The Parliament of the Commonwealth of Australia

Case Studies on Biodiversity Conservation: Volume 1

First interim report of the inquiry into Australia's biodiversity in a changing climate

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

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Foreword

The world's focus on environmental conservation and sustainable development shifted significantly with the Earth Summit held in Rio de Janeiro in 1992. One of the key international agreements on biodiversity conservation came out of that summit: the Convention on Biological Diversity. The United Nations Conference on Sustainable Development—also referred to as Rio+20—will take place on 20–22 June this year, marking 20 years since the 1992 Earth Summit. The Committee's inquiry into Australia's biodiversity in a changing climate is therefore timely, as is the release of this first interim report.

This interim report represents site inspections carried out by the Committee between November 2011 and March 2012. During the inspections, the Committee had the opportunity to hear about the key threats to Australia's biodiversity in various regions, and to see firsthand some of the important conservation work being done on the ground. During the site visits, the Committee was impressed with the expertise, passion and commitment of not-for-profit environmental groups, natural resource management bodies, State government agencies, research institutions, and landholders, all working together to safeguard Australia's precious biodiversity.

Although specific individuals and organisations have been acknowledged throughout the report, I take this opportunity to again thank those who organised the valuable, informative site visits, and who took the time to meet with and brief the Committee. I also appreciate the cooperative and constructive approach my fellow Committee Members have taken in the conduct of this important inquiry.

Tony Zappia MP
Chair

Membership of the Committee

Chair	Mr Tony Zappia MP	
Deputy Chair	Dr Mal Washer MP	
Members	Ms Anna Burke MP (to 7/2/12)	Ms Nola Marino MP
	Ms Jill Hall MP	Mr Wyatt Roy MP
	Mr Harry Jenkins MP (from 7/2/12)	Mr Kelvin Thomson MP (from 25/10/10 to 11/10/11 and from 18/1/12)
	Mr Geoff Lyons MP(from 11/10/11 to 18/1/12)	

Committee Secretariat

Secretary	Ms Julia Morris
Inquiry Secretaries	Ms Peggy Danaee (from 7/11/11)
	Ms Julia Searle (to 4/11/11)
Senior Research Officer	Mr James Nelson
Administrative Officer	Mr Peter Pullen

Terms of reference

The Committee will inquire into and report on biodiversity in a change climate, in relation to nationally important ecosystems. The inquiry will have particular regard to:

- terrestrial, marine and freshwater biodiversity in Australia and its territories
- connectivity between ecosystems and across landscapes that may contribute to biodiversity conservation
- how climate change impacts on biodiversity may flow on to affect human communities and the economy
- strategies to enhance climate change adaptation, including promoting resilience in ecosystems and human communities
- mechanisms to promote the sustainable use of natural resources and ecosystem services in a changing climate
- an assessment of whether current governance arrangements are well placed to deal with the challenges of conserving biodiversity in a changing climate
- mechanisms to enhance community engagement.

The scope of the committee's inquiry shall include some case studies of 'nationally important ecosystems', as defined by submissions to the inquiry.

List of abbreviations

ACE CRC	Antarctic Climate and Ecosystems Cooperative Research Centre
DPIPWE	Department of Primary Industries, Parks, Water and Environment (Tas.)
OCBIL	Very old, climatically buffered, infertile landscapes
SOPA	Sydney Olympic Park Authority
UNESCO	United Nations Educational, Scientific and Cultural Organization

1

Introduction

1.1 On 2 June 2011 the committee commenced its inquiry into biodiversity in a changing climate, in relation to nationally important ecosystems, with particular regard to:

- terrestrial, marine and freshwater biodiversity;
- connectivity between ecosystems;
- how biodiversity loss might affect human communities;
- enhancing climate change adaptation;
- sustainable use of natural resources and ecosystem services;
- adequacy of current governance arrangements; and
- enhancing community engagement.[1]

1.2 The Committee considers that such broad terms of reference necessitate an extensive inquiry process, and has determined that an interim report is appropriate to update the House, and all those who have been involved with the inquiry to date, on progress on aspects of the inquiry.

1.3 Since the inquiry was advertised on 2 June 2011, 79 submissions and 41 exhibits have been received. To date, five public hearings and four site inspections have taken place. Through its ongoing program of site inspections, the Committee has considered case studies on nationally important ecosystems, including those which demonstrate aspects of adaptive management strategies, community engagement, sustainable resource use, and other matters relevant to the inquiry. These case studies are intended to illustrate some of the key issues arising from the

1 The inquiry was referred to the Committee jointly by the Minister for Sustainability, Environment, Water, Population and Communities, and the Minister for Climate Change and Energy Efficiency.

submissions and other evidence received to the inquiry, and demonstrate lessons that could be applied in similar ecosystems or circumstances across Australia.

1.4 To date, the Committee has carried out site inspections in:

- southwest Western Australia, an internationally-recognised biodiversity hotspot;
- the nationally-recognised biodiversity hotspot in the Tasmanian Midlands, and one of Australia's few alpine regions in Tasmania's Central Plateau;
- the New South Wales portion of the Australian Alps; and
- sites in Sydney that illustrate biodiversity conservation in an urban context, and have a focus on community engagement, sustainability, and biodiversity research.

1.5 Site inspections in Victoria and South Australia are planned for May. Visits to Queensland and the Northern Territory are intended to take place later in the year.

Scope of this report

1.6 As noted above, in this first interim report, the Committee provides an update on the progress of the inquiry. Additional site inspections are planned, and the Committee expects to continue to gather evidence at public hearings. To avoid pre-empting future deliberations or prejudicing impending evidence to the inquiry, the Committee has chosen to limit the scope of this report to the site inspections undertaken to date.

1.7 For the same reason, the Committee has reserved its right to make recommendations at this stage. Furthermore, Committee conclusions presented in this report are preliminary and may have only limited application outside the specific sites on which the Committee makes comment.

1.8 The remainder of this report is divided into four chapters; each chapter focuses on one region or site inspection program. The report describes the sites visited, with particular reference to the sites' relevance to the inquiry's terms of reference, and discusses the main issues explored by the Committee. A glossary, containing some of the more technical terms readers may encounter, is included at the back of the report.

2

Southwest Western Australia

2.1 During its visit to Western Australia (WA) on 7–8 November 2011, the Committee held a public hearing in Perth, before visiting various sites in the southwest corner of the state.

2.2 Southwest WA is one of Australia's 15 national biodiversity 'hotspots' and the only biodiversity hotspot located in Australia that is recognised by Conservation International.[1] The Margaret River region also forms the western extremity of Gondwana Link, a landscape connectivity project creating wildlife corridors connecting the forests of southwest WA with the Great Western Woodlands, around 1000 kilometres to the east.[2]

2.3 Southwest WA has been identified as one of three areas worldwide containing 'very old, climatically buffered, infertile landscapes', or OCBILs, which are known for their highly fragmented ecological communities with large numbers of endemic species. Species in OCBILs are particularly vulnerable to rapid climate change due to their evolution under climatically buffered conditions over the past tens of millions of years.[3]

2.4 The Committee was particularly interested to see some examples of the impacts that a recent long term drying trend in the climate of southwest

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1 Department of Sustainability, Environment, Water, Population, and Communities, 'Australia's 15 National Biodiversity Hotspots', <http://www.environment.gov.au/biodiversity/hotspots/national-hotspots.html> viewed 18 April 2012; Conservation International, 'The Biodiversity Hotspots: Asia–Pacific', <http://www.conservation.org/where/priority_areas/hotspots/asia-pacific/Pages/asia-pacific.aspx> viewed 18 April 2012.

2 Gondwana Link, 'The Gondwana Link Vision', <http://www.gondwanalink.org/aboutus/vision.aspx> viewed 16 April 2012.

3 Hopper, S. D. (2009), 'OCBIL theory: towards an integrated understanding of the evolution, ecology and conservation of biodiversity on old, climatically buffered, infertile landscapes', *Plant and Soil*, 322: 19–86.

WA has had on biodiversity in the area, and to learn about some of the management techniques that are being deployed in response.

Committee activities

2.5 The Committee met with organisations in Bunbury and Margaret River, presenting a range of views about some of the projects operating in southwest WA and the challenges facing the region. The Committee was also able to conduct site inspections in Lake Cave and Leeuwin Estate, which highlighted issues of tree decline, changing hydrological patterns (rainfall and groundwater), and connectivity between ecosystems. Several representatives from the organisations below accompanied the Committee for the duration of the 8 November site inspections and provided briefings on a range of issues relating to biodiversity conservation in southwest WA.

Meeting with South West Catchments Council and South Coast Natural Resource Management

2.6 On 7 November 2011, the Committee met with and received presentations from the following organisations in Bunbury:

- South West Catchments Council (SWCC), represented by:
  - ⇒ Mr David Gardner, Chair;
  - ⇒ Mr Bernie Masters, Deputy Chair; and
  - ⇒ Mr Damien Postma, CEO; and
- South Coast Natural Resource Management (SCNRM), represented by Mr Justin Bellanger, Operations Manager.

2.7 The SWCC and SCNRM are two of the nation's 56 natural resource management organisations, the boundaries for which have been established by agreement between the Commonwealth and state and territory governments. The organisations receive funding from the Commonwealth Government under the Caring for our Country initiative, in addition to other funding sources. Together, the two organisations cover an area of more than 10 million hectares of southwest WA.[4]

2.8 The Committee received an overview of the operations of both organisations and some of the particular issues they face in relation to biodiversity conservation. General issues discussed in relation to the

4 Australian Government, Caring for Our Country, 'NRM Regions', <http://www.nrm.gov.au/about/nrm/regions/index.html> viewed 18 April 2012.

governance of natural resource management organisations included the need for longer term funding models to improve staff retention, the importance of skills-based boards of management, the value of administrative funding for small, volunteer-run organisations, and the advantages and disadvantages of Western Australia's non-statutory model of natural resource management.

2.9 During its meeting with SWCC and SCNRM, the Committee was presented with the following documents:

- *Annual Report 2010–11*, SWCC.
- *South West Regional Ecological Linkages: Technical Report*, Western Australian Local Government Association and Department of Environment and Conservation, 2009.
- *State of the Environment Report: Western Australia 2007*, 'Theme 5: Biodiversity', Environment Protection Agency (WA).
- *Phytophthora Dieback: Under the Radar and on the Move*, SCNRM, 2011.
- *Southern Prospects 2011–2016: The South Coast Regional Strategy for Natural Resource Management*, SCNRM, 2011.
- *Identification and Conservation of Fire Sensitive Ecosystems and Species of the South Coast Natural Resource Management Region*, Department of Conservation and Land Management (WA), 2009.
- *Climate Change: Whole of Landscape Analysis of the Impacts and Options for the South Coast Region*, prepared for SCNRM, 2009.
- A variety of other materials including trend data for WA's rainfall, temperature and dam inflows; maps; DVDs; brochures; newsletters; a coastal planting guide; and promotional materials related to phytophthora dieback mitigation.

Meeting with Gondwana Link, Cape to Cape Catchments Group, and Greening Australia

2.10 On 8 November 2011, the Committee met with:

- Gondwana Link, represented by Mr Keith Bradby, Program Director;
- Cape to Cape Catchments Group, represented by:
  - ⇒ Mr Drew McKenzie, Biodiversity Project Officer; and
  - ⇒ Ms Hayley Rolfe, Co-ordinator; and
- Greening Australia, represented by:
  - ⇒ Mr Craig Anderson, CEO Western Australia; and
  - ⇒ Mr Hamish Jolly, Advisor and former National CEO.

2.11 During the meeting, the Committee received presentations on Gondwana Link and the Cape to Cape Catchments Group, and was presented with the following document:

- *Gondwana Link: A Landscape Scale Restoration Project in South-West WA*.

2.12 Further information about Gondwana Link and the Cape to Cape Catchments Group is discussed below.

Lake Cave and nearby marri tree decline

2.13 The Committee travelled to Lake Cave, one of many caves in the Leeuwin–Naturaliste Ridge and a popular local tourist attraction. The Committee was given a tour of the cave by representatives of the Augusta Margaret River Tourism Association, which is responsible for managing the area's caves.

2.14 During the tour, the Committee was shown evidence of declining water levels in the cave, and was informed about the impact this has had on the cave's aquatic subterranean invertebrates, known as stygofauna. The Committee also heard about the recent installation of a rainwater harvesting system to supplement the water naturally occurring in the cave in order to minimise the impact of the drying climate.

2.15 Following the visit to Lake Cave, the Committee was presented with the following document describing the impact of the region's drying climate on the cave's aquatic root mat communities and stygofauna:

- *Lake Cave Eco-Hydrology Recovery Project: Threatened Ecological Community and Hydrology Baseline Monitoring Report No. 1*, Subterranean Ecology Pty Ltd and Augusta Margaret River Tourism Association, 2010.

2.16 Close to Lake Cave, the Committee was also shown a typical example of a large marri tree that has declined in health in recent years. This was facilitated by the representatives of the Cape to Cape Catchments Group.

Figure 2.1 Lake Cave's dramatic opening

Photograph courtesy of committee secretariat

Riparian rehabilitation at Leeuwin Estate

2.17 Also on 8 November 2011, the Committee was shown an example of some riparian rehabilitation work undertaken along a fenced section of the Boodjidup Brook running through the land of the Leeuwin Estate winery, near Margaret River.

2.18 The work has involved plantings of native species appropriate for the area, and was intended to stabilise the banks of the stream and improve the natural amenity of the land. The work was coordinated by the Cape to Cape Catchments Group, with assistance from Leeuwin Estate and from a variety of other groups, including school groups.

Figure 2.2 The Committee inspecting a riparian rehabilitation project near Leeuwin Estate winery

Photograph courtesy of committee secretariat

Issues explored in southwest Western Australia

2.19 Through its program of meetings and site inspections in southwest WA, the Committee heard about issues that were particularly relevant to the region, including changed rainfall patterns, tree decline, phytophthora dieback, reduced groundwater, and connectivity between ecosystems.

Changed rainfall patterns in southwest WA

2.20 The Committee was presented with evidence of a drying trend in rainfall and stream flow patterns across southwest Western Australia, which appears to be associated with various other threats to biodiversity in the region as discussed below.

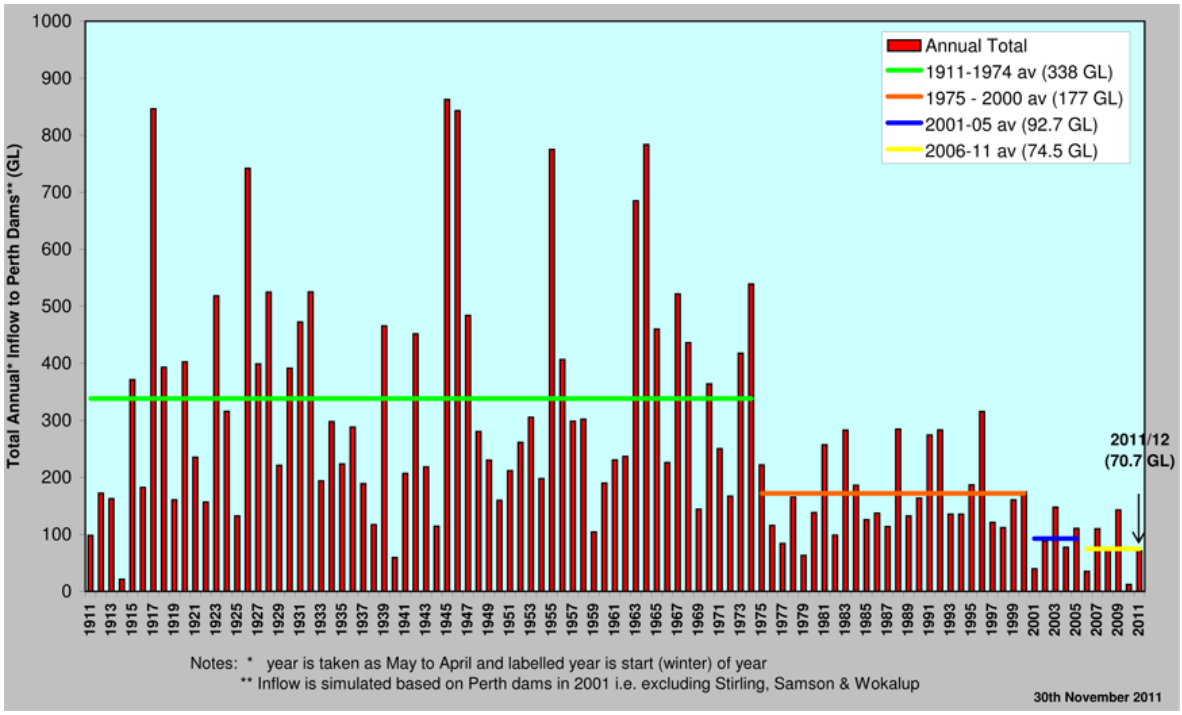
2.21 The Committee was advised that although overall reductions in rainfall in the area have been only moderate, changes in rainfall seasonality and intensity have led to dramatically reduced amounts of run-off. As shown in Figure 2.3, the total annual inflow into Perth dams has reduced from an

average of 338 gigalitres prior to 1975 down to an average of only 74.5 gigalitres over the past six years.[5]

2.22 This was illustrated in Margaret River, where the Committee heard that although rainfall has reduced by only nine per cent in the past ten years, this has resulted in a 46 per cent reduction in stream flow compared to previous decades.

2.23 At the public hearing in Perth on 7 November, representatives of the WA Centre of Excellence for Climate Change, Woodland and Forest Health advised the Committee to consider the impact of these reductions in rainfall and stream flow on WA's biodiversity, noting that water is one of the key drivers of ecosystem function. It was emphasised that 'environmental water'—that is, the water used by forests to maintain biodiversity—is crucial for the health of ecosystems. The Committee heard that over the past two decades there have been significant declines in ground water levels in the region, including falls of up to 10 to 20 metres.[6]

Figure 2.3 Annual stream flow into Perth dams 1911 to 2011



Source *Western Australian Water Corporation*

5 Western Australian Water Corporation, 'Yearly streamflow for major surface water sources', <http://www.watercorporation.com.au/D/dams_streamflow.cfm> viewed 11 April 2012.

6 Prof. Bernard Dell, Chief Investigator, Western Australian Centre of Excellence for Climate Change, Woodland and Forest Health, *Committee Hansard*, Perth, 7 November 2011, p. 37.

Committee comment

2.24 The Committee understands that while the precise impacts on rainfall under different climate change scenarios is difficult to predict, and varies greatly from place to place, southwest WA is one location where there is particularly strong evidence of a drying trend. As noted in the above discussion, the impact of a drying climate on water supplies is already being observed in WA, and this appears to be having a correspondingly severe impact on the region's biodiversity.

Tree decline

2.25 At the public hearing in Perth, representatives of the WA Centre of Excellence for Climate Change, Woodland and Forest Health informed the Committee that over the last decade southwest WA has been experiencing widespread declines in a range of woodland tree species, including tuart, wandoo, WA peppermint, jarrah and marri. While the exact mechanisms leading to these declines are uncertain, the Centre expects that they are at least partially due to the hotter and drier conditions attributed to climate change in the area.[7] In the summer of 2010–11, the area experienced a mass collapse of around 18 000 hectares of northern jarrah forest, a key over-storey species, coinciding with a period of high temperatures, the driest year on record, and the unprecedented ceasing of flow in both 'permanent' and ephemeral streams.[8]

2.26 As noted above, in the Margaret River area the Committee was shown an example of a marri tree that was suffering from decline in health. The marri (*Corymbia calophylla*) is considered a keystone species which a number of threatened species, including the Carnaby's black cockatoo, depend on for food.[9] While the precise causes for marri tree decline are unknown, marri are subject to deterioration in health due to a fungal canker disease that damages stems and branches. They are also subject to a second fungal disease that affects buds, flowers and new shoots.[10] While these diseases were affecting marri trees prior to the advent of modern

7 Prof. Giles Hardy, Director, Western Australian Centre of Excellence for Climate Change, Woodland and Forest Health, *Committee Hansard*, Perth, 7 November 2011, p. 36.

8 Prof. Hardy, Western Australian Centre of Excellence for Climate Change, Woodland and Forest Health, *Committee Hansard*, Perth, 7 November 2011, p. 36; Prof. Dell, Western Australian Centre of Excellence for Climate Change, Woodland and Forest Health, *Committee Hansard*, Perth, 7 November 2011, p. 37.

9 Cape to Cape Catchments Group, 'Threats to Biodiversity', <http://www.capetocape.org.au/ccg-programs/biodiversity/threats-to-biodiversity> viewed 12 April 2012.

10 Cape to Cape Catchments Group, 'Threats to Biodiversity', <http://www.capetocape.org.au/ccg-programs/biodiversity/threats-to-biodiversity> viewed 12 April 2012.

climate change, researchers have suggested that the drying climate has increased the susceptibility of trees to such existing stresses, to the extent that these pathogens are now more capable of killing the trees.[11]

2.27 At the public hearing in Perth, the Committee heard that many forests have unnaturally high densities of young trees due to past timber harvesting, which has resulted in high water usage and higher susceptibility to tree decline under drought conditions. It was suggested that consideration needs to be given to trialling the use of thinning techniques and changes to fire regimes in some forests to attempt to reduce the density of trees to a sustainable level.[12]

2.28 At its meeting in Bunbury, the Committee was cautioned about the inherent conflicts involved in this type of intervention. For example, the Committee heard that to regenerate tuart trees, Western Australian peppermint trees need to be burned in order to create a suitable ash bed. However, as peppermint trees provide important habitat for the threatened western ringtail possum, such burning does not occur.

Committee comment

2.29 The decline and rapid collapse of tree communities in southwest WA in response to recent climatic conditions is of concern to the Committee. The Committee recognises the need for long term monitoring of the tree decline problem in southwest WA, and supports limited trials of management techniques which could help minimise future damage and help conserve the region's biodiversity.

Phytophthora dieback

2.30 Phytophthora dieback refers to the *Phytophthora cinnamomi* pathogen, a water-borne mould which thrives in moist and warm soil environments with a Mediterranean climate around the world.[13] Its presence was first confirmed in Australia in the 1930s, and now infects native forests in all states and the Australian Capital Territory, including around 1 million hectares in southwest WA.[14] According to the WA Department of Environment and Conservation, as many as 2000 out of the estimated 9000 plant species in southwest WA are susceptible to phytophthora dieback.[15]

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11 Science Network Western Australia, 'Is Climate Change Behind Marri Cankers?', <http://www.sciencewa.net.au/topics/environment-a-conservation/item/145-is-climate-change-behind-marri-cankers??tmpl=component&print=1> viewed 12 April 2012.

12 Prof. Hardy, *Committee Hansard*, Perth, 7 November 2011, pp. 37, 38.

13 Markus, N. (2011) *Phytophthora Dieback: Under the Radar and on the Move*, SCNRM, p. 2.

14 WA Department of Environment and Conservation, *Supplementary Submission 74.1*, p. 1.

15 WA Department of Environment and Conservation, *Supplementary Submission 74.1*, p. 1.

Once a susceptible plant is infected, its roots become unable to take up water, causing the plant to become severely affected or die.[16]

2.31 At the public hearing in Perth, phytophthora dieback was described as a 'biological bulldozer' because of the severity and extent of its effect on native ecosystems.[17] Of particular concern is that the sites with low nutrient, fragile soils favoured by phytophthora are also the sites of some of Australia's richest biodiversity, such as the heavily infected Stirling Range National Park.[18]

2.32 SCNRM informed the Committee at its meeting that phytophthora dieback is the single biggest threat to biodiversity in southwest WA, and protection of uninfected areas is a critical concern. It was noted that phytophthora thrives under moist, warm conditions, and that an increase in the proportion of rainfall falling during summer months in southwest WA due to climate change may exacerbate the threat.

2.33 SCNRM advised that priority actions that need to take place to reduce the impact of phytophthora include investments in mapping uninfected areas, testing the susceptibility of species to dieback, management of infected areas, and community education and engagement. The Committee was also informed that more research is needed to better understand how the disease works.

Committee comment

2.34 Although it has received little attention at a national level to date, it is clear that phytophthora dieback has the potential to have a severe impact on Australia's biodiversity. Of particular concern to the Committee is that the pathogen is widespread in parts of southwest WA with very high levels of biodiversity, such as the Stirling Range National Park. These areas are home to many unique and iconic plant species, which could be threatened with extinction if the threat from dieback is not contained.

2.35 The Committee accepts that more needs to be done to help prevent the further spread of phytophthora dieback. This will require increased resourcing for efforts to monitor, contain, and treat affected areas, and to better educate the community about its threat. Additional research may also be required to better understand the phytophthora dieback pathogen and how it might respond to the changing climate in southwest WA.

16 Markus, N. (2011) *Phytophthora Dieback: Under the Radar and on the Move*, SCNRM, p. 3.

17 Mr Keiran McNamara, Director-General, WA Department of Environment and Conservation, *Committee Hansard*, Perth, 7 November 2011, p. 6.

18 Markus, N. (2011) *Phytophthora Dieback: Under the Radar and on the Move*, SCNRM, pp. 3, 5.

Reduced groundwater in Leeuwin–Naturaliste caves

2.36 Groundwater levels in the caves of southwest WA's Leeuwin–Naturaliste Ridge are known to have been declining since the 1970s, and more rapidly in recent years, primarily due to reductions in rainfall in the area.[19] Lake Cave, which has been a major tourist attraction in the Margaret River region for more than 100 years, is one example of an affected cave. The water level in Lake Cave's underground lake has declined from a relatively stable level of around 400 millimetres over the century up until 2005, rapidly declining to less than 200 millimetres in 2010.[20]

2.37 Lower water levels have had a significant effect on the biodiversity of the caves of the Leeuwin–Naturaliste Ridge, which support a number of distinct, groundwater-dependent ecological communities. The caves are home to various species of stygofauna (aquatic invertebrates) that are dependent on aquatic root mat communities (submerged tree roots). These root mat communities have been listed as critically endangered because of the declining groundwater levels, which have led to most known aquatic root mat communities in the Leeuwin–Naturaliste caves disappearing over recent years.[21]

2.38 In Lake Cave, a recent survey identified a 74 per cent reduction in stygofauna diversity, with the number of species reducing from 23 recorded in 2000 down to just six recorded in 2010. This was attributed to the decline in water levels and the subsequent drying out of many of the root mat communities in which these species were previously found.[22] During its visit, the Committee was informed that water acidification associated with lower water levels was also contributing to a decline in the cave's water quality.

2.39 The Committee is aware that rainwater tanks have been installed at Lake Cave. These tanks are being used to pump water into the cave to mitigate the effects of declining water levels. Water is monitored and treated to

19 Subterranean Ecology Pty Ltd and Augusta Margaret River Tourism Association (2010) *Lake Cave Eco-Hydrology Recovery Project: Threatened Ecological Community and Hydrology Baseline Monitoring Report No. 1*, p. 4.

20 Subterranean Ecology Pty Ltd and Augusta Margaret River Tourism Association (2010) *Lake Cave Eco-Hydrology Recovery Project: Threatened Ecological Community and Hydrology Baseline Monitoring Report No. 1*, p. 5.

21 Subterranean Ecology Pty Ltd and Augusta Margaret River Tourism Association (2010) *Lake Cave Eco-Hydrology Recovery Project: Threatened Ecological Community and Hydrology Baseline Monitoring Report No. 1*, pp. 5–6.

22 Subterranean Ecology Pty Ltd and Au% USgusta Margaret River Tourism Association (2010) *Lake Cave Eco-Hydrology Recovery Project: Threatened Ecological Community and Hydrology Baseline Monitoring Report No. 1*, p. 5.

achieve a sufficient level of quality before being fed into the back of the cave through a natural sand bank, using a drip irrigation system.[23]

Committee comment

2.40 The Committee's visit to Lake Cave highlighted the significance of the threat to biodiversity posed by the drying climate in southwest WA. Little attention is usually given to invertebrates in discussions about biodiversity. However, with a 74 per cent drop in the number of species at Lake Cave, this case study demonstrates that invertebrates may be one of the groups of animals most affected by climate change. It is clear that if it were not for the important tourism value of the caves, this particular impact would most likely have gone unnoticed.

2.41 The Committee sees a need for further assessment both of the impact of decreasing groundwater on biodiversity in other caves in the region, and of ways to mitigate species loss on a larger scale. Acknowledging that human interventions in environmental processes can be risky, interventions underpinned by solid research and regular monitoring may be necessary to prevent unacceptable levels of species loss.

Gondwana Link landscape connectivity project

2.42 The Gondwana Link project, established in 2002, aims to reconnect country across south-western Australia: more than 1000 kilometres from the Margaret River region in the west, to the woodlands and Mallee bordering the Nullarbor Plain in the east.[24] Of this area, the Committee understands that over 900 kilometres is intact native habitat, but many of the remaining parts have been heavily cleared for agriculture.

2.43 Gondwana Link incorporates areas of immense biodiversity value, including the Stirling Range and Fitzgerald River National Parks. The Committee was informed that the region supports more than 20 per cent of Australia's plant species. Much of the initial work of the project has concentrated on the area between these two national parks (known as the 'Fitz–Stirling').

2.44 Gondwana Link works with a range of partner organisations and community groups, including Greening Australia and the Cape to Cape Catchments Group, to achieve its goals. In the Fitz–Stirling region, Gondwana Link has secured protection for over 9400 hectares of land,

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23 See Subterranean Ecology Pty Ltd and Augusta Margaret River Tourism Association (2010) *Lake Cave Eco-Hydrology Recovery Project: Threatened Ecological Community and Hydrology Baseline Monitoring Report No. 1*, pp. 6–7.

24 Gondwana Link, 'The Gondwana Link Vision', <http://www.gondwanalink.org/aboutus/vision.aspx> viewed 16 April 2012.

both through acquisitions by organisations like Greening Australia and by encouraging land owners to enter into conservation covenants.[25] Most of the land is former farming land now considered marginal for agricultural purposes. In the Margaret River region, Gondwana Link has partnered with the Cape to Cape Catchments Group, which uses volunteer networks to initiate native habitat rehabilitation projects, such as the riparian rehabilitation project the Committee observed at Leeuwin Estate.

2.45 The Committee heard that community engagement is a major focus of the Gondwana Link project, including through partnerships with landowners, private industry, Indigenous groups, schools groups and the arts community. The Committee was informed that around 80 per cent of funding for Gondwana Link has come from the private sector, supplemented by some 'top-up' funding from the Commonwealth Government. The organisation has been exploring novel ways to fund its activities, including through biodiverse sandalwood plantations. With assistance from Greening Australia, Gondwana Link is now also exploring options for biodiverse carbon farming.

Committee comment

2.46 The Committee recognises the need for greater connectivity between protected areas in order to improve the resilience of ecosystems to climate change and provide opportunities for certain species to migrate. While acknowledging that connectivity corridors are only part of the solution to the biodiversity challenge, the Committee commends the contributions made by programs such as Gondwana Link.

Concluding remarks

2.47 The Committee is aware that one of the challenges in addressing threats to biodiversity is that, while impacts are observable in many ecosystems, threats to some species attract greater public awareness and concern than others. For less high profile species, severe impacts often go unnoticed. Most people are not aware of the devastating decline in biodiversity in ecosystems existing in rootmat communities, for example, but have great concerns about the impact of climate change on iconic animal species.

2.48 Similarly, phytophthora dieback is a threat to biodiversity that has a relatively low profile outside affected areas, and there is legitimate concern that its spread may become even more vigorous under changed climate conditions. During the course of its inspections to date, the

25 *Gondwana Link: A Landscape Scale Restoration Project in South-West WA*, p. 3.

Committee has observed that significant improvements in the public's awareness of threats to biodiversity can be achieved by cooperative projects involving a range of community stakeholders.

2.49 The Gondwana Link project provides a commendable example of how private sector organisations, volunteer groups, landowners and governments can combine resources and work together to achieve positive environmental outcomes and engage the community. The Committee appreciated the opportunity to see a small part of the project's implementation and to hear from some of the people involved. The Committee views this project as a model that could be replicated in other areas of high biodiversity value across Australia, not only for connectivity initiatives but also in response to other challenges such as salinity and invasive species.

2.50 The Committee expresses its thanks to all those who took the time to meet with the Committee during its visit to southwest WA. The opportunity to see and hear about some of the local effects that the changing climate is already having on biodiversity in the area was a valuable contribution to the current inquiry. Particular thanks go to Hamish Jolly for his role in arranging meetings and site visits in the Margaret River region.

3

Tasmanian Midlands and Central Plateau

3.1 Tasmania has been isolated from the Australian mainland for at least 10 000 years. It is characterised by geographic and environmental variation, and high ecological and species biodiversity.[1] The state is home to the Tasmanian Wilderness World Heritage Area, an area recognised by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in part for its unusually high proportion of endemic species.[2] Tasmania also contains one of Australia's few alpine regions, and one of 15 nationally-recognised biodiversity hotspots.[3]

3.2 Average temperatures have been rising in Tasmania since the 1950s, but not as rapidly as the Australian or global averages.[4] And while no significant change to *total* annual rainfall is projected in Tasmania under climate change scenarios, extensive changes are expected to regional and seasonal distributions of rainfall. This is likely to have significant implications for Tasmania's biodiversity.

3.3 The Committee visited several sites around Tasmania on 30 January 2012. Site inspections focussed on climate change impacts on terrestrial biodiversity, while evidence gathered at a public hearing the following day centred on marine ecosystems. This chapter outlines some of the

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1 Department of Primary Industries, Parks, Water and Environment (2010) *Vulnerability of Tasmania's Natural Environment to Climate Change: An Overview*, Department of Primary Industries, Parks, Water and Environment, Hobart.

2 UNESCO, 'Tasmanian Wilderness', <http://whc.unesco.org/en/list/181> viewed 11 April 2012.

3 Department of Sustainability, Environment, Water, Population and Communities, 'Australia's 15 National Biodiversity Hotspots', <http://www.environment.gov.au/biodiversity/hotspots/national-hotspots.html> viewed 11 April 2012.

4 Antarctic Climate and Ecosystems Cooperative Research Centre (2010) *Climate Futures for Tasmania general climate impacts: the summary*, Hobart.

issues the Committee investigated during its site inspections in the Tasmanian Midlands and on the Central Plateau.

Committee activities

3.4 The Committee visited three distinct sites in the Tasmanian Midlands and on the Central Plateau. The inspections provided an insight into the diversity of Tasmania's landscapes, and the challenges both common and unique to each region. The following officers from the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE) joined the Committee for the duration of the site inspections:

- Mr Michael Comfort, Geodiversity Section Leader;
- Ms Louise Gilfedder, Senior Conservation Scientist;
- Dr Wendy Potts, Senior Botanist (Threatened Flora); and
- Mr Peter Voller, Branch Manager, Land Conservation Branch.

3.5 DPIPWE officers provided briefings at each of the sites, and also briefed the Committee on related matters throughout the day, including: the Tasmanian Wilderness World Heritage Area, including threats to biodiversity such as phytophthora dieback; initiatives to promote citizen science; the Wealth for Water program; and weather monitoring and data-gathering.

3.6 During the inspections, the Committee received the following documents from DPIPWE officers:

- *Vulnerability of Tasmania's Natural Environment to Climate Change: An Overview*, DPIPWE, 2010.
- *Potential Climate Change Impacts on Geodiversity in the Tasmanian Wilderness World Heritage Area – Overview*, C. Sharples, 2011.
- *Implications of Climate Change for Australia's National Reserve System: A Preliminary Assessment*, M. Dunlop and P. R. Brown, 2008.

Revegetation in the Tasmanian Midlands

3.7 The Tasmanian Midlands bioregion is one of 15 national biodiversity hotspots, and is home to endemic plant species, endemic freshwater mollusc species, and invertebrates. The area contains 32 nationally-recognised threatened species and more than 180 species listed as

threatened under state legislation. It also contains several wetlands of national and regional significance.[5]

3.8 Of the threats to biodiversity in the Midlands, of significance is the high degree of landscape fragmentation resulting from its land use history, which includes extensive clearing for agriculture and plantation forestry. Native vegetation remnants in the Midlands are small and scattered, and protected areas constitute less than two per cent of the bioregion.[6]

3.9 Members of the Committee had the opportunity to see firsthand the highly fragmented landscape when they visited visited Grassy Hut, a biodiverse carbon restoration research site near Bothwell in the Midlands. The Grassy Hut site is being used to identify priority areas for tree planting, and determine key plant species and optimal species relationships that will be best suited to being grown in the predicted hotter and drier conditions expected to result from climate change.

3.10 At the Grassy Hut site, the Committee received briefings from the following organisations:

- Greening Australia, represented by:
  - ⇒ Mr Jamie Bayly-Stark, President; and
  - ⇒ Dr Neil Davidson, Landscape Ecologist (and Senior Lecturer at the University of Tasmania School of Plant Science); and
- the Tasmanian Land Conservancy, represented by:
  - ⇒ Mr Stuart Cowell, Conservation Programs Manager; and
  - ⇒ Ms Jane Hutchinson, Chief Executive Officer.

3.11 The briefings at the Grassy Hut site covered a range of issues, including: threats to biodiversity in the region and the role of revegetation in mitigating these threats; methods of community engagement in biodiversity conservation initiatives, particularly working with landowners in the Midlands; the importance of rigorous research to better inform revegetation initiatives; and the necessity of cooperation between government, conservation groups and research institutions to ensure good biodiversity outcomes.

5 Department of Sustainability, Environment, Water, Population and Communities, 'Australia's 15 National Biodiversity Hotspots', <http://www.environment.gov.au/biodiversity/hotspots/national-hotspots.html> viewed 11 April 2012.

6 Department of Sustainability, Environment, Water, Population and Communities, 'Australia's 15 National Biodiversity Hotspots', <http://www.environment.gov.au/biodiversity/hotspots/national-hotspots.html> viewed 11 April 2012.

3.12 During the inspection, the Committee received the following documents:

- *Biodiverse Carbon Permanent Research Sites*, copy of slides, Greening Australia.
- *Year in Review*, Greening Australia Tasmania, 2011.
- Grassy Hut research site, map of experimental plots.

Threatened plant species on the Central Plateau

3.13 The Central Plateau is a large alpine and subalpine area in central Tasmania. The higher parts of the Plateau in the west and north are largely either national park or conservation areas, and are included in the Tasmanian Wilderness World Heritage Area.[7] The Plateau suffers from widespread degradation of vegetation and soils as a result of historical land management practices, including inappropriate grazing by domestic and feral animals, burning from wildfires and fires deliberately lit to create pastures for grazing, road construction, and manipulation of lake levels.[8]

3.14 Representing one of Australia's few alpine regions, the Central Plateau is considered to be highly vulnerable to the effects of climate change. Projected temperature rises are likely to increase threats from pests and disease. Increased shrub and tree invasion could lead to significantly transformed alpine ecosystems. It is anticipated that the changing role of fire will present considerable challenges.

3.15 Unlike many other terrestrial ecosystems in Australia, Tasmanian alpine ecosystems have evolved largely in the absence of fire. More frequent fires due to climate change are therefore expected to have significant impacts on the alpine ecosystems of the Central Plateau.

3.16 The Committee visited two distinct sites on the Central Plateau and received various briefings on the biodiversity of the area. Of particular relevance to the inquiry were the cases of two threatened plant species: the pencil pine; and the miena cider gum.

7 Storey, K. and Comfort, M. (2007) *A progress report on the development of rehabilitation priorities for broad scale erosion within the World Heritage Area on the Central Plateau of Tasmania 2005-06*, Department of Primary Industries and Water, Hobart, p. 1.

8 Storey, K. and Comfort, M. (2007) *A progress report on the development of rehabilitation priorities for broad scale erosion within the World Heritage Area on the Central Plateau of Tasmania 2005-06*, Department of Primary Industries and Water, Hobart, p. 1.

Pencil pines

3.17 The pencil pine (*Athrotaxis cupressoides*) is a conifer endemic to Tasmania, and its habitat is generally restricted to sub-alpine areas above an elevation of 800 metres. A close relative of the iconic King Billy pine and Huon pine, the pencil pine can reach ages of over 1200 years. The most extensive pencil pine montane forests and woodlands are located on the Central Plateau, with the vast majority in the Tasmanian Wilderness World Heritage Area. The pencil pine is a threatened species,[9] and is expected to become more vulnerable as a result of the climate change-induced transformation of its habitat.

3.18 The Committee inspected some pencil pines near the Pine Lake boardwalk, and received briefings from DPIPWE officers on threats to the species. The key stressors relate to pests and disease, and changes in fire regimes, as discussed below.

Miena cider gums

3.19 The miena cider gum (*Eucalyptus gunnii* subsp. *divaricata*) is an iconic, small to medium woodland tree endemic to the Central Plateau, where it tends to grow on the edges of frost hollows. It is one of the most frost-tolerant of Tasmania's eucalypts, with a recorded range of 865 to 1150 metres above sea level.[10] However, it is sensitive to the effects of drought, which has led to the death of mature trees in relatively large patches since the mid 1990s. The species is listed as endangered under state and federal legislation.[11]

3.20 The miena cider gum is considered a 'keystone species', with many other species in the ecosystem relying on it for their continued survival. A number of shrub, herb and grass species are associated with the miena cider gum, as are two threatened orchid species. The grassland associated with the miena cider gum is habitat for the vulnerable ptunarra brown butterfly.[12]

9 IUCN, *IUCN Red List of Threatened Species. Version 2011.2*, <http://www.iucnredlist.org/apps/redlist/details/32054/0> viewed 13 April 2012.

10 Threatened Species Section (2010) *Listing Statement for* Eucalyptus gunnii *subsp.* divaricata *(miena cider gum)*, Department of Primary Industries, Parks, Water and Environment, Hobart, p. 3.

11 Department of Sustainability, Environment, Water, Populations and Communities, *EPBC Act List of Threatened Flora*, < http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl?wanted=flora> viewed 18 April 2012; Threatened Species Section (2010) *Listing Statement for* Eucalyptus gunnii *subsp.* divaricata *(miena cider gum)*, Department of Primary Industries, Parks, Water and Environment, Hobart.

12 Threatened Species Section (2010) *Listing Statement for* Eucalyptus gunnii *subsp.* divaricata *(miena cider gum)*, DPIPWE, Hobart, p. 3.

3.21 The Committee inspected a stand of miena cider gums in the Great Lake area on the Central Plateau. The dramatic tree decline was immediately apparent, even from some distance away. Briefings were provided by DPIPWE officers on threats to the miena cider gum, including: browsing by possums and insects; a low rate of seedling establishment due to grazing and browsing by sheep, wild deer, possums, and rabbits; intolerance of mature trees to drought; and fire regimes.

3.22 As a result of these pressures, most stands of miena cider gum consist mainly of over-mature trees that are more susceptible to stressors and, as a result, are often in poor condition. Climate change is likely to exacerbate some of these threats, particularly those relating to the activities of pests, and changes in rainfall patterns and fire regimes.

3.23 During the inspection, the Committee received the following document:

- *Listing Statement for* Eucalyptus gunnii *subsp.* divaracta *(miena cider gum)*, Threatened Species Section, DPIPWE, 2010.

Figure 3.1 Committee members and DPIPWE officers inspect miena cider gums

Photograph courtesy of committee secretariat

Issues explored in Tasmania

3.24 Through its Tasmanian site inspection program, the Committee gathered evidence on how changes to rainfall patterns, fire regimes, and threats from pests and disease are anticipated to change due to climate changes. Other key issues explored by the Committee relate to flexibility and cooperation in biodiversity conservation approaches, and the role of research in ensuring efficient and effective outcomes.

Changes in rainfall patterns

3.25 According to DPIPWE, drought in Australia has become more severe, with increased temperatures and increased evaporation.[13] There have been significant decreases in average annual rainfalls in Tasmania over the last 40 years. There has also been a change in the timing of rainfall episodes, with a reduction in autumn rains.[14] Changes in the timing and geographical distribution of rain are likely to persist as a result of climate change, and this is expected to adversely affect the ecosystems of the Midlands and the Central Plateau.[15]

3.26 The alarming decline of the miena cider gum—a species highly sensitive to drought—has been attributed to observed changes in rainfall patterns. The increasing frequency and intensity of droughts over recent decades has caused a significant decline across the species' geographical range. Coupled with increased temperatures, it is thought that most miena cider gums are now highly stressed by the end of each summer and in need of substantial rain in autumn in order to recover. Given that these autumn rains are now delayed and diminished, the trees are more stressed and more susceptible to other threats, such as pests and disease. In conjunction with inappropriate fire regimes and browsing pressures, observed rainfall pattern changes have created ecosystem disturbances that have resulted in the spiralling decline of the miena cider gum.[16]

13 DPIPWE (2010) *Vulnerability of Tasmania's Natural Environment to Climate Change: An Overview*, p. 7.

14 DPIPWE (2010) *Vulnerability of Tasmania's Natural Environment to Climate Change: An Overview*, pp. 7–8.

15 Antarctic Climate and Ecosystems Cooperative Research Centre (2010) *Climate Futures for Tasmania general climate impacts: the summary*.

16 DPIPWE (2010) *Vulnerability of Tasmania's Natural Environment to Climate Change: An Overview*, pp. 5–7.

Committee comment

3.27 The Committee notes the contribution of changing rainfall patterns to the observed, dramatic decline of the miena cider gum. There is an interrelationship between rainfall patterns and other threats to the species. The Committee is concerned that these threats are expected to be exacerbated by climate change.

3.28 The Committee is aware that the miena cider gum is usually one of the first eucalypt species to show signs of drought stress. As rainfall patterns change under climate change scenarios, other species may reach their tipping points and experience similar declines in years to come. While the loss of individual species clearly has implications for biodiversity at species level, the loss of keystone species in particular is likely to be detrimental to the continued health of functional ecosystems.

3.29 With regional rainfall patterns projected to change, including a decrease in rainfall in the highly fragmented Tasmanian Midlands biodiversity hotspot, it will be important to ensure that revegetation projects in the region are robust and appropriately targeted to withstand new climatic conditions. Research, such as that being carried out at the Grassy Hut site (discussed below), is likely to make important contributions to conservation programs in years to come.

Figure 3.2 Miena cider gums, near Pine Lake, Central Plateau

Photograph courtesy of committee secretariat

Fire regimes in alpine ecosystems

3.30 The Committee was informed that the greatest threat to alpine plants is fire. As noted above, the alpine ecosystems of the Central Plateau have evolved largely in the absence of fire. Since European settlement, however, fires have been lit relatively frequently, to facilitate the growth of pastures for grazing.[17]

3.31 It was suggested to the Committee that inappropriate fire regimes have contributed to the decline of the miena cider gum. As a result of more frequent fires, fewer individual plants have been able to reach maturity or recover sufficiently to set enough seed before the next fire.[18] Frequent fires kill seedlings and young saplings. They also deplete the shrubby understorey that protects surviving plants from grazing animals. Combined with the impacts of browsing and grazing, which make it very difficult for communities to recover from disturbances, inappropriate fire regimes have had a significant impact on the miena cider gum.

3.32 As with all of Tasmania's endemic conifers—including the King Billy pine, celery-top pine, and Huon pine—the pencil pine is a particularly fire-sensitive species.[19] Some of the largest pure stands of pencil pine have been lost due to escaped campfires. Recovery is unlikely for some communities, due to the species' very slow growth and poor seed dispersal abilities. In fact, some species may take between several hundred and several thousand years to recover from fire.[20]

Committee comment

3.33 With higher temperatures and more frequent severe weather events (such as storms and lightning strikes) predicted under climate change scenarios, wildfires are likely to play an ever-increasing role in shaping the biodiversity of Tasmania's Central Plateau. Although alpine ecosystems occupy only a small proportion of Tasmania's total area, they contain considerable biodiversity values. More frequent fires due to climate change are therefore a significant threat to biodiversity.

17 DPIPWE (2010) *Vulnerability of Tasmania's Natural Environment to Climate Change: An Overview*, p. 6.

18 DPIPWE (2010) *Vulnerability of Tasmania's Natural Environment to Climate Change: An Overview*, p. 6.

19 Parks and Wildlife Service Tasmania, 'Native Conifers of Tasmania', <http://www.parks.tas.gov.au/index.aspx?base=3240> viewed 18 April 2012.

20 Parks and Wildlife Service Tasmania, 'Alpine and Subalpine Plants of Tasmania: Introduction', < http://www.parks.tas.gov.au/index.aspx?base=3216> viewed 18 April 2012.

3.34 Fire management is a complex issue, particularly in Australia, where many species and ecosystems have evolved to require a certain amount of fire in order to survive. At the same time, ecological needs must be balanced against public safety considerations. The Committee sees evolving fire management practices as a key emerging issue for biodiversity in a changing climate.

Threats from pests and disease

3.35 The Committee's visit to the Central Plateau highlighted the threats to biodiversity posed by pests and disease. Pest activity and disease in this location have increased due to climate changes in recent decades. The Committee heard that the discovery in Tasmania of around 15 new diseases, and increases in the incidence of known diseases, are thought to be at least partly due to climate change.

3.36 Pests and disease are likely to become even greater threats to biodiversity as the climate continues to change. Projected reductions in the frequency of frosts and the increase in the incidence of so-called 'tropical nights' are likely to further increase the damage caused by disease and pest species on the Central Plateau.

3.37 In the case of the miena cider gum, the Committee heard that the species' tender shoots and regrowth following fire or damage are highly palatable to insects and animals, including sheep; brushtail possums; wallabies; deer; rabbits; and leaf eating and sap-sucking insects, including the introduced European wasp.[21] Climate change has already increased browsing pressure on the miena cider gum, with milder winters having led to increases in insect populations. These trends are expected to persist.

3.38 *Phytophthora cinnamomi*, a soil-borne water mould discussed in Chapter 2, produces an infection which causes root rot or dieback in plants. Many Australian plants are particularly susceptible to it. Parts of the Tasmanian Wilderness World Heritage Area are affected by phytophthora dieback. The Committee heard that dieback is not an issue in the Tasmanian Midlands, but that it may become more relevant as temperatures increase due to climate change, with warmer soils being more susceptible to phytophthora.

3.39 The Committee heard that the stand of pencil pines it inspected near Pine Lake exhibited some dieback several years ago. Investigations did not reveal a pathogen responsible for the dieback, but one hypothesis was that

21 Threatened Species Section (2010) *Listing Statement for* Eucalyptus gunnii *subsp.* divaracta *(miena cider gum)*, DPIPWE, Hobart, p. 6.

nearby roadworks may have inadvertently brought in gravel from a phytophthora affected area. This coincided with a period of unusually high temperatures in the region, which may have allowed the phytophthora water mould to survive in and travel through the warmer soils, possibly infecting the pencil pines. Although this sequence of events was not proven, the theory highlights the possibility of new pests and diseases emerging in new areas as the climate changes.

Committee comment

3.40 It appears that the issue of pest and disease threats to biodiversity will become more significant as the climate changes. Active and adaptive management strategies are likely to become more important. As was noted during the Committee's inspections, the complexity of ecosystems presents a challenge to predictions about the biodiversity of species and ecosystems under climate change scenarios.

Research and cooperation

3.41 The Committee's inspection of the Grassy Hut site highlighted the importance of research and cooperation in ensuring good biodiversity outcomes in a changing climate.

3.42 Research conducted at the site is a cooperative venture between a research body, government, and non-government organisations, and seeks to inform decisions about the design of revegetation programs. It will be used to identify species and, importantly, combinations of species that are likely to grow well under various conditions. It will also explore whether seeds from local species or from hotter, drier areas are likely to be best suited to the Midlands under predicted climate changes.

3.43 In addition to cooperation between organisations, the Committee heard that individuals can also assist policy-makers and land managers by helping to gather data. The Committee was informed that DPIPWE encourages recreational users of Tasmanian parks to monitor the health of important plant species, by printing species field guides that describe and illustrate the characteristics of healthy and unhealthy specimens.

Committee comment

3.44 The Committee acknowledges the value of the research work being carried out at the Grassy Hut site, which seeks to better inform decisions about revegetation initiatives. In a changing climate and with limited resources, the Committee sees rigorous research as an important part of

the biodiversity management response to climate change. Research can ensure that scarce resources are appropriately prioritised and utilised in a way that delivers the best ecological outcomes.

3.45 The Committee is pleased to note the level of cooperation between the Tasmanian Government, the Commonwealth Government, non-government environmental organisations such as the Tasmanian Land Conservancy and Greening Australia, and research bodies such as the University of Tasmania. This cooperative approach is consistent with the Committee's observations based on other site inspections.

3.46 The Committee acknowledges that monitoring and data-gathering can be resource-intensive activities. They are, however, essential to ensuring effective policies and plans for managing biodiversity. Citizen science initiatives may therefore assist in this regard. As the move to adaptive management continues under changing climate conditions, and the need for field information increases, citizen science programs are likely to become more important. Such programs also deliver an important community engagement outcome, making members of the public more aware of biodiversity issues.

3.47 The Committee considers that cooperative ventures provide benefits in terms of allowing organisations and individuals (such as landowners and volunteers) to share their areas of expertise, contributing to better ecological outcomes. In a changing climate, where policy-makers and land managers are facing a variety of challenges and uncertainty, cooperation, information-sharing and effective coordination can only become more important in conserving Australia's biodiversity.

3.48 There is a need to ensure that government policies and administrative practices facilitate—or, at the very least, do not unnecessarily impede—groups of passionate, dedicated, innovative and knowledgeable people working together to deliver positive biodiversity outcomes.

Maintaining flexibility

3.49 Discussions with Greening Australia and the Tasmanian Land Conservancy highlighted the importance of community engagement and retaining the flexibility to use the appropriate conservation tool according to the circumstances. For instance, the Tasmanian Land Conservancy uses a range of tools, including covenants, stewardship agreements, and acquisitions, depending on the needs of each particular conservation site and stakeholder needs.

Committee comment

3.50 The Committees considers that non-government environmental organisations are uniquely placed to engage landholders and members of the public in a way that is often difficult for government agencies, given the constraints they face. The Committee appreciates that organisations such as the Tasmanian Land Conservancy are able to maintain flexibility in their arrangements with landholders, tailoring solutions to each particular situation. There is a need to ensure that government policies and administrative practices do not unnecessarily hamper this flexible approach.

Concluding remarks

3.51 The Tasmanian site inspections illustrated that climate change is a threat to biodiversity that adds to and interacts with the range of existing stressors. Ecosystems involve multiple and complex interactions and feedback loops, and trying to disentangle these is challenging. What is clear is that existing stressors need to be managed as carefully as possible to minimise the interaction effects from climate change.

3.52 The Committee was interested to visit the alpine ecosystems of the Central Plateau, one of the few alpine areas in Australia. As evidence to the inquiry has noted, alpine ecosystems are some of the most vulnerable to climate change impacts, and the Committee found its visit to the Central Plateau very informative.

3.53 The dramatic decline of the miena cider gums was a fascinating case study of a keystone species declining due to a number of interrelated factors, which are expected to be exacerbated under climate change. It highlights the likelihood of ecosystem transformations under climate change—for better or for worse—and the importance of monitoring and management practices for devising effective interventions where possible.

3.54 The fragmentation of the Tasmanian Midlands landscape was an appropriate backdrop to discussions on community engagement in conservation activities, including revegetation programs on private land. Given the projected changes to temperature and rainfall in the Midlands, this was also an appropriate place to discuss the importance of research in optimising the biodiversity outcomes of ecological restoration programs in a changing climate.

3.55 The Committee was heartened to see first-hand some of the excellent biodiversity conservation work being done in Tasmania, under some challenging circumstances. The Committee wishes to record its thanks to the experts with whom it met and from whom briefings were received. In particular, the Committee is grateful to the Tasmanian Department of Primary Industries, Parks, Water and Environment for facilitating the visit and for making their officers available to travel with the Committee.

4

NSW Snowy Mountains region

4.1 On 17 February 2012, the Committee visited the New South Wales (NSW) Snowy Mountains region. The Snowy Mountains are part of the Australian Alps, which extend through NSW, Victoria, and the Australian Capital Territory (ACT), and include the highest peaks on the Australian mainland.

4.2 On the same day, the Committee took the opportunity to meet with representatives of the Great Eastern Ranges Initiative and its local partner organisation, Kosciuszko to Coast. The Committee also held a public hearing in Canberra on 2 March 2012 which largely focussed on issues relating to alpine biodiversity and landscape scale connectivity initiatives.

4.3 During its inspection of the NSW Snowy Mountains, the Committee was interested to see firsthand some of the unique biodiversity of Australia's alpine regions, which many submissions to the inquiry have noted is particularly vulnerable to climate change. Although there are high levels of uncertainty in climate models, the NSW Snowy Mountains are generally predicted to experience hotter and drier conditions under climate change.[1] Between 1950 to 2007, temperatures in mainland areas above 1500 metres increased by 0.74 ^{o}C—equivalent to a 100 metre change in elevation in the Snowy Mountains—and there has been a 30 per cent decrease in snow amounts.[2]

4.4 Under the climate change projections, the area of ground with snow cover for more than 60 days is predicted to reduce by between 38 and 96 per cent by 2050, potentially retreating to just a small area around Mount Kosciuszko.[3] The winter snowpack has been observed to be thawing an

1 NSW Office of Environment and Heritage, NPWS (2006) *Kosciuszko National Park Plan of Management*, p. 38.

2 Green, K., 'Impacts of Climate Change on the Australian Alpine Zone', briefing paper.

3 NSW Office of Environment and Heritage, NPWS (2006) *Kosciuszko National Park Plan of Management*, p. 39.

average of 16 days earlier than when records began in 1954, and there have been no snow patches lasting from one winter to another since 1998.[4] Ice cover on alpine lakes has been observed to be breaking up, and there have been significant changes to the timing of key ecological events such as the flowering of vegetation, the migration of birds, and the emergence of animals in spring.

Committee activities

4.5 The Committee's visit to the NSW Snowy Mountains region included inspections and briefings at Kosciuszko National Park, with a focus on threats to alpine ecosystems due to climate change. The Committee also received briefings from the Great Eastern Ranges Initiative and Kosciuszko to Coast groups near Michelago.

Charlotte Pass, Kosciuszko National Park

4.6 The Committee visited Charlotte Pass, which lies approximately 1840 metres above sea level in the alpine zone of Kosciuszko National Park. During the journey from Jindabyne, the Committee received briefings and commentary from semi-retired alpine ecologist, Mr Roger Good, and officers of the NSW Office of Environment and Heritage National Parks and Wildlife Service (NPWS). At Charlotte Pass, the Committee members walked to a lookout overlooking the Snowy River valley and the Snowy Mountains' Main Range. The Committee received briefings from the following NPWS officers:

- Dr Ken Green, Principal Research Scientist;
- Pam O'Brien, Area Manager;
- Gary Saunders, Manager, Planning and Performance Unit; and
- Mel Schroder, Environmental Management Officer.

4.7 The following documents were provided to the Committee during the visit:

- *Caring for Our Australian Alps Catchments*, Australian Alps Liaison Committee, 2011.
- *Caring for our Australian Alps Catchments: Summary Report for Policy Makers*, Department of Climate Change and Energy Efficiency, 2011.
- *Snow: A Natural History; An Uncertain Future*, Australian Alps Liaison Committee, 1998.

4 Green, K., 'Impacts of Climate Change on the Australian Alpine Zone', briefing paper.

- *Impacts of Climate Change on the Australian Alpine Zone*, briefing paper, K. Green.
- *Factsheet: Feral Horse Management*, Australian Alps National Parks, 2010.
- *Kosciuszko National Park*, briefing paper, NPWS.
- *Kosciuszko National Park Plan of Management*, Summary of the Plan of Management, pp. xvi–xviii, and Section 6.2—Climate, pp. 37-42, NPWS 2006.

4.8 The Kosciuszko National Park was declared in 1944 and covers over 670 000 hectares.[5] It contains Australia's highest mountain range, including Mount Kosciuszko, unique glacial landscapes, and a range of unique flora and fauna. It also contains some of the headwaters of the Murray–Darling river system and is an important winter and summer tourist destination.[6]

4.9 The Kosciuszko National Park Plan of Management identifies climate change as 'one of the greatest potential threats to the values of the park'.[7]

5 NSW Office of Environment and Heritage, NPWS, 'Guide to Kosciuszko National Park, 2011', <http://www.environment.nsw.gov.au/resources/parks/southern/Kosciuszko_National_Park/1KosiGuide2012Intro.pdf> viewed 24 April 2012; NSW Office of Environment and Heritage, NPWS, 'Kosciuszko National Park', <http://www.environment.nsw.gov.au/nationalparks/parkhome.aspx?id=n0018> viewed 24 April 2012.

6 NSW Office of Environment and Heritage, NPWS, 'Kosciuszko National Park', briefing paper.

7 NSW Office of Environment and Heritage, NPWS (2006) *Kosciuszko National Park Plan of Management*, p. 38.

Figure 4.1 View from Charlotte Pass lookout: The headwaters of the Snowy River with Australia's two highest mountains, Mount Kosciuszko and Mount Townsend, in the background

Photograph courtesy of committee secretariat

Meeting with Great Eastern Ranges Initiative and Kosciuszko to Coast

4.10 The Great Eastern Ranges (GER) Initiative is a landscape connectivity project seeking to reduce ecosystem fragmentation along the length of Australia's eastern ranges. Kosciuszko to Coast is a regional partner organisation that is working to implement the GER Initiative's broad vision at a more local level within the Snowy Mountains region.

4.11 The Committee received briefings from the following representatives of the GER Initiative and Kosciuszko to Coast at a property overlooking the Murrumbidgee River near the small town of Michelago:

- GER Initiative—Mr Ian Pulsford, founding manager (2007–10), and currently a private Environment, Protected Area and Linking Landscapes Specialist; and
- Kosciuszko to Coast—Mr Geoff Robertson, President; and Ms Lauren van Dyke, Facilitator.

4.12 The Committee was provided with the following documents during the visit:

- *Connectivity Conservation and the Great Eastern Ranges Corridor*, NSW Department of Environment, Climate Change and Water, 2010.
- *Australia State of the Environment 2011 – Connectivity Conservation in Australian Landscapes*, Department of Sustainability, Environment, Water, Population and Communities, 2011.
- *Australia's Great Eastern Ranges: Our Vision to Protect Them Forever*, DVD, NSW Department of Environment and Climate Change, and International Union for the Conservation of Nature, World Commission on Protected Areas.
- *Australia's Great Eastern Ranges*, brochure, GER Initiative.
- GER Initiative, factsheet series:
  - ⇒ *What is the Great Eastern Ranges Initiative?*
  - ⇒ *What is Connectivity Conservation?*
  - ⇒ *A Project Built On Partnerships.*
  - ⇒ *Fast Facts: Why the Great Eastern Ranges Are Important.*
  - ⇒ *Landholders: Questions and Answers.*
  - ⇒ *A View from the Land – Feedback from Landholders.*
- *Climate Change: How will it Affect the Natural Environment?*, brochure, NSW Department of Environment, Climate Change and Water, 2009.

Issues explored in the NSW Snowy Mountains

Economic importance of water from the Mountains

4.13 During the visit to Charlotte Pass, the Committee's attention was drawn to the recent *Caring for Our Australian Alps Catchments* report, which examined the value and current health of catchments in the Australian Alps.[8] In economic terms, the value of the water flowing from the Alps has been estimated at around $10 billion annually.[9] Waters from the Alps catchments contribute to the Murray–Darling Basin's agricultural production (worth about $15 billion annually), which represents about

8 Worboys, G. L., Good, R. B. and Spate, A. (2011) *Caring for Our Australian Alps Catchments*, Australian Alps Liaison Committee, Canberra.

9 Dr Graeme Worboys, *Committee Hansard*, Canberra, 2 March 2012, p. 2.

45 per cent of Australia's irrigated production.[10] The report found that Alps catchments provide about 29 per cent of the Murray–Darling Basin's average yearly inflow yield.[11] During drought years, the contribution of alpine water is even greater due to the relatively guaranteed source of supply, accounting for around 60 per cent of Murrumbidgee River flows and 33 per cent of Murray River flows; these flows are essential for primary production.[12] The downstream social and environmental benefits of this water are also significant, albeit difficult to quantify.[13]

4.14 During its visit to Charlotte Pass, the Committee heard that alpine trees are net producers, rather than consumers, of water, for reasons including their ability to capture frost. The loss of tree cover can therefore have a measurable impact on water flows. It is estimated that since the introduction of alpine grazing, there are 17 000 fewer hectares of tree coverage, which equates to a net loss of $12 million of water per annum.

4.15 According to the *Caring for Our Australian Alps Catchments* report, climate change is predicted to be the 'single greatest threat to the natural values of the Australian Alps catchments as we know them today'.[14] Dr Graeme Worboys, one of the report's authors, illustrated this point at the Committee's public hearing in Canberra:

> … the natural condition of the Alps actually leads to the water yield, the water quality and the water flow regimes of the catchments. So you do not allow that natural condition to be disturbed because, in effect, you are playing around with the generation of the water, which is worth so much money and affects so many people. That is a really key point …
>
> … a smart society does not let Australia's critical water catchments, worth something like $10 billion annually, be trashed in a climate change world.[15]

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10 Worboys, G. L. and Good, R. B. (2011) *Caring for Our Australian Alps Catchments: Summary Report For Policy Makers*, Department of Climate Change and Energy Efficiency, Canberra, p. 53..

11 Worboys, G. L. and Good, R. B. (2011) *Caring for Our Australian Alps Catchments: Summary Report For Policy Makers*, Department of Climate Change and Energy Efficiency, Canberra, p. 53.

12 Worboys, G. L., Good, R. B. and Spate, A. (2011) *Caring for Our Australian Alps Catchments*, Australian Alps Liaison Committee, Canberra, p. 122.

13 Worboys, G. L., Good, R. B. and Spate, A. (2011) *Caring for Our Australian Alps Catchments*, Australian Alps Liaison Committee, Canberra, p. 122.

14 Worboys, G. L., Good, R. B. and Spate, A. (2011) *Caring for Our Australian Alps Catchments*, Australian Alps Liaison Committee, Canberra, p. 3.

15 Dr Graeme Worboys, *Committee Hansard*, Canberra, 2 March 2012, p. 2.

Committee comment

4.16 The Committee acknowledges that, in addition to their intrinsic natural values, the Australian Alps and its catchments are of immense economic value to the nation, and that it is vital to maintain biodiversity for both water production and the maintenance of its quality downstream. The Committee also notes the critical importance of this water to supporting biodiversity in ecosystems downstream, along the entire length of the Murray and Murrumbidgee Rivers.

Feral animals and invasive weeds

4.17 During the visit to Charlotte Pass, the Committee heard that introduced animal and plant species are threatening the ecosystems of the Kosciuszko National Park. For example, wild horse numbers are causing widespread damage to ecosystems in the area. Horse numbers were estimated at over 7000 in 2009, and are predicted to increase to nearly 15 000 in 2012.[16] Assisted by a warming climate, it is predicted that feral horses will be in the alpine (that is, above the tree line) parts of the National Park within around five years, and that immense damage could be caused by their presence.

4.18 The Committee heard that the Park does not currently have an effective method of controlling horse numbers. Managers currently rely on trapping and removal of horses, some of which are rehabilitated but with most transported to abattoirs. It was suggested that although aerial shooting would be a more effective, humane and economical way to control horse numbers, previous community opposition has prevented its adoption. At the Canberra public hearing, the Committee heard that, given the community's resistance to those methods, 'the biggest muster in the Southern Hemisphere' needs to be undertaken in order to deal with the horse problem.[17]

4.19 The Committee was advised of the increasing threat posed by deer, particularly in the Victorian parts of the Australian Alps, and the similar challenges faced by park managers in controlling deer numbers. Options for shooting or poisoning are limited in their effectiveness, and are not widely accepted by the community.

4.20 Rabbits were identified as being less of a problem for ecosystems in the alpine areas of the National Park, however, they have been observed to be moving to higher altitudes in recent years due to the warming climate.

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16 Australian Alps National Parks (2010) 'Feral Horse Management', factsheet.

17 Dr Graeme Worboys, *Committee Hansard*, Canberra, 2 March 2012, p. 7.

There are concerns that rabbits could become a more serious threat to the region's biodiversity in years to come.

4.21 The Committee is aware that while many species will be threatened by climate change, others will thrive as they react to more favourable conditions. The species most likely to thrive are species which have evolved outside the alpine area and are therefore more capable of adapting to a range of conditions, at the expense of locally evolved species. This includes many invasive weed species.

4.22 The Committee heard that there is a lack of resources for combating environmental weeds in Kosciuszko National Park. Weeds such as blackberry and willows require constant management by Park authorities, whilst other more recent threats from weeds such as hawkweed and oxeye daisy are placing new strain on existing management resources.[18]

Committee comment

4.23 The Committee notes that there is an apparent lack of resources for combating the threats to biodiversity posed by feral animals and environmental weeds. With the additional impact of climate change, these threats are expected to worsen, and it is evident that addressing the shortfall of resources for removing invasive species will need to become a priority in the years to come.

4.24 The Committee also notes the prominent role that community attitudes play in the development of sensible management decisions, particularly in response to reducing feral animal numbers, such as horses and deer. Successful community engagement is required in order to address any future changes in policy with regard to these matters.

Other possible effects of climate change in alpine environments

4.25 During its visit to Charlotte Pass, the Committee heard about a wide range of other impacts on biodiversity that may result from climate change in the alpine regions, including:

- Potential loss of species, particularly invertebrates, that are adapted to living only in high altitude ecological niche conditions. These species would be vulnerable to even relatively small increases in the average temperature.
- Potential drying out of alpine bog and fen ecological communities, threatening endemic species and reducing their ability to store and filter large volumes of water.

18 NSW Office of Environment and Heritage, NPWS, 'Kosciuszko National Park', briefing paper.

- Earlier thawing of the ice cover on Kosciuszko National Park's glacial lakes, threatening endemic organisms that have adapted to a layer of ice lasting into early summer. For example, while ice break-up on Blue Lake has been recorded during most of the twentieth century as occurring in November or December, it now generally occurs in October, and in 2006 occurred in September. This has affected the chemical makeup of the lake and exposed species to higher levels of ultraviolet light in the spring.[19]
- More frequent and intense bushfires. The Committee heard that some species, such as alpine ash, will be less able to recover in the long term if they are burned more frequently.
- Changes to the level of the alpine tree line due to increasing temperatures. The Committee was informed that unlike other mountainous parts of the world, tree lines in Kosciuszko National Park are not moving up in a linear manner. The Committee was shown sites where small numbers of trees had rapidly established higher along a slope before 'backfilling' down the slope with larger numbers of trees.
- Reduced snow cover, impacting certain species that depend on it. Earlier melting of snow reduces the amount of cold water flowing over plant species, which may affect species that have evolved to require this cold water flow.
- Changes to the phenology of alpine species due to seasonal shifts and increased levels of ultraviolet light due to fewer cloudy days. Flowering times, hatching times, migration times and times of emergence from 'hibernation' may all be affected, causing mismatches in normal species to species interactions. For example, the Committee heard that the endangered mountain pygmy-possum (*Burramys parvus*) feeds mainly on the Bogong moth (*Agrotis infusa*) in spring and summer. Earlier thawing of snow cover triggers pygmy-possums to emerge from their winter homes under alpine boulders earlier in spring, while the moths emerge later, in response to different cues from the environment. This leaves the pygmy-possums vulnerable to starvation and increased predation as they are required to look further afield for alternative sources of food.

4.26 Overall, the Committee heard that while climate change will harm some species, others will benefit, or be relatively unaffected. However, the biodiversity of the Alps will be disrupted by changes to the natural distribution of ecosystems and fragmentation of habitats, which will threaten the ecological niches upon which many endemic species depend.

19 Green, K., 'Impacts of Climate Change on the Australian Alpine Zone', briefing paper.

The species that are likely to benefit or be more resilient to climate change are those that have evolved outside the Alps, while species that are uniquely adapted to alpine environments are more likely to be threatened by climate change.

Committee comment

4.27 The Committee has gained some appreciation of the complexity of interactions taking place in the alpine environment in response to the changing climate. While precise outcomes for individual species and ecosystems are difficult to predict, the mix of biodiversity in the Alps will undoubtedly change, and some species will be threatened with extinction. Ongoing research and monitoring is needed in order to better understand these interactions.

Active management across jurisdictions

4.28 Kosciuszko National Park has undergone rehabilitation work since its declaration in 1944. Netting and mulching have encouraged natural ecosystems to develop, particularly in response to damage from alpine grazing, phased out after the Park was established. The Committee was informed that human interventions in the environment can have complex and unpredictable results, particularly under a changing climate. Sound research and ongoing evaluation of management efforts is required, which may require more resources to be allocated.

4.29 At the public hearing in Canberra, Dr Worboys called for more active management. He advised the Committee about the need to establish a 'quantitative understanding' of the resources being managed in order to 'measure and understand change', whether positive or negative, and to be able to adapt to deal with the changes.[20]

4.30 Another management issue identified to the Committee during the visit to Charlotte Pass was the need for effective management of issues across political borders. The Committee heard that the Australian Alps Liaison Committee is part of a four government partnership (Commonwealth, NSW, Victoria and the ACT) that provides a forum for managers from each jurisdiction to exchange information and establish best practice management techniques. Responsibility for day to day management of the National Parks remains with the relevant agency.

4.31 At its public hearing in Canberra, the Committee heard that there is scope for strengthening cooperative arrangements across the alpine areas. Mr Roger Good told the Committee that while the Australian Alps Liaison

20 Dr Graeme Worboys, *Committee Hansard*, Canberra, 2 March 2012, p. 2.

Committee (in which he is a long term participant) has 'engendered research over the years on specific cross-border issues', it is not set up to facilitate program delivery across the Alps. Currently based on a memorandum of understanding, a greater capacity to deliver and coordinate a whole-of-alps program may arise from a formal agreement between all parties.[21]

4.32 Also at the public hearing, Professor Ary Hoffman from the University of Melbourne told the Committee that the Liaison Committee was constrained by a severe lack of funding. He indicated that this funding needs to be substantially boosted to allow for the collection of data for research purposes to aid in the management of the alpine region as a whole.[22]

Committee comment

4.33 The Committee agrees with inquiry participants that active, effective management will be required to respond to threats posed to alpine biodiversity by past, present and future challenges; threats which will be exacerbated by climate change. Underpinning this, greater resources and more research will be needed, and effective systems will be necessary to monitor ecosystem responses to management techniques.

4.34 While the Committee recognises that the Australian Alps Liaison Committee provides a good mechanism for information sharing, there is scope to strengthen the current cooperative arrangements to allow joint management. This would enable cross-border programs to be funded to tackle threats to biodiversity that extend across all jurisdictions, such as weeds and feral animals. There may be a role for the Commonwealth in facilitating or delivering such programs.

Great Eastern Ranges and Kosciuszko to Coast landscape connectivity projects

4.35 The Great Eastern Ranges (GER) Initiative, established in 2007, seeks to improve landscape connectivity between protected areas along the Great Dividing Range and the Great Escarpment, from the Victorian Alps to the Atherton Tablelands in Far North Queensland. The ranges extend over 2800 kilometres of eastern Australia, incorporating three World Heritage Areas, and house such iconic threatened species as the Wollemi pine and the brush-tailed rock wallaby. The Committee heard that around half the length of the ranges is public land, and the other half private.

21 Mr Roger Good, *Committee Hansard*, Canberra, 2 March 2012, p. 7.

22 Prof. Ary Hoffman, ARC Laureate Fellow, Departments of Genetics and Zoology, University of Melbourne, *Committee Hansard*, Canberra, 2 March 2012, p. 22.

4.36 The initial focus of the GER Initiative is in NSW, where state government funding has been secured. Mr Rob Dunn, the current Chief Executive Officer of the Initiative, told the Committee that discussions about the possible take-up of the GER Initiative are currently underway with the Victorian and Queensland Governments.[23]

4.37 In NSW, the GER Initiative is being delivered through five regional partnership organisations and in collaboration with Greening Australia, Bush Heritage Australia, OzGREEN, the Nature Conservation Trust of NSW, the NSW National Parks Association, and the NSW Department of Environment and Heritage.[24] The Committee heard that the GER Initiative funds the employment of facilitators for its partner organisations to bring together local individuals and organisations to work towards the Initiative's goals.

4.38 Kosciuszko to Coast is the GER Initiative's regional partner in southeast NSW. The Committee heard at its meeting that Kosciuszko to Coast pre-dates the GER Initiative, and originally began as a group of individuals working around the Scottsdale Reserve, purchased by Bush Heritage Australia for conservation purposes in 2006. Kosciuszko to Coast has partnerships with 11 other organisations active in conservation in the region, working under the broader vision of the GER Initiative. Kosciuszko to Coast helps facilitate conservation projects that individual organisations may not be able to undertake, and assists local landowners with revegetation on their property. A large part of the organisation's work involves motivating and educating landowners about the roles their properties can play in private biodiversity conservation. The Committee heard that there is generally a small amount of money invested on each individual property.

Committee comment

4.39 As with the Gondwana Link project in Western Australia, the Committee sees great potential for the GER Initiative to play a positive role in biodiversity protection in the mountainous areas of eastern Australia. Although earlier in its implementation than Gondwana Link, the Committee saw that the GER Initiative is already making solid progress in southeast NSW through its regional partner, Kosciuszko to Coast. A particular strength of the GER model is that it enables the numerous existing biodiversity conservation organisations in local areas to work together towards a single goal. The Committee will continue to observe

23 Mr Rob Dunn, *Committee Hansard*, Canberra, 2 March 2012, pp. 13–14.

24 Great Eastern Ranges Initiative, 'What is the Great Eastern Ranges Initiative?', factsheet.

the GER Initiative as it develops, and particularly whether the Initiative is adopted in the other eastern states.

Concluding remarks

4.40 The NSW Snowy Mountains, as with alpine areas in other states, are recognised as being particularly vulnerable to climate change. The region is predicted to become warmer and drier under climate change scenarios, and this trend has already been observed. Snow cover, for example, has reduced by 30 per cent since the 1950s. The Committee recognises that, over time, this will not only affect winter tourism in the area, but it will also lead to significant impacts on alpine biodiversity and on the quantity and quality of water flows into the Murray–Darling basin.

4.41 As outlined above, in the context of a changing climate, there are a range of complex challenges that will need to be addressed by those responsible for managing the Alps. These challenges include dealing with increasing numbers of weeds and feral animals, more frequent and intense bushfires, and the loss of niche habitats for unique alpine species. Responding to these challenges will require concerted and adaptive management efforts, underpinned by robust scientific research and regular monitoring.

4.42 Beyond protected areas such as Kosciuszko National Park, the GER Initiative and its partner organisations are providing leadership in building the resilience of the landscape to be able to cope with changing climate conditions.

4.43 The Committee sincerely thanks all the individuals who made their visit to the Snowy Mountains region possible. Particular thanks go to Mr Roger Good for sharing his broad expertise in alpine ecology with the Committee during its travels; Mr Dave Darlington for making NPWS staff available at Charlotte Pass to talk with the Committee; and Tony and Gill Robinson and Ms Lauren van Dyke for facilitating the Committee's meeting with the GER Initiative and Kosciuszko to Coast.

5

Conservation and engagement in Sydney

5.1 On 27 March 2012, the Committee visited sites in Sydney that highlighted issues relating to ecological restoration, research, ex situ conservation and community engagement. In Australia's most populous city, the Committee welcomed the opportunity to investigate climate change impacts on biodiversity in an urban setting.

5.2 The Committee visited Sydney Olympic Park and the Australian Botanic Garden at Mount Annan. Both sites contained a range of elements of interest to the Committee and provided an opportunity to consider some of the wider themes of the inquiry, such as ecological restoration programs, ex situ conservation, community engagement, and threats to biodiversity such as pests and disease.

Committee activities

Sydney Olympic Park

5.3 Sydney Olympic Park is located 14 kilometres west of the Sydney central business district. With a history of intensive land use, the Sydney Olympic Park site is now used for sporting and cultural events, and contains commercial developments and extensive parklands, including 430 hectares of open space, recreation areas, wetlands and waterways. The site is managed by the Sydney Olympic Park Authority (SOPA).

5.4 The Committee was interested to visit the site in light of Sydney Olympic Park's significant biodiversity values, extensive ecological restoration and remediation program, and public engagement work.

5.5 At Sydney Olympic Park, the Committee met with and received briefings from the following officers from SOPA:

- Mr Mike Bartlett, Manager of Education;
- Ms Kerry Darcovich, Senior Manager of Environment and Ecology; and
- Dr Marianne Sheumack, Project Manager, Education and Sustainability.

5.6 The Committee received the following documents:

- SOPA (2009) *Greenguide: Environmental awareness and due diligence information*.
- SOPA, *Annual Report 2010–11*.
- SOPA (2011) *Fact Sheet – Restoring ecosystems*.
- SOPA (2011) *Fact Sheet – Biodiversity*.
- SOPA (2011) *Fact Sheet – Education*.
- SOPA (2011) *Fact Sheet – Parklands*.
- SOPA (2006) *Urban Water Reuse and Integrated Water Management*.
- Department of Environment and Climate Change (NSW) (2008) *Protecting and Restoring Coastal Saltmarsh*.
- Map of Sydney Olympic Park.

5.7 Key sites visited by the Committee included the Education Centre in Bicentennial Park; the protected Badu Mangroves; the Brickpit Ring Walk; and Haslam's Creek and Narawang Wetland.

5.8 The Committee was briefed on a range of other matters, including the Sydney Olympic Park Water Reclamation and Management System, and Newington Nature Reserve. The Committee was interested to hear that the latter site was formerly managed by the Commonwealth Department of Defence, and includes 13 hectares of remnant Sydney Turpentine-Ironbark Forest. These natural values have been preserved largely because public access to the reserve was restricted by the Royal Australian Navy for over 100 years.

Figure 5.1 Committee members and SOPA officers inspecting the protected Badu Mangroves

Photograph courtesy of Sydney Olympic Park Authority

Australian Botanic Garden, Mount Annan

5.9 An estate under the Royal Botanic Gardens and Domain Trust, the Australian Botanic Garden, Mount Annan, displays over 4000 plants, set in 416 hectares of hills and lakes. The Garden contains remnant Cumberland Plain Woodland and houses horticultural research facilities, including the NSW Seedbank. A new world-class scientific facility called PlantBank is also being constructed at the site.

5.10 The Committee met with and received briefings from the following representatives of the Australian Botanic Garden:

- Dr Catherine Offord, Manager, Horticultural Research, Science and Conservation; and
- Mr Peter Cuneo, Manager, Natural Heritage.

5.11 Prior to the visit, the Committee received the following documents:

- *Briefing notes – Visit to the Australian Botanic Garden, Mount Annan and NSW Seedbank 27th March 2012*, Royal Botanic Gardens and Domain Trust.
- 'Pushed to the limit: consequences of climate change for the Araucariaceae: a relictual rain forest family', C. A. Offord, *Annals of Botany*, 2011, 108, pp. 347–57.

- *Plant Germplasm Conservation in Australia: Strategies and Guidelines for developing, managing and utilising ex situ collections*, C. A. Offord and P. F. Meagher (eds), 2009, 'Chapter 1: Introduction' and 'Chapter 2: Options and major considerations for plant germplasm conservation', C. A. Offord and R. O. Makinson.

5.12 The focus of the Committee's visit was the Australian Botanic Garden's research work; ex situ Wollemi pine collection; expertise in germplasm conservation; and its role in engaging the community on biodiversity issues.

Issues explored in Sydney

Ecological restoration and remediation programs

5.13 Originally part of Homebush Bay, the land now comprising Sydney Olympic Park was formerly used for industrial and military purposes, including a brickworks, abattoir, armaments depot, and several rubbish dumps. In the late 1990s the degraded wetland and terrestrial ecosystems underwent what was, at that time, the largest land remediation exercise ever undertaken in Australia.

5.14 The Committee understands that the ecological aspect of the remediation works aimed to rebuild functional, naturalistic ecosystems within an urban parkland environment, and included remediation of 160 hectares of contaminated land; recovery and containment of nine million cubic metres of waste; restoration of 100 hectares of remnant wetlands and 20 hectares of remnant eucalypt forest; conversion of concrete stormwater channels into a naturalistic tidal waterway; restoration of tidal flushing to a 35 hectare land-locked wetland; construction of new wetland, grassland, woodland and saltmarsh on remediated land; and construction of new habitats for target plant and animal communities.

5.15 Today, Sydney Olympic Park has significant biodiversity values, particularly given that it is situated in the geographic centre of a large city. Habitat restoration and management works are an ongoing part of the Park's management. Approximately 300 hectares of the park provide habitat for threatened species, protected marine vegetation and endangered ecological communities, in addition to hundreds of native plant and vertebrate species.

5.16 The Committee is aware that, although the Park's estuarine habitats are part of a larger network of similar habitats along the Parramatta River, terrestrially and in ecological terms, Olympic Park is effectively an island. Surrounding urban development has meant that the ecological communities in the park are physically disconnected from most natural habitats in the region. The park is therefore subject to the same ecological threats that most island ecosystems tend to face: edge effects; low or zero rates of external recruitment by many species; and low rates of recovery from localised ecosystem disturbances.[1]

5.17 The Committee's visit to the disused quarry at the Brickpit Ring Walk site, which is protected because of its role as the primary habitat of the endangered Green and Golden Bell Frog, allowed Members to see firsthand a good example of a severely degraded ecosystem being actively managed to retain biodiversity values. The Committee heard that the brickpit now supports 40–50 bird species and microbats.

5.18 While the brickpit's natural and constructed wetland habitats are used for biodiversity conservation, part of the site has also been repurposed as a reservoir that supplies non-potable water to Sydney Olympic Park and Newington. The brickpit therefore demonstrates sustainable use of natural resources.

5.19 The Committee inspected the Eastern Water Quality Control Pond. The naturalistic pond moderates the flow of stormwater run-off and absorbs nutrients, before the water is filtered and pumped into the brickpit reservoir for distribution. The pond also provides habitat for five frog species and 40 bird species. It therefore contributes to water filtration, while achieving biodiversity outcomes.

5.20 The Committee also visited the Narawang Wetland and Haslams Creek. The latter previously consisted of concrete stormwater channels, but has been reconstructed into a naturalistic tidal waterway edged by extensive areas of replacement saltmarsh habitat. The Committee heard that saltmarsh habitats are very vulnerable to the effects of climate change because their range is limited to the area between the mean and maximum high tide marks. As sea levels rise, saltmarsh will also need to migrate accordingly, but this is not always possible, especially as many waterside developments include sea walls.

5.21 The Committee also inspected the protected Badu Mangroves which, covering 65 hectares, represents the largest stand of mangroves in the Parramatta River catchment.

1 Sydney Olympic Park Authority (2011), *Fact Sheet – Biodiversity*, p. 2.

Committee comment

5.22 The Committee was impressed with the transformation of the Sydney Olympic Park site as a result of the extensive ecological restoration and remediation works carried out in the late 1990s and more recently. It was clear to the Committee that a great deal of thought and ingenuity had gone into the restoration and creation of functional ecosystems in what was once a much degraded landscape.

5.23 As the effects of climate changes continue to be felt across Australia over the coming years, restoration and conservation programs like the ones undertaken at Sydney Olympic Park—albeit at a smaller scale—may become necessary in various locations. The Park's success story is heartening. The Committee notes that progress of the significant restoration program was assisted by the imposed deadline of the 2000 Sydney Olympics. However, this case study underlines the good ecological outcomes that can be achieved with government commitment and adequate resources.

5.24 The Committee notes that there are currently about 11 000 office workers based at Olympic Park, and that number is planned to increase. It also notes that 16 000 residents are expected to live within the Sydney Olympic Park precinct by 2030. Clearly, the confluence of so many people and land uses in an area of such high biodiversity values will present particular challenges to SOPA in years to come, and the Committee will continue to observe with interest how these challenges will be addressed.

Figure 5.2 A biodiverse urban setting: Office tower in Sydney Olympic Park as viewed from the protected Badu Mangroves

Photograph courtesy of committee secretariat

Community engagement

5.25 Sydney Olympic Park and the Australian Botanic Garden both engage the community on environmental matters by managing their parks and open spaces for members of the public to visit and enjoy. Specific initiatives are also used to promote engagement: SOPA engages young people and opens up conservation sites to the public without jeopardising its conservation work; and PlantBank facility will enhance the Australian Botanic Garden's capacity for effective public engagement on biodiversity issues.

5.26 The Committee heard that, each year, half a million school students attend school events, excursions and activities at Sydney Olympic Park. About 28 000 of those are students—from government and non-government primary and secondary schools—who visit Sydney Olympic Park as part of SOPA's program of school excursions.[2]

2 SOPA, *Annual Report 2010–11*, p. 80; Sydney Olympic Park Authority (2011) *Fact Sheet – Education*, p. 1.

5.27 At the Education Centre in Bicentennial Park, where SOPA teaches school children using hands-on learning and curriculum based environmental education programs, the Committee had the opportunity to see high school science and geography students engaged in excursion programs. The Committee heard that SOPA offers around 35 separate curriculum based school excursion programs for Kindergarten to Year 12 school students. The vast majority of these programs are wetlands-based excursions focusing on geography and science. The Committee understands that SOPA also runs professional development courses for school teachers.

5.28 As discussed above, the brickpit at Sydney Olympic Park is a site for the conservation of the endangered green and golden bell frog's primary habitat. Following pressure to allow public access to the brickpit site, an elevated ring walk was constructed in 2005. This has allowed members of the public—including members of the Committee during this site inspection—to visit the site and to learn about the threatened species and related conservation work, without disturbing the habitat. This has enabled the brickpit to achieve biodiversity conservation goals, as well as community engagement outcomes.

5.29 At the Australian Botanic Garden, the Committee heard that the removal of entry fees for the Garden in 2011 had resulted in a significant increase in visitor numbers. The Committee also heard about plans for the PlantBank facility, currently under construction. The Committee heard that the facility has been designed with community engagement principles in mind, and that the PlantBank would make seedbanking and ex situ biodiversity conservation much more open to the public. The facility is discussed in more detail below.

Committee comment

5.30 SOPA's excursion programs and the Brickpit Ring Walk are good examples of initiatives that can foster the community's engagement with the issue of biodiversity and the environment more generally, particularly in an urban context.

5.31 The Committee was impressed with the use of Sydney Olympic Park as a resource for educating young people on biodiversity issues. School children visiting the Park as part of SOPA excursion programs, represent an excellent opportunity to improve the next generation's understanding and appreciation of environmental matters, including biodiversity and climate change. The Committee considers it especially important that the school excursion programs are able to engage young people from an

urban environment in particular, who may not have routine exposure to or high awareness of ecological issues.

5.32 The Committee notes that, in some senses, SOPA has become a victim of its own success. As community engagement with the site has improved and the number of visitors to the Park has increased, so too have the pressures on Sydney Olympic Park's maintenance and ecological management programs. The Committee noted above that increases in the number of residents and workers in the precinct was likely to put pressure on SOPA's resources. This is true also of the number of visitors to the Park. While the increasing visitor numbers are commendable, the Committee foresees potential stresses on SOPA's resources and programs.

5.33 The Committee is pleased that visitor numbers to the Australian Botanic Gardens have increased, due partly to the removal of entry fees. The Committee is supportive of initiatives that encourage more people to make use of botanic gardens. The Committee is also pleased that the Australian Botanic Garden's PlantBank has been designed to improve public engagement. Such facilities have the potential to engage novices as well as researchers and students.

The role of botanic gardens

5.34 Botanic gardens have a range of roles relating to the conservation of biodiversity, as exemplified by the Australian Botanic Garden, Mount Annan.

5.35 The most obvious role of botanic gardens relates to their horticultural displays. These displays can be used as a form of ex situ conservation of plant genetic diversity. The displays can contribute to ensuring the survival of high value and threatened plant species in particular.

5.36 Botanic gardens also manage and preserve areas of natural vegetation. The Committee heard about the Australian Botanic Garden's program to eradicate the African olive noxious weed (*Olea europaea* subsp. *cuspidate*). The African olive existed on the site when the Australian Botanic Garden was opened in 1988, and has been actively managed since.

5.37 Botanic gardens have a role in community engagement, botanical research and plant taxonomy, and this is certainly true of the Australian Botanic Garden. These issues are discussed below in the context of the PlantBank facility.

Committee comment

5.38 The Committee's inspection of sites at the Australian Botanic Garden highlighted the potentially increasing role for botanic gardens in conserving biodiversity in a changing climate. Botanic gardens' horticultural, research and community engagement activities in particular will be important for informing biodiversity conservation initiatives, educating the public, and promoting biodiversity conservation as a worthwhile goal.

5.39 In light of these important roles, there is a need to ensure that botanic gardens are appropriately resourced. Visitor levels will also need to be monitored, as increased numbers of visitors are likely to result in additional pressures on the gardens' land management resources.

Figure 5.3 African olive grove in the distance, Australian Botanic Garden, Mount Annan

Photograph courtesy of committee secretariat

NSW Seedbank and PlantBank

5.40 At the Australian Botanic Garden, the Committee visited the NSW Seedbank facility and received briefings on the state's seedbanking activities. Seedbanking is a form of ex situ biodiversity conservation, where plant germplasm is stored for future use.

5.41 The Committee heard that most Australian plants have dry seeds that tend to store very well, making them good candidates for seedbanking. It was also informed that stored seeds from NSW Seedbank have been used to revegetate sites were local extinctions had occurred. For example, a species of *Allocasuarina* (she-oak) was reduced to one female individual at Nielsen Park in Sydney Harbour, due to stressors such as weeds, Phytophthora infection, and fire regime changes. Stored seeds were able to be used in situ to bolster the number of she-oaks.

5.42 The Seedbank is a significant repository for threatened species' seed in Australia. The Committee was informed that seed has been collected for 36 per cent of threatened species. The collection does not involve merely storing the seed, but also results in better understanding the biology of those seeds. This is particularly important in Australia, where seed biology is especially complicated because many plants have evolved in the presence of fire.

5.43 The NSW Seedbank was originally very small and was intended to service only the needs of the Australian Botanic Garden and its horticultural displays. Its role has evolved to include a conservation focus, partly due to its involvement in the Millennium Seedbank Project.

5.44 NSW Seedbank is part of the Australian Seedbank Partnership, which is a legacy of the Millennium Seedbank Partnership Project initiated by the United Kingdom's Kew Gardens. The project received funding from the Millennium Foundation. The botanic gardens at Mount Annan and in the Blue Mountains joined the project and have banked the seeds of approximately 250 native plant species annually. These seeds have also been sent to the Millennium Seedbank in Kew to form a duplicate collection.

5.45 The Committee heard that Project partners are required to duplicate their seed collections at the Millennium Seedbank. However, because funding for the Partnership has been cut, many partners are unable to meet this obligation. The scarcity of funding has also made it more difficult to attract new partners. Notwithstanding these challenges, the Committee heard that there are also a number of cases where the financial

relationship with the Project has ceased but the seedbanking work has continued.

5.46 The Committee also visited the site of the NSW PlantBank facility currently under construction. The facility will house a large seedbank and integrated plant conservation centre. The Committee heard that some species of plant, for example, rainforest species, are not good candidates for seedbanking. It was explained that part of the PlantBank concept was to provide ex situ conservation options for seeds from such species, such as by cryogenic freezing.

5.47 Construction of PlantBank is expected to be complete by early 2013. Most of the funding for the $19.8 million facility will be provided by the NSW Government, although $4.3 million is expected to be funded from external sources.

Committee comment

5.48 The Committee notes the significant capital investment the NSW PlantBank represents. It also heard that much of the facility's ongoing funding will need to be generated from external sources. The Committee considers that ex situ conservation facilities such as PlantBank will be an important part of Australia's biodiversity conservation response to climate change. It is therefore important that such facilities are funded adequately.

5.49 There may be scope for seedbanks to better focus their activities to prioritise habitats under the greatest threat from climate change, such as alpine ecosystems. During the course of its inquiry the Committee anticipates hearing more from other Australian seedbanks and the Australian Seedbank Partnership in relation to issues such as coordination.

5.50 The Committee also notes the emerging interest in connectivity corridor programs as a biodiversity conservation measure, particularly in the context of climate change. It expects that seedbanking and the research associated with it will prove valuable in ensuring sufficient and appropriate seed for revegetation projects.

Wollemi pine as a 'living fossil'

5.51 The Wollemi pine (*Wollemia nobilis*) is an endemic Australian evergreen conifer reaching 25 to 40 metres tall. It is a member of the *Wollemia* genus of trees, which was known only through the fossil record until David Noble discovered living *Wollemia nobilis* in Wollemi National Park in 1994. The discovery was made in a remote series of deep, narrow gorges, in a

temperate rainforest wilderness area of the national park, which is part of the Greater Blue Mountains World Heritage Area in NSW. The Wollemi pine species was thought to be extinct, the last fossil record of the species being dated at about 200 million years ago.[3]

5.52 Fewer than 100 individual trees exist in the wild, in three localities that remain undisclosed to the public. The main threat to the Wollemi pine's survival in the wild is visitation by humans. In November 2005, Wollemi pine trees growing in the wild were found to have been infected by the *Phytophthora cinnamomi* water mould, and it is believed that the pathogen was introduced to the site by unauthorised visitors.

5.53 Following the species' discovery in 1994, the Australian Botanic Garden was involved in a propagation program to make the Wollemi pine available to botanic gardens in Australia and overseas. Subsequently, the propagation and distribution of the species was commercialised, and members of the public are now able to purchase seedlings for their own gardens.

5.54 The Committee inspected the ex situ Wollemi pine collection at the Australian Botanic Garden. The collection contains representatives of every known Wollemi pine plant growing in the wild. The collection is also the ultimate source of all Wollemi pines propagated worldwide.

Committee comment

5.55 The Wollemi pine provides an interesting case study that demonstrates the importance of refugia and protected areas in helping species survive changes in climate. This may be particularly important as climate changes take place and ecosystems are transformed in coming decades.

5.56 The Wollemi pine cultivation program is also an example of an innovative conservation strategy that also engages the community. The plants are distributed within Australia and internationally under commercial licence, with the aim of conserving the species by having the pine grown in parks, gardens and homes. Moreover, royalties from sales are returned to programs for the conservation of the Wollemi pine and other rare and threatened species. This dual conservation approach is also combined with the community engagement outcomes that are achieved by exposing more people to the species and its story.

3 Royal Botanic Gardens and Domain Trust, *Wollemi Pine – Age and ancestry*, <http://www.rbgsyd.nsw.gov.au/plant_info/wollemi_pine/age_and_ancestry> viewed 17 April 2012.

Pests and disease

5.57 As noted above, at the Australian Botanic Garden the Committee heard that many of the wild-growing Wollemi pines had been infected by phytophthora, highlighting the importance of containment, research, and public education, as discussed in Chapter 2.

5.58 The Committee heard that phytophthora was also present at the Australian Botanic Garden site when it was acquired by the Royal Botanic Gardens and Domain Trust. The Committee heard that the Australian Botanic Garden has managed the threat of phytophthora mainly by planting species that are tolerant to the mould.

5.59 The Committee was interested to hear that myrtle rust (*Uredo rangelii*) is an emerging and significant issue for biodiversity, particularly in NSW. The Committee understands that myrtle rust came from South America, through a nursery in NSW. It is a newly described fungus that has spread relatively rapidly along the east coast of Australia. As a windborne pathogen, it has been very difficult to contain. It has been in Australia for only about 18 months and is said to have already caused a great deal of devastation to more than 100 naturally susceptible plant species. Several types of endemic Australian plants are susceptible to myrtle rust, including bottle brush, tea tree, and eucalypts.

5.60 The Committee also heard about the presence of phytophthora and myrtle rust in Sydney Olympic Park. SOPA officers advised that stringent hygiene procedures have been put in place for contractors. The Committee was also informed that the chytrid amphibian fungus is present at Sydney Olympic Park, but that the local frog communities appear to have some resistance to it. It is thought that this resistance could be due to the presence of heavy metals in the water.

Committee comment

5.61 The Committee notes the considerable threat to Australia's biodiversity posed by the spread of myrtle rust. Appropriate governance and adequate funding are necessary to ensure the damage from myrtle rust is minimised. Governance arrangements could also benefit from further consideration to ensure that authorities have the flexibility to act quickly when a pathogen outbreak is detected in future.

5.62 The Committee was advised that the CSIRO is conducting research into the vulnerability of different plant species to myrtle rust. However, the Committee understands there may be a need for more research on the epidemiology of myrtle rust, so that the fungus can be better understood.

This would be of benefit in the context of climate change, as a better understanding of the disease and the likely impact of temperature changes may assist policy-makers and land managers in formulating appropriate and targeted responses. Given that myrtle rust arrived from South America, the Committee notes the importance of sound and rigorous biosecurity measures, particularly in the context of uncertainties about system interactions in a changing climate.

5.63 The Committee notes that considerable effort goes into controlling weed species in Sydney Olympic Park and at the Australian Botanic Garden, especially in threatened habitats (such as the coastal saltmarsh at Olympic Park) and in scarce remnant vegetation (such as the Cumberland Plain Woodland at the Australian Botanic Garden). The Committee considers there is a need for vigilance and appropriate funding for weed eradication programs.

Concluding remarks

5.64 The Committee's inspection program in Sydney made a valuable contribution to the inquiry, particularly through the coverage of issues such as ecological restoration and remediation; community engagement; ex situ conservation and innovative conservation strategies; and the impact on biodiversity of threats such as pests and disease.

5.65 At Sydney Olympic Park, the Committee appreciated the opportunity to inspect a diverse range of sites that demonstrated:

- ecological management practices to maintain and improve remnant ecosystems in the Badu Mangroves;
- severely degraded landscapes that are actively managed for biodiversity as well and community engagement outcomes;
- remnant native forest in the Newington Nature Reserve, demonstrating the biodiversity benefits of regulated protection of areas, albeit incidental in this case; and
- the benefits of community engagement and education programs, particularly in urban environments.

5.66 The scale and success of the ecological restoration undertaken at Sydney Olympic Park could provide lessons for application to other sites across Australia. The Park's urban location provides a point of comparison with other restoration works the Committee has inspected to date, and

information about its school excursion program has made an important contribution to the community engagement aspect of the Committee's inquiry.

5.67 At the Australian Botanic Garden, the Committee was interested to learn about the role of seedbanks in ex situ conservation efforts. The Committee is pleased that the new PlantBank facility will bring together conservation, research, teaching and community engagement activities. The visit to the Australian Botanic Garden made an excellent contribution to the Committee's understanding of the types of disease-related threats facing Australia's terrestrial ecosystems.

5.68 The Committee wishes to record its thanks to the Sydney Olympic Park Authority and the Royal Botanic Gardens and Domain Trust for making their officers available to provide extensive briefings to the Committee and to facilitate the visits.

Mr Tony Zappia MP
Chair
May 2012

Glossary of terms

adaptive management	Management practices that accommodate and respond to uncertain future events.
biodiversity	A word derived from 'biological diversity'. The variety of all life forms: the different plants, animals and micro-organisms, their genes and the communities and ecosystems of which they are part.
bioregion	An ecologically and geographically defined area.
browsing	A type of feeding where herbivores eat woody twigs and leaves from trees and shrubs.
citizen science	Scientific research that is carried out, in whole or in part, by amateur or nonprofessional scientists.
connectivity	The extent to which particular ecosystems are joined with others of similar kind; the ease with which organisms can move across the landscape.
ecological niche	The relational position of a species or population within an ecosystem, with respect to both its role and the space it inhabits.
ecology	The scientific study of the distribution and abundance of life on Earth, and the interactions between organisms and their environment.
ex situ	A Latin phrase which translates literally to 'out of position'. In ecological terms it refers to an organism out of its natural habitat. Ex situ conservation refers to off-site protection of organisms.
endemic	Occurring only in the stated area.
fire regime	The combination of fire frequency, intensity, interval and season.

germplasm	A term used to describe a collection of genetic resources of an organism. For plants, the germplasm may be stored as a seed collection.
grazing	A type of feeding where herbivores eat grass or other low vegetation.
in situ	A Latin phrase which translates literally to 'in position'. In ecological terms it refers to an organism in its natural habitat.
invertebrate	An animal lacking a backbone (spinal column).
keystone species	Species that have a disproportionately large effect on an ecosystem, their presence or absence changing the interactions among the species in that ecosystem.
phenology	The study of periodic plant and animal life cycle events and how these are influenced by seasonal and interannual variations in climate.
remnant	A remaining portion of natural habitat.
resilience	The capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain function, structure, identity and feedbacks; the extent to which a system is able to change in response to a disturbance.
riparian	Relating to the interface between land and a watercourse
stygofauna	Subterranean aquatic invertebrates
tipping point	(or critical threshold or ecological threshold) The point at which a relatively small change in external conditions causes a rapid change in an ecosystem, often leading to an abrupt change in ecosystem health.
tropical nights	Indicated by overnight temperatures of 20 degrees Celsius or above.
vertebrate	An animal with a backbone (spinal column), including: sharks and rays; bony fish; amphibians; reptiles; birds; and mammals.