Australian Government
Director of National Parks

BOODEREE NATIONAL PARK

Booderee National Park

Climate Change Strategy 2010-2015

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1. Background

The Intergovernmental Panel on Climate Change Fourth Assessment Report concluded that human induced climate change is expected to have a discernable influence on many physical and biological systems. The resilience of many ecosystems is likely to be exceeded over the course of the twenty-first century and approximately a quarter of all plant and animal species are likely to be at increased risk of extinction if increases in global average temperature continue to match current projections (IPCC 2007).

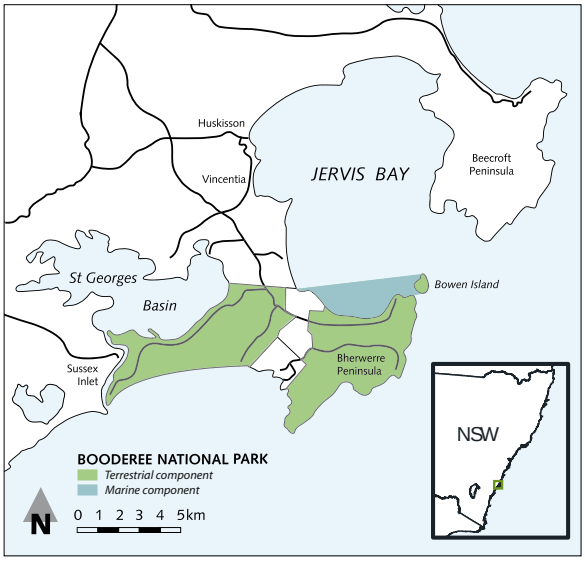
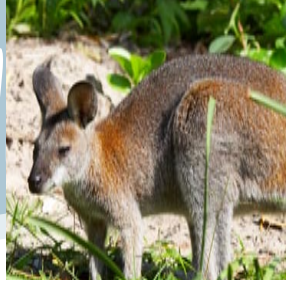


Figure 1: Location of Booderee National Park

Booderee National Park is located on the south-east coast of Australia within the Jervis Bay Territory and includes most of the Bherwerre Peninsula, Bowen Island and the waters and seabed in the southern part of the Bay (Figure 1). The park is located less than 200 kilometres south of Sydney and covers an area of 6,379 hectares which includes a marine area of 875 hectares (Director of National Parks 2009).

The park contains approximately 200 bird species, 26 native terrestrial mammal species, 17 reptile species, 14 amphibian species and at least 308 fish and marine macroinvertebrate species (Director of National Parks 2009). Booderee is a major biogeographic node of south-east Australia containing a variety of relatively undisturbed terrestrial and marine habitats.

Booderee is rich in cultural heritage and has been a significant place for generations of Aboriginal people who have lived and cared for the country for thousands of years. The park is jointly managed under the direction of a Board of Management, which has an Aboriginal majority from the Wreck Bay Community representing the traditional owners. Day-to-day management is carried out by Parks Australia, a division of the Australian Government Department of the Environment, Water, Heritage and the Arts. Park managers will need to adapt current park management practices based on a contemporary and scientific understanding of the likely impacts of climate change and the accumulated traditional knowledge of the changes that have occurred in the Booderee region over thousands of years.



The *Booderee National Park Climate Change Strategy 2010-2015* recommends the preliminary adaptation, mitigation and communication actions that are required to manage the consequences of climate change and reduce the carbon footprint of the park. The strategy is consistent with the *Parks Australia Climate Change Strategic Overview 2009-2014* and the policies and actions of the *Booderee National Park Draft Management Plan 2010-2020* which is currently being finalised.

Climate change is a long–term issue and this strategy is an incremental 'first step' to what must be a long–term and enduring response. This strategy is an adaptive tool subject to ongoing review, and management responses will be amended to take account of improvements in the understanding of the implications of climate change for the park.

2. Regional Climate Change Projections

The future climate of the Sydney region of New South Wales is expected to be warmer and drier (CSIRO 2007). These projected trends are likely to lead to increased evaporation, heat waves, extreme winds and fire risk. A summary of these effects are provided in Table 1 (uncertainties shown in brackets).

Table 1: Climate change scenarios for the Sydney region of New South Wales

Climate change factor	Baseline (1975-2004)	2030 scenarios	2070 scenarios
Sea level rise [a]	0	+17cm	+50cm
Annual average temperature [b]	Max 26°C Min 17°C	+0.2°C (±1.6°C)	+0.7°C (±4.8°C)
Annual average days >35°C [a]	5 days	4-6 days	4-18 days
Annual average days with very high or extreme forest fire danger [a]	9 days	9-11 days	10-15 days
Annual average rainfall [b, c]	1,241mm	-13% (±7%) [b]	-40% (±20%) [b]
Annual average potential evaporation [b]	-	+1% (±8%) [b]	+2% (±24%) [b]
Extreme weather events [a]	-	Increasing periods of drought and increasing frequency and intensity of storm activity	
CO_2 concentration [b]	353ppm	+165ppm	+365ppm

a Hyder 2008
b CSIRO 2007
c Bureau of Meteorology 2010

3. Impacts of Climate Change on Booderee National Park

Booderee National Park contains both marine and terrestrial environments that will be threatened by the effects of climate change. The key threats of climate change to the moist sub-tropical climatic zone of the Australian east coast are an increase in the frequency, intensity and extent of fire, local extinctions within a fragmented landscape and sea level rise in coastal areas (Dunlop & Brown 2008). There is a degree of uncertainty regarding how some of these projections of climate change will specifically affect the natural, cultural and economic values of Booderee National Park. However, based on regional climate change projections the following impacts are expected.

Fire frequency and intensity

Increased atmospheric CO_2 concentrations may increase photosynthesis and plant biomass of certain species that may impact on vegetation community structure and composition (Hyder 2008). The build up of undergrowth and invasive annual grasses in woodland habitats may lead to increased fuel loads. When this is combined with an increase in extreme temperature days and evaporation, it is likely that there will an increase in the frequency and intensity of fire in the park.

Vegetation communities in the park that are particularly vulnerable to an increase in fire frequency include rainforests, swamp oak forests, dune systems and heath communities (either along swamp/riparian zones or on skeletal soils). Conversely, some species in the park such as *Eucalyptus stricta* and *Eucalyptus sclerophylla* are expected to benefit from an increase in fire frequency which may alter the existing composition and structure of some of the forest habitats. More fire resistant species and communities are expected to be advantaged by climate change (Hyder 2008).

Some fauna are particularly susceptible to fire, whilst others are vulnerable to changes in fire frequency and intensity. Key issues for mobile species include the scale of fire, patchiness of habitat and connectivity to suitable habitat following fire. The entire breeding habitat of little penguins (*Eudyptula minor*), a flightless ground nesting sea bird which breeds on Bowen Island, could be destroyed in a single fire. Eastern bristlebirds (*Dasyornis brachypterus*) and sugar gliders (*Petaurus breviceps*) also seem to be very susceptible to fire and are more likely to be predated upon after fire.

The park has good data on faunal responses following recent fires. This will be invaluable in considering the impacts of climate change on the park. Modelling of key indicator species in the park against expected changes in fire frequency and intensity would be desirable.

Sea level rise and increased storm intensity and frequency

An increase in sea level combined with increased intensity and frequency of storm events may result in direct damage to fringing coastal habitat, particularly in some of the more exposed areas of Bowen Island. Seabirds nesting on sites close to the mean high water mark may be affected. The foraging behaviour and diet of seabirds relying on clear water to source food (e.g. little penguins and cormorants) may be impacted by increased turbidity in the waters in and surrounding the park (Hyder 2008).

Increased erosion and sedimentation is likely to result from increased storm frequency and intensity which is expected to impact on the marine environment of the park, in particular damage to seagrass habitat. Erosion may also lead to a more rapid deterioration of cultural artefacts located within the park such as midden sites, rock shelters and ceremonial grounds (Hyder 2008).

Biodiversity impacts

Higher annual average temperatures are likely to affect triggers for life cycle events, population ecology and the occurrence of suitable habitats for a range of species. Climate change will impact on the ecology of individual organisms that will ultimately lead to changes in populations. Dunlop and Brown (2008) identified four main outcomes that might be expected from populations in response to the effects of climate change. These outcomes are not mutually exclusive as a number of the factors may occur together within a population. They are:

- survival within the current distribution (although there may be changes in abundance, behaviour or habitat)
- evolutionary adaptation to enable survival (this may be at a genetic, species or population level)
- changes in population distribution
- extinction.

Indigenous and cultural impacts

Booderee has always been a significant place for Koori peoples. It has provided sustenance and shelter for hundreds of generations and the loss of culturally significant sites and species due to the effects of climate change would be devastating. Key threats to Indigenous and cultural values of the park from climate change include:

- impacts on sacred sites, middens and other sites of cultural significance
- changes in the abundance and distribution of bush tucker and medicinal plants
- changes in the composition of freshwater and saltwater species (e.g. possible migration of tropical marine species such as stinging jellyfish).

Changes to ocean current

Booderee National Park includes the southern part of Jervis Bay which is influenced by the southward flowing continental-scale East Australia Current which is in turn affected by global-scale currents of the Pacific Ocean (predominantly the South Equatorial Current). These currents have a major bearing on the productivity and availability of food in Jervis Bay. The frequency and strength of local currents are driven by global climate phenomena such as the El Niño-Southern Oscillation. Under climate change the El Niño phases may become longer and more frequent which may lead to extended periods of low productivity as a result of reduced nutrient flow into the bay.

Arrival of new species

Climate change is likely to change the species composition of communities and ecosystems. Invasive weeds and pests will be more likely to establish due to increased disturbance and less suitable conditions for local species (Dunlop & Brown 2008). The spread of kikuyu grass (*Pennisetum clandestinum*) on Bowen Island and bitou bush (*Chrysanthemoides monilifera*) across the park is of particular concern. New arrivals may also be native species that extend their range in response to changing climatic conditions. These species may have an impact on existing resident populations.

Visitor impacts and human health

The relationship between visitor expectations and actual visitor experiences in relation to fauna and flora interactions, park access and weather conditions will need to be managed as the impact of climate change becomes better understood. An increase in the annual average temperature, the number of days greater than 35°C and changing rainfall patterns may impact on visitor and staff comfort and satisfaction. The incidence of heat stroke and heat stress is also likely to increase. More extreme weather events may increase the risk of injury to both park visitors and staff. Visitor safety may be at increased risk on days of extreme fire danger which may force the park to close altogether in order to protect park visitors.

Buildings and infrastructure

More extreme climatic conditions are expected to place additional pressure on the resilience and suitability of park infrastructure, which is likely to have flow-on implications for maintenance costs. Increased erosion caused by more intense storm activity is likely to adversely impact infrastructure such as walking tracks and roads. Increased fire frequency may result in the need for more frequent closure of walking tracks and camping areas. There may be a need to relocate existing assets from high risk areas.

Water resources for the park are obtained exclusively from Lake Windermere (a natural water table lake located in the park). The future viability of the lake as a dependable water supply for the Jervis Bay Territory may be threatened under climate change scenarios of more frequent and persistent droughts.

4. Recommended Management Strategies

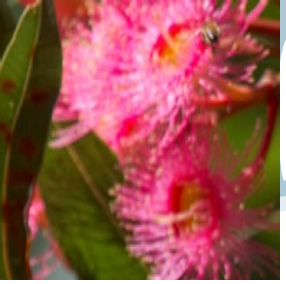
The recommended management strategies align with the five objectives of the *Parks Australia Climate Change Strategic Overview 2009-2014* outlined below.

1. To understand the implications of climate change.
2. To implement adaptation measures to maximise the resilience of our reserves.
3. To reduce the carbon footprint of our reserves.
4. To work with communities, industries and stakeholders to mitigate and adapt to climate change.
5. To communicate the implications of, and our management response to, climate change.

4.1 Understand the implications of climate change

A good knowledge of the implications of climate change is necessary to enable us to prepare and implement an effective response. Given the uncertainties of climate change at a local scale, and our current knowledge gaps, the task of improving our understanding will be an on-going effort. Understanding how various natural and cultural elements of the landscape may respond to changing conditions, and designing long term research and monitoring programs that inform management responses is a priority.

	Recommended Management Actions	Timeframe
4.1.1	Identify critical knowledge gaps in baseline data and identify priorities for further research or integrated monitoring programs to study the causes and effects of landscape change, how these processes interact and how effects vary across different vegetation communities in conjunction with key stakeholders and scientists (e.g. Australian National University, Australian Research Council, Bushfire Cooperative Research Centre and CSIRO).	By 2011
4.1.2	Continue to partner with research institutions on projects that target identified knowledge gaps and improve understanding of the resilience of species and communities in the park.	Ongoing
4.1.3	Work with partners to develop spatial information systems that assist in predictive modelling of climate change impacts on the distribution and abundance of vulnerable species and communities (including invasive species) under different scenarios.	By 2015
4.1.4	Continue existing long term monitoring programs for significant fauna species expected to be impacted by climate change (e.g. eastern bristlebird, emu wren), significant flora species (e.g. magenta lillipilli (*Syzygium paniculatum*) and swamp oak (*Casuarina glauca*)) and vegetation communities (e.g. casuarina swamp forest, littoral rainforests and sedgelands).	Ongoing
4.1.5	Identify a set of baseline parameters (climatic, geomorphological, hydrological, ecological and social) to effectively monitor the effects of climate change.	By 2011
4.1.6	Establish and implement a monitoring program for parameters identified in Action 4.1.5 that are not already targeted in existing long term monitoring programs. Methods used to monitor the effects of climate change must have appropriate sensitivity to detect changes. Monitoring program should have explicit measures for communicating outcomes between land managers, researchers and the general community.	By 2012
4.1.7	Undertake a risk assessment, in partnership with the Wreck Bay Community, of the likely impacts of climate change on significant cultural sites and identify the mitigation measures that may be required.	By 2014
4.1.8	Continue to improve data management and the technical capacity of park staff (e.g. GIS, remote-sensing and field monitoring skills).	Ongoing



4.2 *Implement adaptation measures to maximise the resilience of our reserves*

The condition of the natural and cultural values of the park is dependent on the rate of climate change itself and the resilience of the park to cope with this change. A focus of park management is to reduce the impact from invasive species and inappropriate fire regimes. This will maximise the resilience of species and communities to adapt to the additional challenges brought about by climate change. The park needs to be managed using an ecosystem-based approach (rather than single species), in partnership with park neighbours, to maximise opportunities for changes in the distribution of species or populations.

	Recommended Management Actions	Timeframe
4.2.1	Continue to implement the existing strategic weed and feral pest monitoring and control programs to maximise the resilience of species and habitats in the park.	Ongoing
4.2.2	Continue to develop and implement landscape unit-based fire management strategies for the major landscape types in the park.	Ongoing
4.2.3	Identify species and habitats where impacts from feral pests, weeds, fire and high visitation rates are likely to be exacerbated by climate change and revise management programs accordingly.	By 2012
4.2.4	Identify, map and protect areas likely to be used as transitional or habitat refugia that will allow for latitudinal shifts in the distribution and abundance of species and communities in the face of climate change and sea level rise.	By 2012
4.2.5	Continue collaboration with neighbours (e.g. NSW National Parks and Wildlife Service, Wreck Bay Aboriginal Community, Emergency Management Committee stakeholders) to ensure coordination of data, fire, weed and feral management.	Ongoing
4.2.6	Continue collaboration with the Australian National University in relation to fire management research projects and incorporate key findings into fire management strategies.	Ongoing
4.2.7	Continue collaboration with relevant land planning agencies to protect park values from inappropriate coastal development on neighbouring land to bolster connectivity with other elements of the national reserve system.	Ongoing
4.2.8	If parts of the landscape are changing in ways that are of concern, the Director and Board, in consultation with relevant stakeholders, will jointly decide on further monitoring requirements, and whether protective, rehabilitation or adaptation measures are feasible. If cost effective, appropriate actions will be implemented.	Ongoing

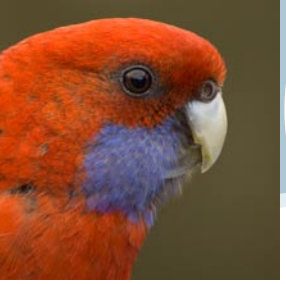
4.3 Reduce the carbon footprint of our reserves

The park adopts environmental best practice principles for resource use and management of waste products in the park. These principles are consistent with the need to conserve the park's natural and cultural resources, and meet broader commitments to reduce greenhouse gas emissions, reduce water use and minimise the potential impacts associated with waste management.

Park operational activities such as transport, electricity generation and use, housing design, development of new infrastructure and waste management all contribute to the park's carbon footprint. Land management activities such as revegetation projects, fire management and pest management also have implications for the carbon cycle. It is necessary to better understand the impact of land management activities (including carbon sequestration) on the size and nature of the park's carbon footprint to allow performance to be holistically measured and improved over time. Careful management of these activities can help to reduce overall emissions.

Parks Australia will aim to reduce greenhouse gas emissions from park operational activities (such as energy use, transport and waste management) to 10 per cent below 2007-08 levels by mid 2015.

	Recommended Management Actions	Timeframe
4.3.1	Develop an environmental management plan for the park that identifies actions to reduce the carbon footprint of park operations and the level of carbon emission reduction associated with each mitigation action.	By 2012
4.3.2	Until an environmental management plan is developed (as per Action 4.3.1) investigate the feasibility of: • transitioning the park depot and camping areas to renewable energy sources such as solar energy • transitioning existing electric hot water systems to more efficient systems (e.g. solar hot water, gas, efficient heat pumps) as replacement becomes necessary • converting existing wood-fired BBQs into electric or gas BBQs • installing energy efficient light fixtures and light-controlling devices (e.g. motion sensors) in all park facilities • replacing older vehicles with more efficient vehicles • establishing guidelines to formalise waste reduction strategies into standard park practices (e.g. reducing consumption, printing double sided, recycling).	Ongoing
4.3.3	Work with partners to improve quantification of the carbon cycle as it relates to the management of fire, vegetation, soil and invasive species in the park.	By 2014
4.3.4	Based on the quantification of the carbon cycle of land management activities (Action 4.3.3), refine weed, feral pest and fire management regimes to reduce the carbon footprint of the park and maximise carbon retention in natural vegetation.	By 2015
4.3.5	Investigate opportunities for the park to participate and capitalise on future carbon trading schemes.	Ongoing



4.4 Work with communities, industries and stakeholders to mitigate and adapt to climate change

Many communities and businesses rely on Booderee National Park to attract tourists and provide essential ecosystem services. Climate change will have an impact on these communities and industries and they will need to mitigate and adapt to the changes. The park will work with local communities and stakeholders to identify and support proactive measures to reduce the negative impacts of climate change and to adapt where climate change induced impacts are unavoidable. The increase in frequency and intensity of extreme weather events will necessitate the development of risk control measures to protect life, infrastructure and the natural and cultural values of the park.

	Recommended Management Actions	Timeframe
4.4.1	Continue to work with the Wreck Bay Aboriginal Community and other park stakeholders (e.g. tourist accommodation providers) to promote renewable energy projects.	Ongoing
4.4.2	Identify employment opportunities for Wreck Bay Community to participate in climate change monitoring and remedial activities.	Ongoing
4.4.3	Investigate opportunities to assist tourism businesses dependent on the park to adapt their businesses to the impacts of climate change.	Ongoing
4.4.4	Continue training of field staff to ensure improved response capability and operational management of park incidents.	Ongoing
4.4.5	Continue the park's active role on the Jervis Bay Territory Emergency Management Committee and continue to hold joint exercises with relevant emergency management agencies to test emergency response plans and capacity to respond to extreme weather events.	Ongoing
4.4.6	Continue to reassess risks and amend or develop appropriate emergency management policies (e.g. fire evacuation plans, total fire ban policy) as required.	Ongoing
4.4.7	Conduct an infrastructure risk assessment to identify assets at risk from climate change impacts and extreme weather events. Assessment should recommend assets requiring upgrading, relocation or those unsuitable in the future climate change environment.	By 2013

4.5 Communicate the implications of, and our management response to, climate change

Climate change is a global issue affecting all aspects of our community and it is vital we share our knowledge with stakeholders, government bodies and the general public. This will ensure that stakeholders and the public are informed about potential climate change impacts and the management directions that are being taken. This also ensures that efforts between government agencies, scientific researchers and the community are well coordinated.

	Recommended Management Actions	Timeframe
4.5.1	Develop and implement a communications strategy to better inform staff, traditional owners, stakeholders (including the tourism industry) and the general public of the implications of, and our management response to, climate change.	By 2012
4.5.2	Support the maintenance of publicly available information on the Parks Australia and Booderee websites for climate change policies, strategies and other documents relevant to the park.	Ongoing

5. Implementation and Review

The *Booderee National Park Climate Change Strategy 2010-2015* will be implemented over a five year period. While the strategy is consistent with the *Booderee National Park Draft Management Plan 2010-2020* (currently being finalised), implementation of the recommended management actions is subject to budgetary and resource constraints. The strategy will be reviewed on a rolling basis to take account of new information or changes in policy directions.

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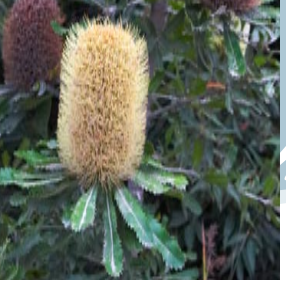

Prepared by: Director of National Parks

Note: This strategy sets out the preliminary actions and tools necessary to manage the consequences of climate change at Booderee National Park. While the Australian Government is committed to acting in accordance with the strategy, the attainment of objectives is subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the strategy due to changes in knowledge and policy direction.

This strategy should be cited as:

Director of National Parks 2010. *Booderee National Park Climate Change Strategy 2010-2015.* Department of the Environment, Water, Heritage and the Arts, Canberra, Australia.

This strategy is available from the Department's web site at: environment.gov.au/parks/climate.html

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