiversity and climate change, and raise awareness of adaptation actions

Background information

Effectively reducing emissions, planning for climate change and dealing with the impacts of climate change on biodiversity require contributions from everyone. The NSW Government will raise awareness of the causes and impacts of climate change, and of the ways in which individuals can reduce their emissions and plan for the future, by:

- implementing targeted education campaigns
- providing knowledge, skills, tools and mechanisms which can be used by government, key stakeholders and the community, especially land managers
- providing easily accessible information on the best science regarding climate change impacts and solutions
- publicly recognising and championing solutions that reduce emissions in the long term.

The key information will include:

- the projected changes in climate
- how these changes will affect biodiversity
- biodiversity contributions to providing clean air and water which are crucial for human survival and wellbeing
- some impacts that present opportunities
- the costs that need to be considered when making decisions, especially long-term decisions
- the potential physical impacts of climate change, the possible social and economic implications, and the adaptation options that need to be understood.

Decision makers must understand the complexity of these issues and the need for multidisciplinary and multijurisdictional cooperation in dealing with them. They must also consider ways of incorporating their knowledge of climate change issues into decision-making.

The NSW Government alone cannot respond to all challenges created by climate change, but can raise awareness in other sectors and provide information and support to help other levels of government, businesses, and the public to develop their own responses.

As places of high biodiversity value are often places of important Aboriginal cultural heritage value, the actions undertaken to deal with climate change impacts on biodiversity will also benefit Aboriginal heritage. An outline of some impacts of climate change on Aboriginal cultural heritage values is given in *Box 1*.

Objectives

1. To increase awareness and understanding that climate change is already happening and that there are immediate and long-term impacts on NSW's biodiversity.
2. To increase awareness in NSW of the need to adapt to a changing climate, minimise risks and maximise opportunities.

Immediate priorities

- To promote understanding of the community's economic and social vulnerability when confronted with changes in biodiversity and loss of natural resources resulting from climate change (local or otherwise).
- To incorporate climate change considerations concerning biodiversity impacts and adaptation into regional planning processes, protected area management plans, natural resource management and public investment opportunities.

Actions

Since the release of the *NSW Greenhouse Plan* in November 2005, several projects and programs have begun, including:

- a Schools Climate Change Awareness Program
- increasing the NSW Government's information on climate change on the internet
- providing support for climate change-related conferences and events
- planning for workshops to share best practice knowledge in different sectors (e.g. an agricultural industries and rural communities workshop)
- implementing a climate change project for small and medium businesses and for local government
- developing a voluntary Green Driver Information and Action Program
- developing an Agricultural Extension Program.

Details of these projects can be found at www.greenhouse.nsw.gov.au.

Additional actions

- continuing to develop and maintain internal agency networks in the Department of Environment and Climate Change NSW (DECC), the NSW Department of Primary Industries (DPI), the NSW Department of Planning (DoP), and an inter-agency working group for biodiversity and climate change impacts.
- undertaking a rural awareness campaign to improve farmers' risk management skills regarding climate change and climate variability, which will in turn improve natural resource management on agricultural land and conserve biodiversity – see *Box 2*.
  Lead agency – DPI.
- developing climate change profiles for each Catchment Management Authority (CMA) in NSW – these were developed by DECC and the CSIRO and will assist local land users by providing information about climate change impacts as well as suggested adaptation techniques – see *Box 3*.
  Lead agency – DECC.

Box 1: Impacts of climate change on Aboriginal cultural heritage

Aboriginal cultural heritage refers to objects, places and landscapes that Aboriginal people and communities have cultural associations with and attachments to. The items may be physical (tangible) or non-physical (intangible); they include items of traditional occupation of Country such as campsites, middens, and scarred trees; historical places such as mission and massacre sites; sacred places such as burial sites and ceremonial places; stories, songs and knowledge; and natural features such as waterways, plants, animals and seasons. Some plants and animals have food or medicinal uses and others are of totemic value to an individual, family or group.

Places of high biodiversity value are often places of high Aboriginal cultural heritage value, so adaptation actions undertaken for climate change impacts on biodiversity will also be relevant for conserving Aboriginal heritage. However, the complex associations and attachments of Aboriginal people and communities with Country will require specific consideration.

For example, a recent audit of Aboriginal heritage in coastal NSW found that this heritage was in generally poor condition. The rise in sea levels and more extreme climatic events will lead to greater erosion of midden sites and exposure of highly significant burial sites.

Inland areas will also be severely affected by climate change, as increased temperatures and reductions in water flow may exacerbate existing environmental threats. Animals of cultural significance such as food and medicine plants, goannas, echidnas and kangaroos may also decline locally and regionally.

Other likely impacts of climate change will be on seasonal and natural cycles of life that are integral to Aboriginal culture and wellbeing. For example, the germination and pollination of plants and the complex interrelationships between plants and animals will be altered by climate change. Furthermore, changes in bushfires and increased competition from invasive species will have dramatic effects on the viability of natural ecosystems and their associated cultural connection to Aboriginal people.

Where significant sites are at risk from climate change, works to reduce vulnerability and improve site stability may be necessary. On occasions, important material may need to be moved to safer locations with cultural permission.

Aboriginal people have lived in Australia for at least 40,000 years and thus have a long history of adaptation to climatic fluctuations. They have adjusted to around 130 m of sea level rise from the last glacial maximum 18,000 years ago until the present level was reached around 6,000 years ago (Pittock 2003). It has also been argued that Aboriginal people modified and managed the landscape through the controlled use of low-intensity fire (Kohen 1995), and these approaches may be helpful in managing changing vegetation patterns and increased fire danger in a changing climate.

Information supplied by DECC and the NSW Department of Aboriginal Affairs.

Box 2: Climatology in Agriculture Project

The main objective of action 2.4 of the *NSW Greenhouse Plan*, the Climatology in Agriculture Project, is to develop tools and guidelines for use by farmers and CMAs.

The project will:

- raise awareness of climate change impacts on agriculture
- provide training to improve the skills of farmers, CMAs and DPI staff in climate risk management
- enable farmers to work with CMAs to incorporate climate risk management into property management planning and to develop effective adaptation strategies.

Improving the resilience and sustainability of farming will benefit agricultural production, improve natural resource management and conserve biodiversity.

Lead agencies: DPI and DECC

G. Johnson, *The State of NSW* through NSW Dept. of Primary Industries

Box 3: Catchment climate change profiles

DECC has commissioned CSIRO to prepare climate change profiles for land users in each catchment area in NSW.

In preparing these profiles, CSIRO converted the latest peer-reviewed scientific studies into easy-to-read, individually tailored brochures which provide:

- an overview of the problem of climate change, including its causes
- a user-friendly summary of the latest climate projections for each catchment, including temperature and rainfall projections
- an assessment of the likely impacts of climate change on water resources, farms, communities, biodiversity and forests
- suggested strategies to implement to adapt to climate change.

Lead agency: DECC
Funding: NSW Government

Action area 2: Research and monitor impacts of, and adaptation to, climate change

Background information

The effect of projected changes in climate on biodiversity is likely to be highly significant, with many species and ecological communities with narrow climatic ranges most obviously at risk. Nevertheless, the degree of potential change is so great that most ecological communities will be affected in some way.

For example, more than half the 819 species of *Eucalyptus* in Australia have a geographical distribution that spans a climatic range of less than 3°C mean annual temperature (Hughes et al 1996). Based on CSIRO climate modelling, this means that parts of eastern Australia may become no longer climatically suitable for their survival, although their actual climatic tolerances may be greater than the climate envelope they currently occupy.

In addition to temperature increases, plants and animals will also be affected by increasing carbon dioxide levels in the atmosphere and oceans. At present, there is a limited understanding of how individual species and communities and the structure and functions of various ecosystems might be altered as a result of these elevated levels.

Historically, biodiversity and nature have been protected in permanent conservation reserves. These reserves were set up to conserve particular species or ecological communities, but may not be climatically suitable for those species in the future. Based on climate change modelling many, if not most, species and ecosystems will have to migrate to cooler latitudes or altitudes.

As much of NSW is used for production purposes, such as grazing, it is even more important to set aside land to enable plants and animals to move around the landscape in response to climate change. Land left in its natural state or modified for development must be managed to enable plants and animals to adapt to climate change in the long term.

Off-reserve conservation measures are also important for biodiversity conservation. Many agencies in NSW are already working with local communities, individual landowners, the private sector and non-government agencies to encourage and facilitate the achievement of conservation objectives outside reserves. These measures should continue to be encouraged as climate change will make them even more imperative.

Adaptation strategies for biodiversity should not exist in isolation and information on the biological and physical impacts of climate change needs to be integrated with the socioeconomic needs and restrictions of current and future land management practices. As a result, actions in this framework are designed to benefit all natural resource management and land use planning activities and programs.

Under objective 2.1 of the *NSW Greenhouse Plan,* a $2 million Climate Change Impacts and Adaptation Research Program (CCIARP) will increase knowledge of climate change impacts on:

- bushfire risk
- coastal erosion and storm surge
- estuarine inundation
- water availability and flooding in the Greater Metropolitan Region
- water availability in the Murray–Darling Basin
- flooding on the NSW north coast
- biodiversity and threatened species
- weeds and pests in natural and agricultural systems
- human health risks from climate change.

Objectives

1. To understand the impact of climate change on the distribution of a range of species and ecological communities.
2. To understand the interaction between climate change land use management and biodiversity.
3. To instigate research that will help NSW develop biodiversity adaptation strategies and land management practices that will minimise the impact of climate change on biodiversity.
4. To develop an adaptive monitoring program that can measure the success of any adaptation strategy.

Immediate priorities

- To refine and improve regional bioclimatic climate change scenarios for NSW so regional impacts can be predicted.
- To develop an integrated climate change biodiversity adaptation research and monitoring program that:
  - identifies information sources and projects that are underway
  - analyses the key information required to enable NSW to refine impact scenarios and develop adaptation responses.

Actions

Progress the projects under the *NSW Greenhouse Plan's* CCIARP. Specific projects are as follows:

- **Bushfire risk:** undertake a three-year study to examine changes in bushfire frequency and severity, and specify increasing risks from bushfires to biodiversity, ecosystem functions, people and their property.
  Lead agency – DECC.
- **Invasive species:** undertake a three-year study to determine the effects of climate change on invasive species and specify the resulting impacts on biodiversity, especially on species already under threat.
  Lead agency – DECC.
- **Modelling tools:** undertake a two-year project to adapt existing conservation models to account for climate change impacts such as changes in species distribution.
  Lead agency – DECC.
- **Terrestrial biodiversity:** undertake a three-year study to determine effects of climate change on key threatened species and ecological communities.
  Lead agency – DECC.
- **Inland aquatic ecosystems:** undertake a three-year study to determine the effects of climate change on inland aquatic ecosystems and provide information to guide future conservation priorities.
  Lead agency – DECC.
- **Sydney metropolitan water availability:** undertake a three-year study into the climate change impacts on the supply and demand for water in Sydney's Greater Metropolitan Area.
  Lead agencies: NSW Department of Water and Energy, Sydney Catchment Authority, CSIRO and the Australian Greenhouse Office.
- **NSW coastal impacts:** undertake a two-year study to assess the current and future impacts of erosion, storm surge and estuarine inundation on coastal NSW resulting from climate change and the rise in sea levels.
  Lead agency – DECC.
- **Coastal planning:** undertake a two-year project to map the NSW Hunter and Central Coast coastlines and hinterland to assess potential climate change impacts on coastal NSW.
  Lead agency – DoP.

Action area 3: Incorporate adaptation strategies that deal with impacts of climate change on biodiversity into policy and operations

Background information

Different ecosystems will be affected in different ways by predicted increases in temperature, changes in rainfall frequency and levels, rises in sea levels and increased frequency and intensity of severe weather. Adaptation strategies for these impacts need to be factored into regional conservation plans and other biodiversity protection strategies. In turn, these strategies can be incorporated into catchment action plans and, particularly in urban areas, guide land use planning.

The Council of Australian Governments (COAG) recently identified that settlements and infrastructure, water supply and natural ecosystems would benefit most from early regional adaptation planning.

Natural resource management programs will increasingly include climate change considerations, and the need to develop appropriate adaptation strategies for the impacts of climate change on biodiversity.

Regional strategies, developed by DoP, guide local government revision of all local environmental plans (LEPs), which requires councils to consider the impacts of climate change in the coastal zone.

The planned five-yearly review of regional strategies will enable new priority actions for biodiversity adaptation to climate change to be incorporated into the reviewed strategies and LEPs. As LEPs will guide local development assessment, climate change considerations could then be reflected in assessment of individual proposals.

NSW Government agencies are still learning about all the interactions that influence plants and animals, their habitats and climate. However, measures can already be taken to increase resilience to, and mitigate, threats that climate change may pose. These measures include preserving and improving vegetation links between conservation areas on public and privately-owned land to allow species to migrate in a changing climate – connecting natural areas will allow species to move and find refuge. Working with private landowners to set up corridors and areas of natural bushland linking national parks and other natural areas will thus be a priority action to mitigate the effects of climate change on biodiversity.

Objectives

1. To reduce the vulnerability of ecosystems by identifying land use planning measures to increase the ability of plants and animals to adapt to the impacts of climate change.
2. To use all available strategies, including natural resource management plans and land use planning policies, to strengthen the above measures.

Immediate priorities

- To finalise regional strategies which require councils to consider climate change impacts in LEPs and development assessment processes.
- To develop adaptation strategies incorporating the impacts of climate change on biodiversity (and on infrastructure and human settlement), which can then be included in catchment action plans, regional strategies and LEPs.
- To improve regional climate change data so specific climate change scenarios can be modelled.
- To improve the knowledge of managers and planners in all sectors (state and local

government, agricultural, industrial and community) regarding the impacts of climate change.

- To connect areas of public and privately-owned bushland to help protect biodiversity during climate change.

Actions

- Initiate programs to improve knowledge essential for adaptation planning which will enhance ecosystem resilience to climate change.
  Lead agencies – DECC and DPI.
- Conduct vulnerability and risk assessments, particularly for coastal and floodplain areas. As approximately 40% of the NSW coastline is in DECC reserves, much biodiversity is under threat on the coast (see *Boxes 4* and *5*).
  Lead agencies – DECC and DoP.
- Require LEPs to incorporate climate change adaptation strategies into land use planning and development assessment processes, to help protect biodiversity.
  Lead agency – DoP.
- Collect detailed data on low-lying coastal settlements and test it against CSIRO projected climate change scenarios to inform land use planning, then use the data to identify measures to protect elevation-dependent biodiversity such as salt marsh, and inform biodiversity and reserve planning (see *Box 6*).
  Lead agencies – DoP and DECC.
- Develop and implement the Australian Alps to Atherton initiative (see *Box 7*).
  Lead agency – DECC.

Box 4: Preliminary assessment of the climate change impacts on, and adaptation options for, coastal NSW

Climate change scenarios, including a rise in sea levels, increased frequency and severity of storms, and changes in rainfall patterns, are likely to increase the risk of severe coastal inundation and erosion, with significant implications for NSW's biodiversity. Estuarine ecosystems, water quality and hydrodynamics are also likely to significantly change.

With the growing awareness of ways in which climate change will impact on the coast, a systematic study of the NSW coastline needs to be undertaken.

Importantly, the extent of the vulnerability of coastal features to climate change impacts has not been defined. The costs associated with potential coastal erosion, inundation, and the degradation of estuaries and associated biodiversity values due to climate change, and the cost–benefit of any adaptation responses to climate change impacts, cannot be evaluated without evidence provided by a systematic study. As a result, a two-year study commenced in September 2006.

Two representative NSW coastal sites, the Clyde River/Batemans Bay system and Wooli Wooli River system have been selected as case studies. The relative impacts associated with various climate change scenarios are being qualitatively and, to some extent, quantitatively measured. These areas have been chosen as impacts affecting them are likely to occur elsewhere along the NSW coastline.

The study is being undertaken in three stages:

- low, mid, high and probable maximum (PM) level environmental impacts are being measured over 25 and 75 years
- these impacts on coastal and estuarine environments are being quantified
- the costs and benefits associated with adopting low, moderate and high cost adaptation responses to deal with the low, medium, high and PM level impacts are being evaluated for the two representative study areas and other NSW coastal regions.

Lead agency: DECC
Funding: NSW Government

Box 5: Regional climate change adaptation strategies in cities

This project aims to develop and trial regional climate change adaptation strategies in cities. The project will:

- develop and test the likely impacts of climate change on, and feasible adaptation strategies for, Sydney
- deepen understanding of the likely impacts of climate change on Sydney by pooling relevant knowledge, testing various features for their vulnerability to climate change and analysing the features' ability to adapt to climate change.

Workshops with local government and other stakeholders will determine regional vulnerabilities. Different scenarios for future climate change will simulate changes in climate hazards. Impact models of human and environmental systems under different scenarios will be developed. These models will test the physical (e.g. coastal erosion and inundation), ecological (e.g. habitat loss) and socioeconomic (e.g. infrastructure and development damage) effects of climate change.

Once the models are completed, further workshops will be conducted in each local government area to discuss local priorities for adaptation and determine local variables which may affect adaptation planning.

Recommendations will be made to councils on how to improve their adaptation planning and programs. Councils will also be provided with monitoring and evaluation frameworks to help benchmark and improve their adaptation planning strategies into the future.

Lead agencies: Sydney Coastal Councils Group in partnership with CSIRO
Funding: Australian Greenhouse Office – Urban Integrated Assessment Program

J. Winter, DECC

Box 6: Coastal zone planning – high resolution terrain mapping

A rise in sea levels and increased hazards associated with global climate change are projected to increase risks to existing and proposed development and greatly affect biodiversity in coastal areas. The DoP is leading a strategic planning project funded under the Greenhouse Innovation Fund Climate Change Impacts and Adaptation Research Program. The pilot project commenced in June 2006 and will be completed in September 2007. It has three main components:

- For priority coastal areas in the Hunter and Central Coast areas, the aim is to assess the risk from rising sea levels to enable long-term strategic planning. To achieve this aim, high resolution terrain information using LiDAR technology, also referred to as airborne laser scanning, will be collected up to the 10 m topographic contour, below which existing topographic data is inadequate for reliably modelling risks.
- Potential impacts on priority coastal areas will be demonstrated by superimposing existing and proposed development over the detailed LiDAR-derived topography.
- Workshops will be conducted with local councils and communities, both in the study area and elsewhere on the NSW coast, to demonstrate project methods and results.

The data gathered from this project will allow land use planners and managers to better assess future risks to the built and natural environments in these regions.

Lead agency: DoP
Funding: NSW Government

J. Little

Box 7: Australian Alps to Atherton

Australian Alps to Atherton involves communities, landowners and governments working together to conserve, protect, restore and link landscapes and ecosystems along the Great Dividing Range and Great Escarpment of eastern Australia. Stakeholders will use cultural knowledge, their own knowledge and the best available science to combine and extend two significant conservation corridors that have been established in south-eastern Australia on public lands during the last 60 years – the Great Dividing Range and the Great Escarpment of Eastern Australia conservation corridors.

Linking intact natural ecosystems that include a wide range of habitats will enable plants and animals to move and adapt as climate conditions change, and will reduce habitat fragmentation that has occurred since European settlement.

The objectives of this project are to:

- develop and implement strategies to connect bushland along the NSW section of the Great Escarpment and Great Dividing Range
- develop a vision, objectives and strategies with landholders, stakeholders, government agencies and local government across Australia
- ensure the goals and principles of this project are given high priority in planning and management by all levels of government and by agencies
- link corridors in areas at greatest risk of biodiversity loss.

This project will result in:

- increased awareness of the importance of linking public and privately-owned bushland to help protect biodiversity during climate change
- the implementation of voluntary conservation agreements, revegetation and restoration in high priority areas
- partnerships to include conservation objectives and principles for linking land within conservation planning instruments, plans and investment strategies.

Lead agency: DECC
Funding: NSW Government

DECC

Action area 4: Provide adaptation planning methods and tools to deal with climate change impacts on biodiversity

Background information

NSW agencies have begun to incorporate biodiversity and climate change information into natural resource management strategies. However, more tools and information are needed to assist government, industry and the community to manage uncertainty and risks to biodiversity conservation posed by climate change, and to create strategies that will maintain and improve biodiversity.

Objectives

1. To increase understanding of options that will increase the capacity of biodiversity to adapt to changes in climate.
2. To provide tools and guidance for decision makers to assist them in incorporating climate change strategies relating to biodiversity into their activities.

Immediate priorities

- To undertake and support research and awareness raising campaigns about the likely changes in climate and likely impacts on biodiversity, and integrating this information with regional planning and adaptation.
- To provide guidance and training on how to assess impacts, and to develop cost–benefit analyses and risk management guides to enhance biodiversity conservation.
- To modify existing, and develop new, models and tools that can be used to understand how climate change will affect human and natural systems.
- To undertake case studies of adaptation options for biodiversity conservation and evaluate these, to assist future adaptation planning.

Actions

- Incorporate results of climate change research into existing strategies for biodiversity conservation.
  Lead agencies – DECC and DPI.
- Develop predictive models and tools which can deal with variability and uncertainty and can be incorporated into biodiversity conservation programs (see *Box 8*).
  Lead agencies – DECC and DoP.
- Undertake pilot studies to assess changes, evaluate biodiversity conservation adaptation options and raise awareness.
  Lead agencies – DECC and DoP.
- Implement a climate change adaptation and capacity building program for local government (see *Box 9*).
  Lead agency – Local Government and Shires Association (LGSA).

Box 8: Conservation planning software and climate change

DECC has developed software to evaluate regional land use and management of terrestrial biodiversity. This software is already being applied to many assessment and planning activities across NSW including natural resource management projects in conjunction with CMAs, regional strategy/ regional conservation plan development in coastal regions, and multi-species recovery planning.

While the software already considers a variety of pressures and threatening processes (e.g. vegetation clearing, urban expansion, grazing, invasive species) it does not yet address climate change. Addition of this capability will enable climate change impacts to be considered when making major land use and management decisions across NSW.

This project will draw on the best available information from related activities (e.g. see *Box 11*). In turn, the enhanced software will translate information generated by other activities into a more applicable form for practical planning and decision-making.

Lead agency: DECC
Funding: NSW Government

Box 9: Local government capacity building

The NSW Government and local councils have joined forces to help local communities address the impacts of climate change. The Government has committed $250,000 towards a two-year project, supported by an in-kind $55,000 contribution from the LGSA.

This project will:

- assist councils to access grants and funding
- involve the recruitment of a specialist project officer
- establish a reference group to manage the project and ensure relevance and scientific rigour
- prepare guidance material to assist councils
- conduct regional workshops for councils.

Local councils are responsible for the social, economic and environmental wellbeing of their local government area. Councils are therefore well placed to lead communities in adapting to climatic change and promoting sustainable practices, which are important for biodiversity conservation.

Lead agency: LGSA
Funding: NSW Government.

M. Lauder, DECC

Box 10: Sustainable regional development options for managing NSW's marine environment

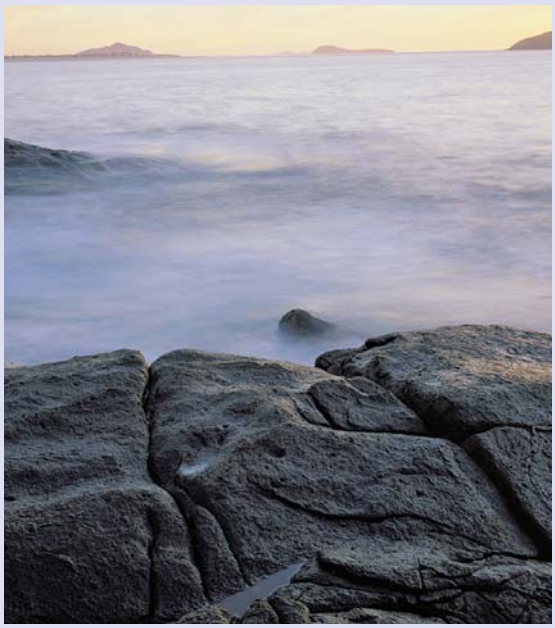
NSW's marine and coastal environment will change extensively in the future, partly due to climate change impacts. Simultaneously, the community will continue to expect to enjoy a healthy and robust environment.

This project will undertake strategic research that will assist planners, decision-makers and the community to sustainably develop regional coastal and marine ecosystems so they are ecologically healthy and economically productive.

CSIRO Marine Research has already developed complex computer models to help managers identify and discover strategies that generate good biological, economic and social outcomes, regardless of the uncertainties that exist. This project will apply and extend the development of CSIRO's software to the coastal regions of NSW over the timespan of 1950–2030. This period involves rapid development and environmental change, and a manageable projection period of immediate interest to policy makers.

The initial phase of the project will focus on the north coast, particularly the Clarence River system. In the final phase of the project, standards and targets will be evaluated so future regional and aquatic plans can include well-considered performance measures.

Project lead: DPI
Funding: NSW Government



G. Woods, DECC

Action area 5: Minimise the impacts of climate change on key ecosystems and species

Background information

There is already evidence of impacts of climate change on biodiversity, including effects on the physiology and distribution of species, and the timing of life-cycles (Hughes 2000, 2003; Howden et al 2003). For example, native and feral animals which traditionally move out of the Alps in winter are returning earlier, flowering and fruiting times are changing, and the range of some migratory species is expanding southwards. Rainforests, freshwater wetlands, coral and coastal ecosystems and alpine areas are particularly vulnerable to the impacts of climate change.

The complexity of potential impacts on biodiversity is significant. For example, there are complex interactions between various stressors such as invasive species, altered fire regimes and increased levels of carbon dioxide, and complex effects resulting from these interactions.

There is growing scientific information about the possible effects of climate change on inland aquatic and semi-aquatic species and ecosystems, and adaptation actions to deal with these effects. Several hydrology modelling projects that include climate change projections have taken place in NSW.

In NSW, climate change is listed as a key threatening process under the *Threatened Species Conservation Act 1995*. Existing conservation efforts in NSW, such as maintaining the reserve system, will offer some safeguards against climate change. Large reserves and protected areas allow for some shifts in habitat.

However, some species and ecosystems such as the mountain pygmy possum face local or even complete extinction in the wild under a worst case scenario. Species may be able to adapt if other threats, such as invasive species and fragmentation, are removed.

Existing and newly created marine sanctuaries provide broad-scale protection of marine, coastal and estuarine species that are vulnerable to climate change. However, there is a lack of information on species' distributions and abundance in marine and estuarine environments. There is also insufficient information for policy makers to identify specific refuge areas and little information about species that will be able to move to other areas if necessary.

Modelling the interactions of climate change with other threatening processes (such as invasive species, altered fire regimes, salinity, and pathogens such as *Phytophthora cinnamomi*) involves dealing with significant uncertainties and makes it difficult to assess the overall impact of projected climate change on ecosystems.

Objectives

1. To continue and expand research and monitoring projects to increase understanding of the impacts of climate change on biodiversity, especially on vulnerable species and ecosystems.
2. To improve regional/bioclimatic modelling to help understand regional impacts to inform management practices.
3. To ensure that particular emphasis is given to research/modelling in coastal and estuarine ecosystems, as these systems have been identified as particularly vulnerable to the risks associated with climate change. Additionally, 40% of the NSW coastline is in the reserve system and over 80% of the population lives in coastal regions.
4. To use research findings to better integrate climate change issues with other natural resource management planning.

Immediate priorities

- To promote a greater understanding of water interactions under climate change scenarios, as the lack of understanding in this area may be impeding progress in dealing with climate change and biodiversity issues regarding water use and management for conservation purposes.
- To increase understanding of predicted rises in sea levels, and increased risks of storm surges and coastal recession, to aid planning in the coastal zone.
- To undertake strategic and prioritised research to reduce uncertainty about the impacts of climate change on biodiversity. Areas to focus on include how vulnerable species, communities and ecosystems are to the impacts of climate change; ways in which species, communities and ecosystems will adapt to climate change; and which components of the environment need to be better understood.
- To provide information and build the capacity of natural resource managers to assess the risks of alternative policy and management options for biodiversity conservation.

Actions

- Progress the climate change adaptation research projects under the *NSW Greenhouse Plan's* CCIARP, which will aid in future biodiversity conservation planning.
  Lead agencies – DECC, DPI and DoP.
- Identify and monitor the most vulnerable species and ecological communities at risk from climate change (see *Box 11*).
  Lead agency – DECC.
- Investigate the potential impacts of bushfires under climate change (see *Box 12*).
  Lead agencies – DECC and DPI.
- Assess the likely effects of climate change on inland aquatic ecosystems (see *Box 13*).
  Lead agencies – DECC and DPI.
- Recognise the priority of coastal ecosystems and wetlands, as these have been identified as being highly vulnerable to the risks from climate change.
  Lead agencies – DECC and DPI.
- Implement *Department of Environment and Climate Change NSW Adaptation Strategy for Climate Change Impacts on Biodiversity* to guide implementation of actions in the *National Biodiversity and Climate Change Action Plan* (Natural Resource Management Ministerial Council 2004).
  Lead agency – DECC.
- Improve current conservation planning including programs in and outside of reserves, to incorporate knowledge of ecosystem responses to climate change, and implement regional investment strategies that protect and improve links and corridors.
  Lead agencies - DECC and DPI.
- Continue actions to minimise the disruption of climate change on the control of invasive species based on the NSW Weeds Strategy.
  Lead agencies – DECC and DPI.
- Link research capabilities, agency networks and collaboration across agencies.
  Lead agencies – all agencies (climate change specialists).
- Conduct research such as risk assessments to ensure multiple benefits and applications where possible.
  Lead agencies – DECC and DoP.
- Incorporate research results into ongoing management on issues such as environmental flows, water management plans, marine parks, controlling fire and invasive threats, promoting private land conservation and managing the reserve system. Knowledge will need to be transferred across agencies to enable effective management.
  Lead agencies – DECC and DoP.

- Provide advice, as available, on incorporating climate change impacts on biodiversity into plans including catchment management and water sharing plans.
  Lead agency – DECC.

Box 11: Biodiversity and climate change

Human-induced climate change has been listed as a key threatening process under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth). There is currently little understanding of ways in which climate change may affect biodiversity beyond simplistic bioclimatic modelling. In terms of land management, habitat loss and threats must be minimised, and ecological processes and strategies to minimise disturbance must be maintained in remnant habitats. For species that can move to higher altitudes or to other habitats, there must be sufficient remnant habitat, control of invasive species and vegetation links between habitats.

Before embarking on costly reserve acquisition or restoring cleared land, the best and most cost-effective measures to protect all flora and fauna across diverse landscapes and habitats must be identified. This requires assessing ways in which different species, including threatened species, will be affected by climate change, and ways in which the structure and composition of ecological communities will change.

DECC will identify species and ecological communities at risk from climate change. This will include the methodology used, ways in which climate change will impact on the species and communities, and conservation options. Threatened species and ecological communities in NSW will be examined and reported on. The impacts of climate change on life history will also be examined. In particular, detailed monitoring programs to examine the impacts of climate change will be developed and established in Kosciuszko National Park and Central Eastern Rainforest Reserves of Australia, and on Lord Howe Island.

Lead agency: DECC
Funding: NSW Government

T. Auld

DECC

Box 12: Fire and climate change

Effects of fire are complex and governed by frequency, intensity and season. While short-term effects of individual fires are important, long-term impacts can only be evaluated by understanding the effects of fire on social, economic, ecological and natural resource values.

The necessity for a risk-based approach to fire management is a key recommendation of the recent national COAG inquiry on bushfire mitigation and management.

A DECC-led project will focus on climate change and fire risk in the greater Sydney basin – a key region where climate change effects from bushfires may most acutely affect a wide range of values. In this region, there are areas of fire-prone bushland that contain high biodiversity values (e.g. Blue Mountains National Park which is a World Heritage Area), adjoin large towns and cities, and affect services, such as water and clean air.

Desired outcomes will be to:

- quantify the risk of fire regime changes from predicted changes in climate
- quantify the predicted risks from more intense and frequent fires to biodiversity, ecosystems, people and property
- develop mitigation strategies to deal with these risks
- identify trade-offs that will be needed to adapt to climate change in the Sydney basin.

Lead agency: DECC
Funding: NSW Government

N. Paton, DECC

Box 13: Inland aquatic ecosystems and climate change

Regional-scale climate change projections remain uncertain but suggest a reduction in rainfall and increased temperatures over many areas of western NSW (Hennessy et al 2004) that will threaten inland wetlands and biodiversity. For example, the reproductive rates of migratory birds that depend on wetlands for their breeding cycle will be affected by drier conditions (Hassall and Associates 1998). Current environmental stresses on aquatic and semi-aquatic ecosystems (such as modified flow regimes, habitat destruction, altered patterns of salinity, algal blooms and invasive organisms) will potentially increase the vulnerability of aquatic biodiversity to climate change (Natural Resource Management Ministerial Council 2004).

DECC will assess the likely effects of climate change on inland aquatic ecosystems of outstanding value and provide information that will guide future conservation and protection priorities to:

- improve future land use and water planning
- focus policy and funding to conserve assets of greatest long-term resilience and significance.

Lead agency: DECC
Funding: NSW Government

G. Croft Sunset, DECC

J. Winter, DECC

G. Croft, DECC

Action area 6: Minimise the increased threat of invasive species on native species that comes with climate change

Background information

Invasive pest species are among the greatest threats to biodiversity throughout Australia. In NSW, they threaten 70% of species, populations and communities listed under the *Threatened Species Conservation Act 1995*. They affect native species more than any other process except the destruction and disturbance of native vegetation. Minimising the impacts of invasive species on biodiversity is thus a key objective of pest management programs.

Many invasive pests are distributed widely across Australia and eradication is not possible in the foreseeable future. Invasive pests often spread quickly and have high reproductive rates, allowing them to re-establish rapidly following control. Resources are therefore concentrated on areas where impacts are greatest, to ensure control programs reduce these impacts.

New invasive pest species continue to invade the environment either through the importation of new species into Australia or the escape of domestic plants and animals. Prevention, early detection and eradication are the most cost-effective ways of minimising the impacts of new pests.

In NSW, the response to new and emerging pest threats and priorities for managing widespread invasive pests will be coordinated through the NSW Invasive Species Plan, which is currently being prepared.

Little scientific data is available on the impacts of climate change on invasive species. The effect of invasive species on biodiversity as a result of climate change could be observed in NSW as:

- an increase in new pests
- a change in the distribution and abundance of existing invasive species
- a change in the range of exotic species that are currently restricted in range, causing them to become invasive
- a change in the distribution and abundance of native species that are threatened by invasive species, due either to an expansion or change in the distribution of native species so they become exposed to threats from invasive species, or to a reduction in the distribution and abundance of native species so they become threatened and their protection from invasive species becomes a higher priority.

Objectives

1. To understand the interaction between climate change, invasive species and biodiversity.
2. To identify changes in the distribution, abundance and impact of invasive species to ensure management practices are adapted to minimise future impacts (climate change-related or otherwise) on NSW's biodiversity.

Immediate priorities

- To undertake research and monitoring to gain a better understanding of the likely impacts of climate change on invasive species.
- To identify invasive and native species that are most likely to experience changes in distribution and abundance as a result of climate change.
- To determine if these changes in distribution and abundance cause additional threats from invasive species.
- To monitor new incursions.
- To monitor the success of control programs for selected widespread invasive species.

Actions

- Undertake studies to determine the invasive species most likely to be affected by climate change and ways in which these species will affect biodiversity (see *Box 14*).
  Lead agencies – DECC and DPI.
- Gain a better understanding of likely changes in the distribution, abundance and impacts of invasive species through modelling.
  Lead agencies – DECC and DPI.
- Establish and adapt existing long-term monitoring programs to verify the outcomes of modelling.
  Lead agencies - DECC and DPI.
- Ensure existing management frameworks use research and information from the above projects.
  Lead agencies – DECC and DPI.

Box 14: Invasive species and climate change

Invasive plant and animal species are the second greatest cause of biodiversity loss in the world (IUCN 2000) and in NSW (Coutts-Smith and Downey 2006). Invasive animals threaten 14 of Australia's 15 World Heritage Areas and 13 of 15 'biodiversity hotspots'. Invasive plants and animals affect 70% of NSW's threatened species (Coutts-Smith and Downey 2006). Such impacts are likely to increase as a result of climate change (Natural Resource Management Ministerial Council 2004).

A DECC-led project aims to project the impacts of climate change on a range of invasive plant and animal species, which can be used to decide how such species should be controlled in the future. The objectives of this project will be consistent with the *National Biodiversity and Climate Change Action Plan* (Natural Resource Management Ministerial Council 2004).

Desired outcomes will be to develop:

- a priority list of invasive species affected by climate change
- models which assess the influence of climate change on invasive species
- recommendations that focus on management of invasive species in NSW according to the objectives of the *National Biodiversity and Climate Change Action Plan* (Natural Resource Management Ministerial Council 2004).
- a list of future research priorities.

Project lead: DECC
Funding: NSW Government

DECC

R. Hoskings, DECC

3 Appendices

Appendix 1. Acronyms and abbreviations

CCIARP	Climate Change Impacts and Adaptation Research Program
CMA	Catchment Management Authority
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DECC	Department of Environment and Climate Change NSW
DoP	NSW Department of Planning
DPI	NSW Department of Primary Industries
LEP	Local environmental plan
LGSA	Local Government and Shires Association

Appendix 2. Key contacts and further information

Australian Greenhouse Office: www.greenhouse.gov.au

National Biodiversity and Climate Change Action Plan:
www.deh.gov.au/biodiversity/publications/nbccap-brochure/future.html

Department of Environment and Climate Change NSW: www.environment.nsw.gov.au

NSW Department of Primary Industries: www.dpi.nsw.gov.au

NSW Department of Planning: www.planning.nsw.gov.au/index.asp

Australian Museum: www.austmus.gov.au

Botanic Gardens Trust: www.rbgsyd.nsw.gov.au

Further information

For further information about this document, please contact the Manager, Biodiversity and Threatened Species Section, Department of Environment and Climate Change NSW. Write to PO Box A290, Sydney South NSW 1232, phone (02) 9995 5000 or email info@environment.nsw.gov.au.

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5 Glossary

TERM	MEANING IN THIS DOCUMENT
Adaptation actions	Responses, whether natural or assisted by humans, which enable species and ecological processes to adjust and evolve in response to a changed environment.
Biodiversity	The diversity or variability of living organisms of all types, including genetic, species, and ecosystem diversity.
Climate	The weather conditions of a region, such as temperature, pressure, humidity, precipitation, sunshine, cloudiness and winds, averaged over some period of time, such as the 30-year timespan used by the World Meteorological Organization.
Climate change	The statistically significant variation in the average state of the global or regional climate persisting for an extended period. The UNFCCC definition relates to changes in climate due to anthropogenic factors in addition to changes caused by natural processes.
Ecosystem	A community of organisms, interacting with one another and with the environment in which they live. It includes all living and non-living components, and the local climate.
Resilience	The ability to withstand or recover from environmental stresses. For example, the healthier an ecosystem is, the greater its resilience, and the lower its vulnerability to environmental threats.
Refuge	A place where species have survived past environmental and climatic changes. Also a place where species may survive the immediate effects of climate change or other threats and from where they may move to new locations if necessary.
Strategic wildlife habitats and corridors	Places important for species persistence or migration, providing suitable habitat enabling movement across the landscape in response to climate change or other threats.
Weather	The state of the atmosphere, characterised by variables such as temperature, wind, precipitation, clouds, pressure, humidity and sunshine.