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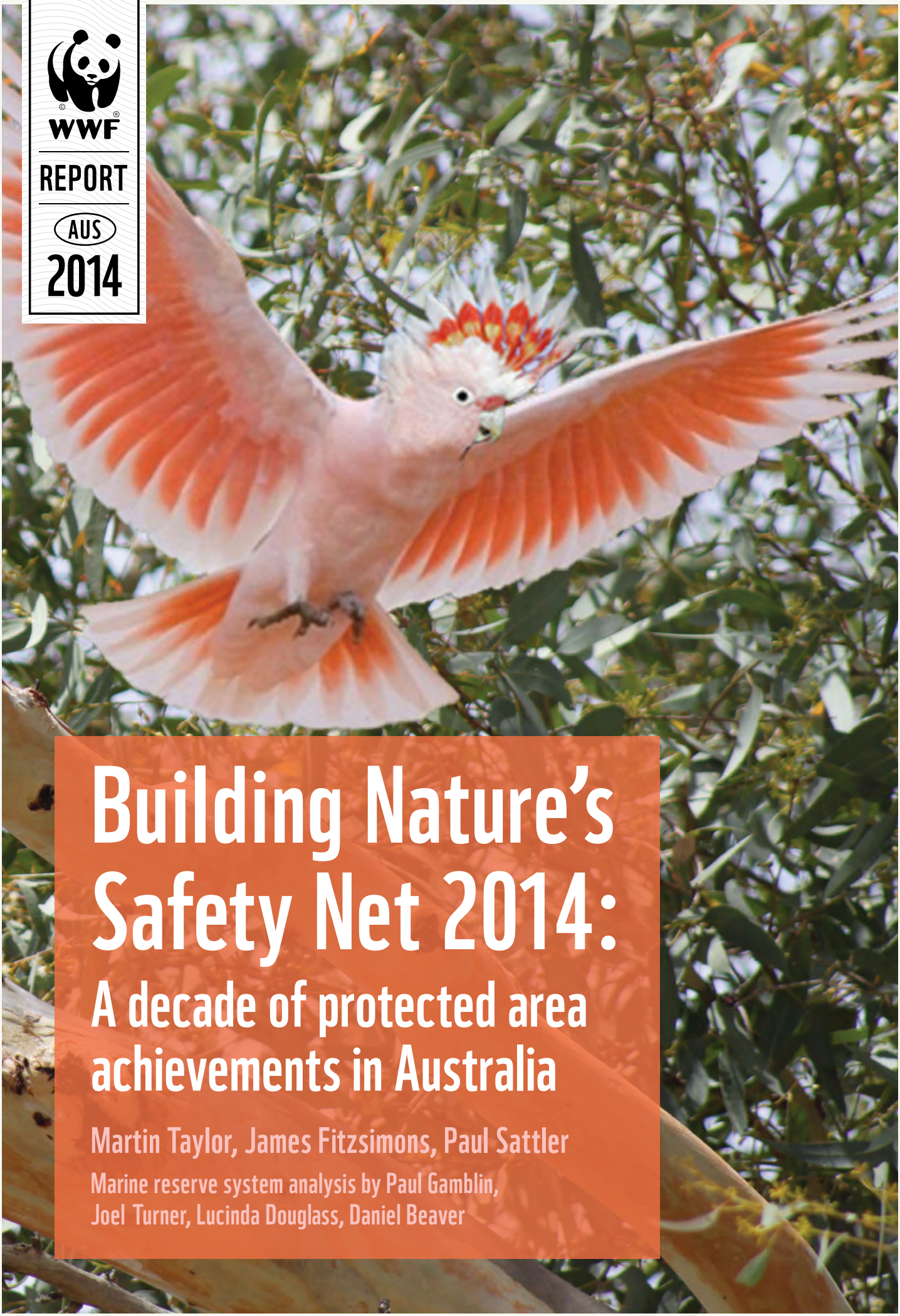

Building Nature's Safety Net 2014:

A decade of protected area achievements in Australia

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Marine reserve system analysis by Paul Gamblin, Joel Turner, Lucinda Douglass, Daniel Beaver

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About the authors

- **Martin Taylor** is WWF-Australia's Protected Areas Policy Manager and has published important analyses of the effectiveness of the Endangered Species Act in the United States, threats to international whale habitats, and the effectiveness of conservation actions in Australia including protected areas for threatened species. He has served on the Scientific Committee of the International Whaling Commission and as an NGO observer at CITES. He is a member of the IUCN World Commission on Protected Areas.
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- **Paul Sattler OAM** was the principal architect in doubling Queensland's National Park estate in the early 1990s, and pioneered the development of a biologically representative park network across the State. Paul initiated and guided the comprehensive description of Queensland's bioregional ecosystems and assessment of their status, providing an essential planning tool for conservation and natural resource management. He was principal author of the National Land and Water Resources Audit's terrestrial biodiversity assessment of Australia, which was the first detailed national assessment of biodiversity at a range of scales. Paul has been awarded an OAM for his services to biodiversity conservation.

FOREWORD FROM PENELOPE FIGGIS AO

There is a simple fact: without protected areas the wonders and immense values and benefits of nature would have virtually no chance of surviving our over-crowded, resource consuming world beset by climate change.

R. DONALD

"WWF has played a critical role in advocacy for progress and deserves great credit for periodically measuring how we are progressing against our targets."

In all countries it is in protected areas where the water runs clear, where wild creatures find sanctuary, where landscapes and seascapes of great beauty and majesty are testament to 4.5 billion years of shaping by the earth's evolutionary processes. They have immense cultural, social, economic and often livelihood values for their nations and visitors.

Between the Durban Parks Congress in 2003 and the Sydney Parks Congress in 2014 much progress has been made around the world. In Australia, we have been fortunate to have a long period of bipartisan support for building a scientifically based system of protected areas of various types – the National Reserve System (NRS). The NRS has been embraced as our key strategy to give the best hope of protection to Australia's unique heritage of cultural sites and native wildlife and plants which reflect the long isolation of our vast island continent. Our native species are not only scientifically important but a major component of our national identity and Australia's attraction as a tourist destination.

In building this crucial system, WWF has played a critical role in advocacy for progress and deserves great credit for periodically measuring how we are progressing against our targets. In releasing this latest volume on the occasion of the IUCN World Parks Congress there is much to celebrate with some of the highlights being:

- Major expansion of the terrestrial NRS over the decade;
- The exponential growth of non-government private protected areas, co-managed and Indigenous Protected Areas (IPAs), which now are approaching half of the NRS by area;
- The significant boosting of Australian Government investment in the NRS in 2008 which provided critical leverage for state investments, the private land sector and IPAs;
- An additional 436 terrestrial ecosystems and 176 terrestrial threatened species have been brought up to a minimally adequate standard of habitat protection;
- A substantial reduction in the number of terrestrial bioregion priorities identified as poorly protected from 17 in 2002 to 7 in 2012;
- The growth in citizen led, inclusive, large scale connectivity initiatives such as the Great Eastern Ranges Initiative and the identification of key national landscape connectivity initiatives through the Australia's National Wildlife Corridors Plan;
- Expansion within the Great Barrier Reef Marine Park from 5% to 33% in 2004 of fully protected marine areas, also known as no-take or green zones; and
- The extension of marine reserves throughout Commonwealth waters.

With Australia's terrestrial NRS now close to 17 per cent of land area, and the marine NRS above 10 per cent of all Australian waters, Australia appears at first glance to be close to meeting Aichi Target 11 of the Convention on Biological Diversity. Under this target CBD signatories like Australia committed by 2020, to bring "at least 17 per cent of terrestrial and inland water[s], and 10 per cent of coastal and marine areas" under protection.

However, it is widely understood that area alone does not equal effective conservation and many issues, particularly effective management, are crucial to protected areas achieving their purpose.

This is especially true in Australia with the vulnerability of our species even in protected areas to invasive species and to climate change impacts. This Report makes it clear that Australia still needs to make considerable additional effort to achieve other key aspects of Aichi Target 11, to ensure our reserve system is "effectively managed", "well-connected" and "ecologically representative".

The Aichi Target 11 also calls for priority conservation of "areas of particular importance for biodiversity and ecosystem services". However, areas which function as refuges in climatic change - *refugia* - identified by researchers as conservation priorities, are still poorly protected. This Report shows that 1,655 terrestrial ecosystems are still entirely unprotected, as well as the habitats of 138 threatened species.

Australia has also made impressive steps in marine conservation in recent years, most states have made significant declarations and major advances have been made in the Great Barrier Reef and in the Commonwealth marine reserve system. This is highly appropriate given that Australia has one of the largest and most biodiverse marine territories on earth. This bestows on us a special responsibility to contribute to the global effort to face the serious decline of the ocean and protect and manage our waters and contribute to international efforts to pass on the health and wealth of the ocean to future generations.

However, despite this very significant progress there is a clear view from marine scientists that we have not achieved representativeness, particularly of the contested, rich continental shelf waters. Certainly not every marine bioregion is above 10 per cent protected at present. WWF argue that because further declarations require a marine planning exercise, not involving area purchase and the costs are comparatively modest, that Australia can go beyond global targets and that the development of a fully comprehensive, adequate and representative marine reserve system should be a feasible target for 2020. It would be a globally significant contribution.

This latest WWF *Building Nature's Safety Net* Report breaks new ground by documenting the change in connectivity of the terrestrial reserve system in the past decade. The Connectivity approach stresses the need for thinking beyond isolated conservation connectivity enclaves or islands to a 'whole of landscape' or seascape vision of many lands, seas under various tenures and jurisdictions contributing to an integrated approach. It is widely endorsed internationally and reflected in Target 11 which calls for protected areas to be "well connected" and "integrated into the wider landscape and seascapes". Distances separating protected area have shortened on average, with quite a number of significant large scale initiatives. Unfortunately, the Report suggests that land use intensification along these linkages means that functional connectivity is generally eroding, not improving. The far sighted National Wildlife Corridors Plan appears to be in abeyance making it difficult for Australia to claim the NRS is "well-connected" and "integrated into the wider landscape".

So often, conservation comes down to political will and resources. Can Australia afford to invest in more protected areas at the levels WWF estimates are needed to meet Aichi Target 11? Again the WWF Report breaks new ground by making a hard dollar value argument which turns that question around. Can Australia afford NOT to invest in more protected areas?

Protected areas help save our wonderful animals and plants and our most beautiful land and seascapes for the world and future generations to enjoy. It is impossible to put a price on this. But it is possible to develop dollar estimates for the benefits which flow from intact nature: the value of ecotourism, of securing genetic resources for pharmaceuticals and agriculture, of beneficial species like pollinators and fish nurseries, and of carbon storage, clean water, flood control and climate moderation. The estimated economic value of these ecosystems services and tourism values secured and provided by the NRS dwarfs the total annual investment by all Australian governments in expanding and managing the system.

Given these clear benefits and the well documented successes of the program, the recent termination of the dedicated NRS funding and administration program has been both alarming and inexplicable. WWF has endeavoured to illustrate that the comparatively modest investment in the NRS over the years has cost the Australian Government only $44.40 on average per hectare purchased. In addition this funding has had a dramatic leverage impact on private philanthropy, raising very substantial sums from the broader society and increasing social enthusiasm for conservation. It has also had a major and enthusiastic response from Indigenous people allowing them to manage their country for conservation, and in some cases like Fish River in the Northern Territory, even buy it back, with substantial additional social and economic benefits. It therefore remains a mystery why, given the clear comparative advantage of investing in protected areas for secure outcomes, there is still a struggle for long term secure funding, as opposed to the pervasive investment in short term conservation measures.

I commend this Report to the government and non-government conservation sectors in the hope that its important message will hit home. Our National Reserve System is a great bipartisan national achievement: a remarkable collaboration from all levels of government, from non-government organisations, Indigenous people, and individual landholders committed to conservation. It will benefit all Australians now and in the future. Its continued building and improvement through inclusive and properly resourced management should be the top conservation priority for governments at all levels.

Penelope Figgis AO

Vice Chair IUCN World Commission on Protected Areas
Director Australian Committee of the IUCN

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Appendices are posted as a separate document at
www.wwf.org.au/buildingnaturesafetynet2014

SATIN BOWERBIRD, LAMINGTON NATIONAL PARK © STAFFAN WIDSTRAND / WWF

CORAL LICHEN, GIRRAWEEN NATIONAL PARK, QUEENSLAND © ROSELLA TAYLOR

EXECUTIVE SUMMARY

THE NATIONAL RESERVE SYSTEM

The single most important asset for the conservation of Australia's unique and globally significant biodiversity is the National Reserve System, a mosaic of over 10,000 discrete protected areas on land on all tenures: government, Indigenous and private, including on-farm covenants, as well as state, territory and Commonwealth marine parks and reserves.[1]

In this report, we cover major National Reserve System initiatives that have occurred in the period 2002 to the present and highlight issues affecting progress toward agreed national objectives.

We define a minimum standard for the National Reserve System to comprehensively, adequately and representatively protect Australia's ecosystem and species diversity on sea and land. Using government protected area, species and other relevant spatial data, we quantify gaps: those areas needing to move from the current National Reserve System to one which meets this standard. We also provide new estimates of financial investments in protected areas and of the benefits that protected areas secure for society.

1 More formally known as the National Representative System of Marine Protected Areas in the marine environment.

BENEFITS

Protected areas primarily serve to secure Australia's native plants and animals against extinction, and to promote their recovery.

Protected areas also secure ecosystem services that provide economic benefits for human communities including water, soil and beneficial species conservation, climate moderation, social, cultural and health benefits. On land, we estimate these benefits are worth over $38 billion a year, by applying data collated by the Ecosystem Services Partnership. A much larger figure is estimated to have been secured by marine protected areas in the form of moderation of climate and impact of extreme events by reef and mangrove ecosystems. While these estimates have not been verified by studies specific to Australia, they are indicative of a very large economic contribution of protected areas.

NATURE TOURISTS SPEND OVER $23.6B PER YEAR

Visitors to national parks and nature reserves spend over $23.6 billion a year in Australia, generating tax revenue for state and territory governments of $2.36 billion a year.

All these economic benefits taken together greatly exceed the aggregate annual protected area expansion and management spending by all Australian governments, estimated to be ~$1.28 billion a year. It is clear that Australian society is benefiting far greater than its governments' investment into strategic growth and maintenance of the National Reserve System.

FINANCING

Government investment and policy settings play a leading role in strategic growth of the National Reserve System in Australia, and provide a critical stimulus for non-government investment. Unprecedented expansion of the National Reserve System followed an historic boost in Australian Government funding under Caring for Our Country 2008–2013.

This expansion was highly economical for the Australian Government, costing an average of only $44.40 per hectare to buy and protect land forever. State governments have contributed about six times this amount toward the expansion of the National Reserve System, after including in-perpetuity protected area management costs. The growth of Indigenous Protected Areas by the Australian Government has cost ~$26 per hectare on average, including management costs capitalised in-perpetuity, while also delivering Indigenous social and economic outcomes.

The aggregate annual investment by all Australian governments has been ~$72.6 million per year on protected area growth and ~$1.21 billion per year on recurrent management costs.

For the first time in almost two decades, however, the Australian Government's National Reserve System Program, comprising a specialist administrative unit and funding allocation, was terminated in late 2012. This program was fundamental in driving significant strategic growth in Australia's protected area estate. It is highly unlikely that Australia can achieve its long-standing commitments to an ecologically representative National Reserve System, and prevent major biodiversity loss, without this dedicated funding pool. The Australian Government has budgeted ~$400 million per year over the next five years (2013-2018) under the National Landcare and related programs. This funding program should give high priority to delivery of national protected area commitments by providing a distinct National Reserve System funding allocation.

BIODIVERSITY CONSERVATION

Under the Convention on Biological Diversity (CBD), Australia has committed to bringing at least 17 per cent of terrestrial and at least 10 per cent of marine areas into ecologically representative, well-connected systems of protected areas by 2020 (Aichi Target 11).

Australia also has an agreed intergovernmental Strategy for developing a comprehensive, adequate and representative National Reserve System on land and sea that, if implemented, would deliver on this CBD target.

Due to dramatic recent growth, the National Reserve System covers 16.5 per cent of Australia's land area, with highly protected areas, such as national parks, covering 8.3 per cent. The marine National Reserve System extends over one-third of Australian waters with highly protected areas such as marine national parks, no-take or green zones covering 13.5 per cent.

Growth has been uneven however, and the National Reserve System is still far from meeting Aichi Target 11, which requires that it also be ecologically representative and well-connected.

1,655

ECOSYSTEMS AND HABITATS FOR 138 THREATENED SPECIES REMAIN UNPROTECTED ON LAND

On land, 1,655 of 5,815 ecosystems and habitats for 138 of 1,613 threatened species remain unprotected.

Nonetheless, 436 terrestrial ecosystems and 176 threatened terrestrial species attained minimum standards of protection due to growth of the National Reserve System on land between 2002 and 2012. The gap for ecosystem protection on land – the area needed to bring all ecosystems to the minimum standard of protection – closed by a very substantial 20 million hectares (from 77 down to 57 million hectares) between 2002 and 2012, not including threatened species protection gaps.

Threatened species attaining a minimum standard for habitat protection increased from 27 per cent to 38 per cent over the decade 2002–2012. A low proportion of critically endangered species meeting the standard (29 per cent) and the high proportion with no protection at all (20 per cent) are cause for concern, but one which should be relatively easy to amend, as the distributions of these species tend to be small and localised.

Protected area connectivity has increased modestly for terrestrial protected areas in terms of the median distance between neighbouring protected areas, but this progress has been undermined by increasing land use intensity in landscapes between protected areas.

A comprehensive, adequate and representative marine reserve system, which meets a standard of 15 per cent of each of 2,420 marine ecosystems and 30 per cent of the habitats of each of 177 marine species of national environmental significance, would require expansion of marine national parks, no-take or green zones up to nearly 30 per cent of state and Australian waters, not substantially different in overall extent from that of the current marine reserve system, but different in configuration.

Protection of climate change refugia, connectivity and special places for biodiversity is still low and requires high priority attention.

FINANCING TO FILL GAPS AND MEET COMMITMENTS

If the 'comprehensiveness' and 'representativeness' targets in the agreed terrestrial National Reserve System Strategy were met by 2020, Australia would be likely to have met the 'ecologically representative' requirement of Aichi Target 11. This would require expanding the terrestrial reserve system by at least 25 million hectares. Considering that the terrestrial ecosystem protection gap has closed by 20 million hectares over the past decade, this required expansion would be feasible with a major boost in investment and focus on long-standing priorities.

A realistic mix of purchases, Indigenous Protected Areas and private land covenants would require an Australian Government National Reserve System investment of ~$170 million per year over the five years to 2020, representing ~42 per cent of the $400 million per year which the Australian Government has budgeted for landcare and conservation over the next five years.

State, territory and local governments, private and Indigenous partners would likewise need to boost financial commitments to both expand and maintain new protected areas to meet the agreed National Reserve System strategic objectives.

The total cost of Australia achieving a comprehensive, adequate and representative marine reserve system that would satisfy Aichi Target 11 is an estimated $247 million.

GRAMPIANS NATIONAL PARK, VICTORIA © GLEN C CAMPBELL / OZSTOCK IMAGES PTY LTD

RECOMMENDATIONS

Recommendation 1: 25
The Australian Government should forge a new partnership with state and territory agencies and non-government conservation organisations, coordinated with natural resource management agencies, to continue advancing toward the long-standing goal of a comprehensive, adequate and representative National Reserve System that meets national and international commitments, and saves Australia's unique biodiversity from loss and extinction.

Recommendation 2: 27
The Australian Government should meet Aichi Target 11 by increasing funding to the National Reserve System program to at least $170 million per year, comprising grants to public and private partners to purchase land for new protected areas; to establish and manage Indigenous Protected Areas (IPAs); and to establish and manage private land conservation covenants.

Recommendation 3: 27
State and territory conservation agencies should likewise ensure sufficient budgetary resources for continued protected area growth, as well as for effective protected area management spending to keep pace with the increase in areas protected.

Recommendation 4: 27
More broadly, Landcare and natural resource management investments should be prioritised to landholders voluntarily adopting new – or with existing – perpetual conservation covenants that secure those investments for the future and which also contribute to or are complementary with the National Reserve System, with focus on restoring landscape connectivity and resilience to climate change.

Recommendation 5: 29
Australian state and territory governments in partnership can meet the marine and coastal element of Aichi Target 11 by declaring a comprehensive, adequate and representative marine reserve system at a cost of ~$247 million in fisheries adjustment assistance. Reviews of marine protected areas, planned or currently in progress, should be based on the best available science and achievement of this long-standing goal in all jurisdictions.

Recommendation 6: 33
Where land is leased for pastoral purposes or available for mining, State and territory governments should legislate to provide a mechanism to prohibit these activities where land is placed under a permanent conservation covenant.

Recommendation 7: 33
Governments should encourage and promote the adoption of verified high environmental performance standards for agricultural and fishing industries to ensure protected areas are surrounded and supported by complementary natural resource use across entire landscapes and seascapes.

DAINTREE RAINFOREST, NORTH QUEENSLAND © GLOBAL WARMING IMAGES / WWF-CANON

ROYAL PENGUIN COLONY, MACQUARIE IS © ALEKS TERAUDS

PART I: THE NATIONAL RESERVE SYSTEM

INTRODUCTION

The single most important asset for the conservation of Australia's unique and globally significant biodiversity is the National Reserve System, a mosaic of over 10,000 discrete protected areas on land on all tenures: government, Indigenous and private, including on-farm covenants, as well as state, territory and Commonwealth marine parks and reserves.[2]

Australian biodiversity globally significant

After 80 million years of isolation, most of Australia's animals and plants have evolved to be unique, without close relatives anywhere else.

Australia as a biogeographic region, including the once connected islands of Tasmania and New Guinea, is the only place on Earth where all three major divisions of mammals are present: the egg-laying monotremes (platypus and echidna); the marsupials; and the placental mammals. Of the 17 megadiverse countries, which together harbour the majority of Earth's species, Australia ranks at the top for vertebrate diversity and fifth for vascular plant diversity. [3]

At least 130,000 different species of native animals and plants, nearly 8 per cent of all life on Earth, are found in Australia,[4] along with three globally important regions for biodiversity: the Eastern Australian Forests, and Southwest Australia plant diversity hot spots and the Great Barrier Reef.[5]

Australian oceans and seas also have high levels of endemism, featuring species such as the Little Penguin, Australian Sea Lion, Snubfin Dolphin and Flatback Turtle.

Today, 55 animals and 39 plant species are listed as already extinct on the national threatened species list, and 1,652 species are listed as threatened with extinction.[6]

Many ecosystems have become endangered due to clearing and degradation on land,[7] while aquatic and marine ecosystems also suffer from widespread fishing pressure, industrialisation and pollution exported from land use in the catchments.

The National Reserve System

Australia's National Reserve System is a multi-jurisdictional, multi-tenure mosaic of protected areas on land and waters under government, Indigenous and private management.

2 More formally known as the National Representative System of Marine Protected Areas in the marine environment.

3 Mittermeier RA et al, 1997. *Megadiversity: earth's biologically wealthiest nations,* CEMEX, Agrupación Sierra Madre, Mexico City.

4 Chapman AD, 2009. *Numbers of living species in Australia and the world,* 2nd edn, Australian Biological Resources Study, Canberra.

5 Mittermeier RA et al, 1998. Biodiversity hotspots and major tropical wilderness areas: approaches to setting conservation priorities, *Conservation Biology* 12, 516–20.
Williams KJ et al, 2011. Forests of East Australia: the 35th biodiversity hotspot, *Biodiversity Hotspots*, Springer, Berlin, pp 295–310.

6 Australian Government Department of the Environment, 2014a. *Biodiversity*, webpage (http/:www.environment.gov.au/biodiversity) accessed 30 June 2014. This does not include other species listed only on state and territory threatened species lists.

7 Taylor MFJ et al, 2014. *Changing land use to save Australian wildlife*, WWF-Australia, Sydney.

With the commencement of the Convention on Biological Diversity (CBD) at the Rio Earth Summit in 1992, Australia in ratifying the Convention committed to developing a national strategy for the conservation of Australia's biodiversity and to "the development of a national comprehensive system of parks and reserves [...] in cooperation with States and Territories."[8]

Two partnerships were formed between federal, state and territory governments: the National Reserve System Cooperative Program and the National Representative System for Marine Protected Areas. These were the cornerstones of Australia's response to the ongoing global and national crisis of biodiversity loss.

The Australian Government created a National Reserve System grants program to assist states and territories in purchasing land for new public protected areas, such as national parks, later expanded to non-government proponents. The Indigenous Protected Areas program was also established in 1996 to assist Indigenous landholders who wished to declare Indigenous Protected Areas over their country, with appropriate management plans. The National Reserve System program later included a "Protected Areas on Private Land" subprogram to stimulate the adoption of covenants on private land that advanced National Reserve System goals. This subprogram began in Tasmania and was progressively rolled out through all states and territories.

The National Reserve System program also coordinated the development of national conservation policy with state and territory partners, under the aegis of the intergovernmental Council of Australian Governments (COAG), adopting a strategy in 2005 (*Directions for the National Reserve System*), which was updated in 2009 as the current *Strategy for the National Reserve System 2009–2030*.[9]

With the creation of the Natural Heritage Trust (NHT) in 1997, the Australian Government assisted in establishment of a national network of regional Natural Resource Management (NRM) bodies to deliver NRM outcomes using NHT funding. The National Reserve System grants program was recognised in the NHT Act as a priority, but the funding allocation was recognised as inadequate.

In regard to the regional NRM arrangements, the Australian Auditor General found:

> "there was little evidence that there has been any substantial movement towards landscape scale repair and replenishment of natural resources as envisaged by the NHT [...] which suggests that stronger tightening [...] towards the highest priorities and most critical national assets is necessary" [10]

However, in addressing the underfunded National Reserve System program, the Auditor General found it was:

> "a cost-effective mechanism for achieving conservation outcomes. The IBRA provides a robust, nationally agreed planning framework for identifying priority areas for conservation. The National Reserve System Programme has, through partnerships, acquired suitable land for the National Reserve System but the total area protected to date has fallen short of the 2005 targets."[11]

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8 Australian Government Department of the Environment, 2014. *About the National Reserve System*, webpage (http://www.environment.gov.au/topics/land/National Reserve System/about-National Reserve System/history).

9 National Reserve System Task Group, 2009. *Australia's Strategy for the National Reserve System 2009–2030*, Australian Government, Canberra.

10 Australian National Audit Office, 2008a. *Regional Delivery Model for the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality. Audit Report No.21 2007–08*, Australian Government, Canberra (http://www.anao.gov.au/uploads/documents/2007-08_Audit_Report_21.pdf).

11 Australian National Audit Office, 2008b. *Review of the Administration of the National Reserve System. 28 Feb 2008,* Australian Government, Canberra. IBRA refers to the Interim Biogeographic Regionalisation of Australia, the national map of bioregions.

In recognition of this shortfall due to inadequate funding, the National Reserve System was named as one of six priorities under the Caring for our Country program and received a fivefold boost in funding to $180 million over the five years 2008–2013, targeting areas of low ecological representation. At the same time, the sister program for Indigenous Protected Areas was also boosted to $50 million dollars over five years. [12]

About this report

Building Nature's Safety Net series is an independent, non-government audit of protected area establishment and funding. The reports are based on information provided by jurisdictions, in particular the Collaborative Australian Protected Areas Database 2012 terrestrial and marine (CAPAD) compiled by the Australian Government in collaboration with state and territory governments. [13]

This report is the fourth in a series with previous reports published in 2006, 2008 and 2011. [14]

In this report, we cover major protected area initiatives that have occurred in the period 2002 to the present and highlight issues affecting progress toward agreed protected area objectives.

We define a minimum standard for an ecologically representative reserve system for sampling of ecosystem and species diversity on sea and land.

Using government protected area, species and other relevant spatial data, we quantify the gaps: those areas needing to move from the current reserve system to one which meets these minimum standards.

We also provide new estimates of both financial investments in protected areas and the benefits that protected areas secure for society.

Major advances on previous reports include:

- preliminary estimation of the ecosystem services value secured in Australian protected areas;
- spatial reserve prioritisation analysis for marine reserves; and
- assessment of robustness to climate change.

12 See note 8 above.

13 Australian Government Department of Environment, 2012. *Collaborative Australian Protected Areas Database 2012*, spatial data (http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7B6B98FD1F-17B0-48F4-88F3-A814DA1E171A%7D terrestrial and http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7BAB09E7E0-E6BC-47A7-B522-B426C8E572AE%7D marine).

14 Sattler PS, Glanznig A, 2006. *Building Nature's Safety Net: A review of Australia's terrestrial protected area system, 1991–2004*, WWF-Australia, Sydney.
Sattler PS, Taylor MFJ, 2008. *Building Nature's Safety Net 2008. Progress on the Directions for the National Reserve System,* WWF-Australia, Sydney.
Taylor MFJ et al, 2011a. *Building Nature's Safety Net 2011. The state of protected areas for Australia's ecosystems and wildlife,* WWF-Australia, Sydney.

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Box 1. Some of Australia's unique threatened species

The Dawson Yellow Chat (*Epthianura crocea macgregori*): This critically endangered saltmarsh and coastal grassland songbird was once widespread along the central Queensland coast. The Chat has declined to only 200 birds in three remnant populations, and until recently largely unprotected and subject to livestock use. The Curtis Island population could be extinct, but habitat was recently brought into National Park, correcting a long-standing lack of habitat protection for this species (see *Curtis Island National Park expansion* below).[16]

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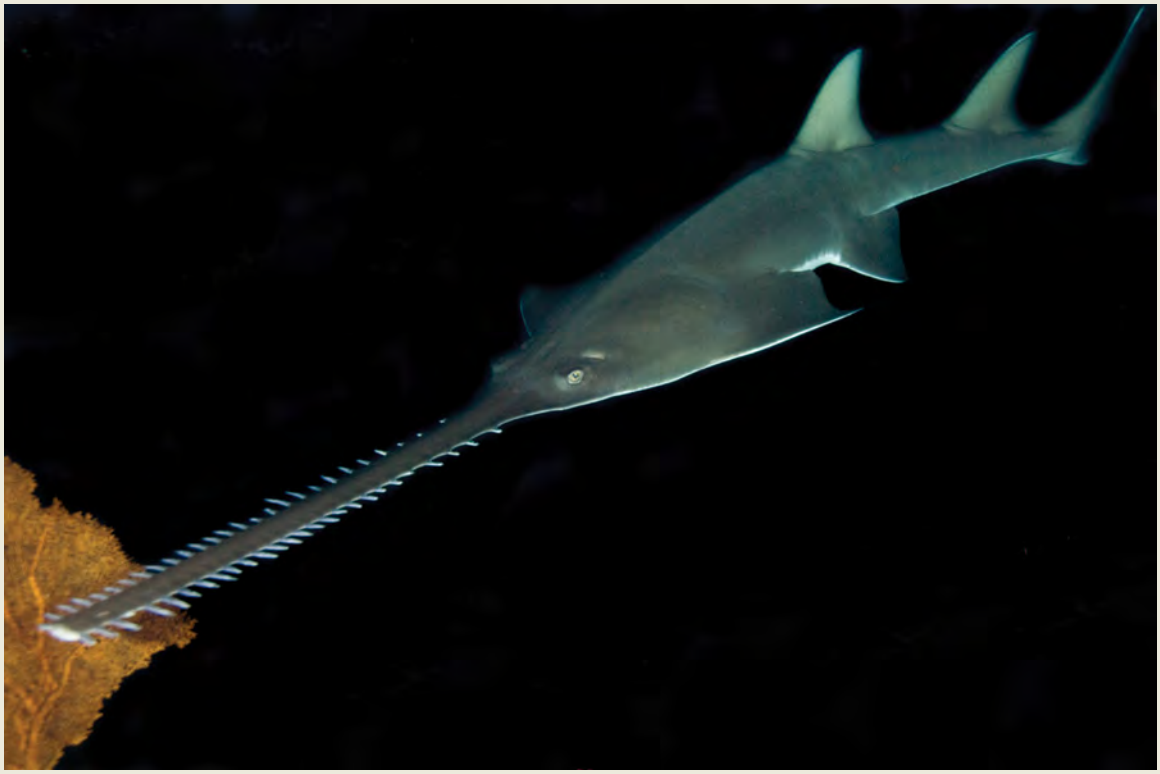
The Northern Hairy Nosed wombat (*Lasiorhinus krefftii*): The world's largest burrowing herbivore is listed as critically endangered by the IUCN, and endangered in Queensland and nationally. Its population previously extended from Central Queensland to the Victorian border, but is now reduced to just 176 individuals in the last remaining wild population on Epping Forest National Park in central Queensland and 12 recent colonists at the Richard Underwood Nature Refuge in southern Queensland. Although 100 per cent of its 'known' or 'likely to occur' habitat is protected, very little of its historic or potential habitat is protected. Land clearing and competition from grazing livestock represent the chief threats. This wildlife camera shot shows the first joey born into the recently established colony.[15]

15 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=198.
16 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67090.



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The Green Sawfish (*Pristis zijsron*)[18]: Listed as critically endangered by IUCN, this ancient and unusual shark relative is a specialist of muddy bottoms and estuaries. It was previously found as far south as New South Wales waters but now only occurs north of Cairns across northern estuaries. Remarkably, none of its 'known' or 'likely to occur' distribution, as mapped by the Australian Government, falls within a highly protected area. However, the recently created Eighty Mile Beach Marine Park in Western Australia should include sawfish habitat in marine national parks once zoning is finalised (see *Western Australia* profile).

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The Northern Serrate Dryandra (*Banksia serratuloides perissa*): This critically endangered heath plant of the Geraldton Sandplains in Western Australia occurs in just 16 populations in three locations. Only 13 per cent of its mapped 'known' and 'likely to occur' habitat is protected.[17]

17 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82767.
18 http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68442.

KEY ISSUES AND RECOMMENDATIONS

Protected area institutions

Strategic growth of Australia's National Reserve System would benefit from reestablishing a strong partnership between federal, state and territory governments constituted under the Council of Australian Governments (COAG). The National Reserve System has a long-term strategy to 2030 for the terrestrial reserve system, agreed on by all jurisdictions.[19] The National Representative System of Marine Protected Areas has also had a national framework since 1998.[20]

Considering the significant and growing investment in growth and maintenance of the National Reserve System from non-government partners, this partnership should be complemented by a broader working group that includes land trust, covenanting and Indigenous Protected Area representatives.

The Australian Government can best meet its long-standing national commitments by providing for a specialist National Reserve System planning and implementation agency tasked with:

- implementing and updating National Reserve System strategies in partnership with the state and territory jurisdictions, Indigenous and private protected area sectors;
- establishing, promoting and implementing policies, standards and strategies for protected areas under a whole of landscape or seascape approach, including international obligations under CBD Aichi Targets;
- coordinating marine and terrestrial reserve system planning; and
- developing institutional capacity to deliver the National Reserve System strategy.

BLACK-FLANKED ROCK WALLABY, CENTRAL WHEATBELT © CRAIG PENTLAND

19 National Reserve System Task Group, 2009. *Australia's Strategy for the National Reserve System 2009–2030,* Australian Government, Canberra.
20 ANZECC, 1998. *Guidelines for Establishing the National Representative System of Marine Protected Areas*, Australian Government, Canberra. (http://www.environment.gov.au/topics/marine/marine-reserves/overview/resources).

RECOMMENDATIONS

Recommendation 1.

The Australian Government should forge a new partnership with state and territory agencies and non-government conservation organisations, coordinated with natural resource management agencies, to continue advancing toward the long-standing goal of a comprehensive, adequate and representative National Reserve System that meets national and international commitments, and saves Australia's unique biodiversity from loss and extinction.

GREATER BILBY (*MACROTIS LAGOTIS*), AUSTRALIA © MARTIN HARVEY / WWF-CANON

WOYLIE JOEY AND MOTHER OR BRUSH-TAILED BETTONG, WESTERN AUSTRALIA
© KANYANA WILDLIFE REHABILITATION CENTRE

Terrestrial protected areas investment

Despite the boost in National Reserve System funding under Caring for Our Country (2008–2013), and resulting progress in strategic growth of the National Reserve System (Figure 1, Figure 2), the Australian Government, in late 2012, discontinued the dedicated funding for the National Reserve System.[21]

Although other government and non-government agencies have continued investing in protected area establishment, their investment now achieves less in the absence of the critical stimulus of Australian Government co-investment. The financial commitment of the Australian Government was a significant factor in increasing private philanthropic investment in protected area growth over the last two decades.

Most government conservation spending is devoted to short-term land management activities with little regard to long-term security of investments made. Such investments are at risk of reversal in the absence of permanent protection (for examples, through conservation covenants on the land title that binds all future landholders). By investing in new or existing protected areas, including conservation covenants, governments can ensure long-term security of such conservation investments, while advancing progress to national goals and targets.

Australian Government investment in purchase of protected areas secures an enduring conservation outcome, with very high leverage, attracting six-fold the amount contributed by the Australian Government, in terms of co-investments by state government in purchases and in-perpetuity management (see *State and territory investments* below).

Expansion of the National Reserve System requires a strong focus on ecological representation, and coordination through effective bioregional scale planning focussed on priority bioregions (Figure 2).

21 Department of Sustainability, Environment, Water, Population and Communities, 2012a. *One Land–Many Stories: Prospectus of Investment 2013–2014,* Australian Government, Canberra.

RECOMMENDATIONS

Recommendation 2.

The Australian Government should meet Aichi Target 11 by increasing funding to the National Reserve System program to at least $170 million per year, comprising grants to public and private partners to purchase land for new protected areas; to establish and manage Indigenous Protected Areas (IPAs); and to establish and manage private land conservation covenants.

Recommendation 3.

State and territory conservation agencies should likewise ensure sufficient budgetary resources for continued protected area growth, as well as for effective protected area management spending to keep pace with the increase in areas protected.

Recommendation 4.

More broadly, Landcare and natural resource management investments should be prioritised to landholders voluntarily adopting new – or with existing – perpetual conservation covenants that secure those investments for the future and which also contribute to or are complementary with the National Reserve System, with focus on restoring landscape connectivity and resilience to climate change.

GHOST GUM. WEST MACDONNELL NATIONAL PARK, NORTHERN TERRITORY © KLEIN & HUBERT / WWF

Marine reserves

A major leap forward in the marine reserve system at state and Australian government levels over the past decade, has dramatically improved ecological representation.

Australian, state and territory governments could protect at least 10 per cent of each marine bioregion by adding nearly 10 million hectares of new marine parks in a few bioregions. However, the resulting reserve system would still be far from ecologically representative, as required by Aichi Target 11. It is quite feasible, though, to meet Aichi Target 11 by moving directly to a comprehensive, adequate and representative marine reserve system. This would require adding another 11 per cent of Australian waters to marine parks, but at a relatively modest total cost of ~$247 million (see *A comprehensive, adequate and representative marine reserve system* below)

The Australian Government recently cancelled management plans and fisheries adjustment assistance for new marine reserves that were scheduled to come into effect in July 2014, and has commissioned an independent review into management plans including zoning schemes.[22] A similar review is being conducted on a pilot basis in New South Wales.[23] Reviews of state marine parks in Queensland have recently resulted in retention of marine national parks, also known as no-take or green zones (see *Queensland* below).

If conducted with emphasis on both adequate biodiversity conservation and sustainable management of seascapes, these marine reserve system reviews should not only endorse retention of existing no-take marine park zones but also recognise the need for further strategic growth, while leaving ample opportunity for recreational and commercial natural resource uses over more than two-thirds of Australian waters.

22 Australian Government Department of the Environment, 2014c. *Commonwealth Marine Reserves Review,* webpage (http://www.environment.gov.au/marinereservesreview/home).

23 NSW Government, 2014a. *Marine Park Management Pilots*, webpage (http://www.marine.nsw.gov.au/key-initiatives/marine-park-management-pilots).

RECOMMENDATIONS

Recommendation 5.

Australian state and territory governments in partnership can meet the marine and coastal element of Aichi Target 11 by declaring a comprehensive, adequate and representative marine reserve system at a cost of ~$247 million in fisheries adjustment assistance. Reviews of marine protected areas, planned or currently in progress, should be based on the best available science and achievement of this long-standing goal in all jurisdictions.

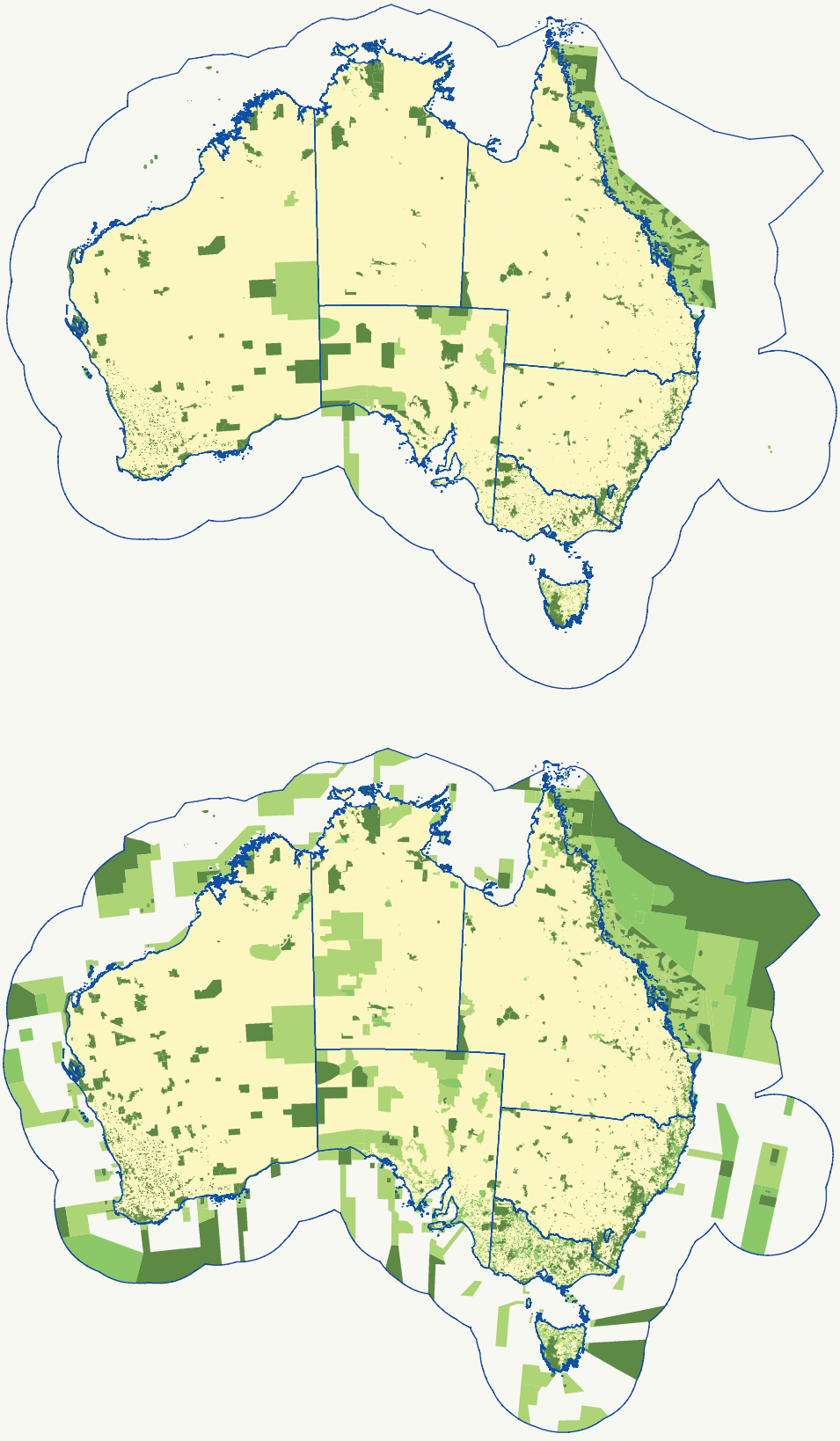
DUGONG © ANDREY NEKRASOV / WWF-CANON

FIGURE 1

Australia's National Reserve System on land and sea in 2002 (top) and 2012 (bottom).[24]

Highly Protected Areas IUCN I-IV on land, IUCN I-III on sea

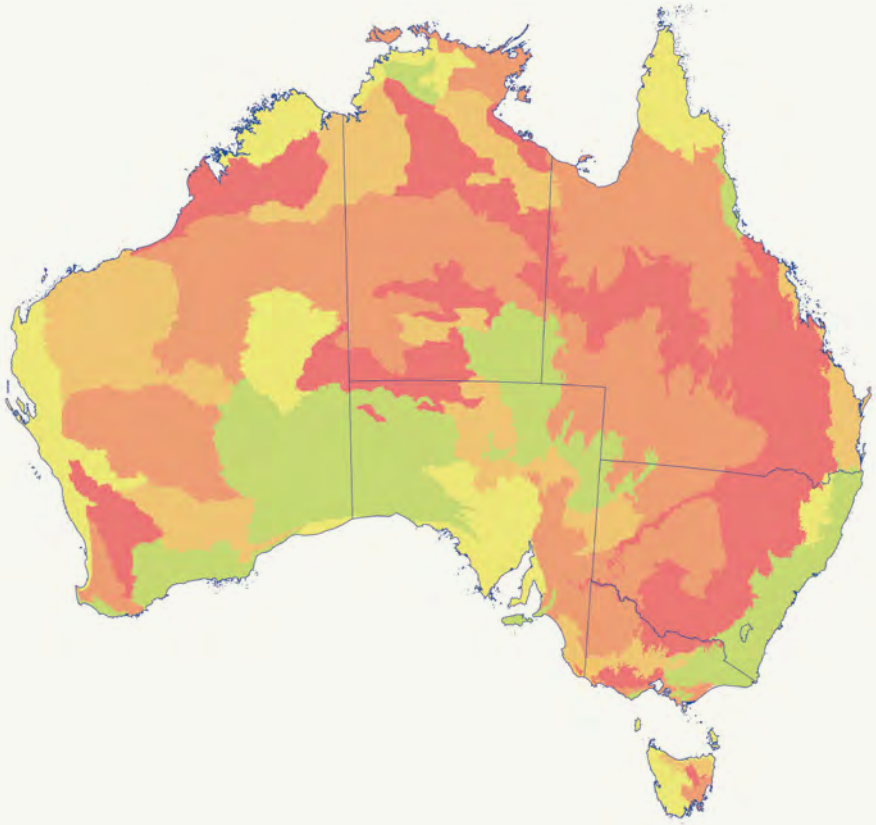
Other protected areas or marine park zones



24 According to the Collaborative Australian Protected Areas Databases for those years. See Appendix 3.

FIGURE 2

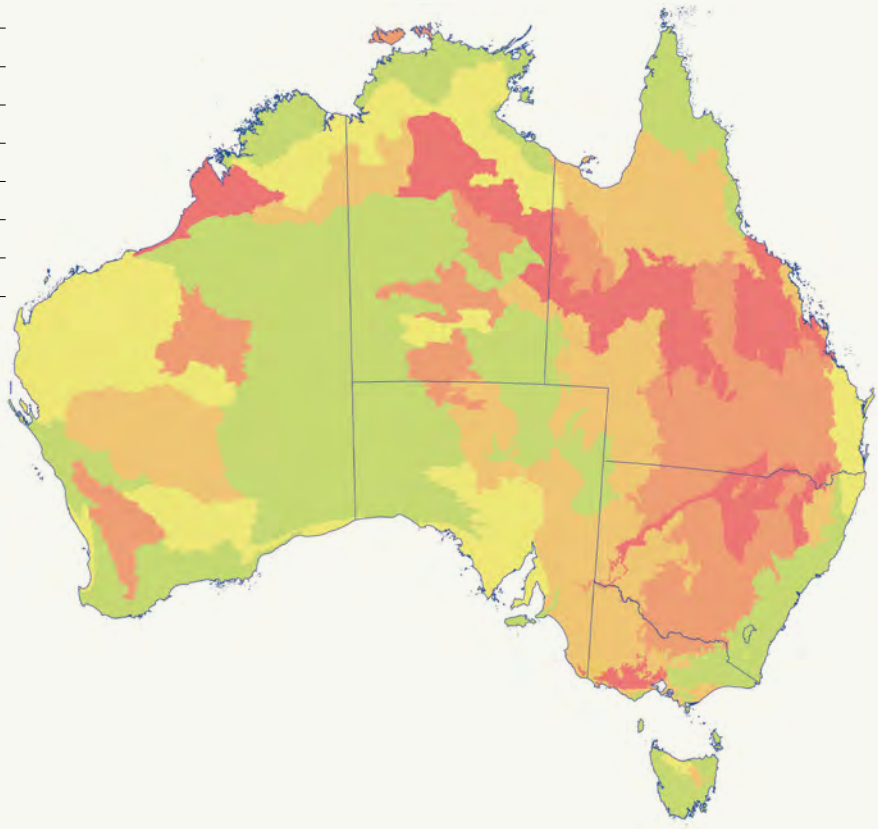
Terrestrial bioregional priorities for strategic growth of the National Reserve System in 2002 and 2012.[25] Many bioregions in central, western and northern Australia have moved from higher to lower priority as a result of the major expansion of the terrestrial National Reserve System over the decade as shown in Figure 1. Note that the number of bioregions has increased between the two periods.



Bioregional priorities 2002

- 1 High priority
- 2
- 3
- 4
- 5 Low priority

	2002		2012	
Priority	**N**	**%**	**N**	**%**
1 (High)	17	21%	7	8%
2	20	24%	13	15%
3	15	18%	15	18%
4	16	20%	16	19%
5 (Low)	14	17%	34	40%
Total	**82**	**100%**	**85**	**100%**



Bioregional priorities 2012

- 1 High priority
- 2
- 3
- 4
- 5 Low priority

25 see *Terrestrial ecosystem protection* section below and Appendix 3 for detailed methods.

Whole of landscape or seascape approach

A prosperous society and economy requires an appropriate system of protected areas securing essential ecosystem services, within a matrix of well-managed and appropriately located fishing grounds, farms, settlements, infrastructure, mining and industry. The whole of landscape or seascape approach ensures such an adequate system of protected areas, complemented by high environmental standards for natural resource use, through whole of landscape or seascape planning.

Conservation covenants

Conservation covenants on private land and on farms could become a dominant form of private protected area in Australia, and also provide the best vehicle for a whole of landscape approach, if provided with sufficient financial support. However, many private protected areas must contend with state mining laws that only prohibit mining for highly protected public land uses, such as national parks. Also, state land pastoral lessees may wish to convert their leases to protected areas, but may be unable to do so because the law may not provide a means of declaring protected areas over such leases (see Box 5). Governments should capitalise on the growing demand for permanent private land conservation by providing for more secure private protected areas in legislation.[26]

Governments should also prioritise conservation funding toward securing and maintaining enduring conservation agreements that integrate protected area covenants with high environmental performance standards for agriculture in surrounding landscapes.[27] Recent research shows that reversals of covenants are very low; however, the sector would greatly benefit from clearer and unified standards and strategic objectives.[28]

Sustainable agriculture

Primary producers should be able to receive appropriate recognition for their products in the marketplace if it can be independently verified that their fishing or farming techniques meet a high environmental standard, while also saving important habitats in private protected areas.

Third party certification of products produced to high environmental standards gives retailers or consumers the confidence to prefer such products in the marketplace. Examples include the Forest Stewardship Council certification for timber products and the Marine Stewardship Council certification for fish and other marine products. However, for agriculture, there is still no major trusted standard in Australia, though there are valuable and promising initiatives, such as the Australian Land Management Group's Certified Land Management system, Global Roundtable for Sustainable Beef, Gippsland Enviromeat and koala-friendly certification.[29]

Government can stimulate the uptake of such certified high environmental standards by assisting industries in development of standards, assisting primary producers to become certified and by supporting marketing of certified products. The Western Australian Government, for example, recently committed $14.56 million toward securing Marine Stewardship Council certification of its state managed fisheries.[30]

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26 Fitzsimons JA, Carr CB, 2014. Conservation covenants on private land: Issues with measuring and achieving biodiversity outcomes in Australia, *Environmental Management 54*, 606–616.

27 Taylor MFJ et al, 2014, cited above.

28 Hardy M, Fitzsimons JA, Gordon A (unpublished data).

29 Forest Stewardship Council webpage http://au.fsc.org/;
Marine Stewardship Council webpage http://www.msc.org/;
Certified Land Management system webpage http://www.almg.org.au/certified-land-management/certification-process;
Global Roundtable for Sustainable Beef webpage http://grsbeef.org/;
Gippsland Enviromeat webpage http://www.enviromeat.com.au/;
Koala-friendly certification webpage https://www.savethekoala.com/our-work/certified-koala-friendly-products.

30 WA Department of Fisheries, 2012. *Western Australian commercial fisheries third party certification program with the Marine Stewardship Council*, webpage (http://www.fish.wa.gov.au/Documents/commercial_fishing/msc_certification/MSC_certification_fact_sheet.pdf).

RECOMMENDATIONS

Recommendation 6.

Where land is leased for pastoral purposes or available for mining, State and territory governments should legislate to provide a mechanism to prohibit these activities where land is placed under a permanent conservation covenant, to better secure the conservation investments of Australian taxpayers.

Recommendation 7.

Governments should encourage and promote the adoption of verified high environmental performance standards for agricultural and fishing industries to ensure protected areas are surrounded and supported by complementary natural resource use across entire landscapes and seascapes.

ORANGE BELLIED PARROT, TASMANIA © DEJAN STOJANOVIC

PROTECTED AREA BENEFITS

- *Protected areas primarily serve to secure Australia's native plants and animals against extinction, and to promote their recovery.*
- *Protected areas also secure ecosystem services that provide economic benefits for human communities including water, soil and beneficial species conservation, climate moderation, social, cultural and health benefits. On land, we estimate these benefits are worth over $38 billion a year, by applying data collated by the Ecosystem Services Partnership. A much larger figure is estimated to have been secured by marine protected areas in the form of moderation of climate and impact of extreme events by reef and mangrove ecosystems. While these estimates have not been verified by studies specific to Australia, they are indicative of a very large economic contribution of protected areas.*
- *Visitors to national parks and nature reserves spend over $23.6 billion a year in Australia, generating tax revenue for state and territory governments of $2.36 billion a year.*
- *All these economic benefits taken together greatly exceed the aggregate annual protected area expansion and management spending by all Australian governments, estimated to be ~$1.28 billion a year. It is clear that Australian society is benefiting far greater than its governments' investment into strategic growth and maintenance of the National Reserve System.*

FRASER ISLAND, QUEENSLAND © MARCO SIMONI / OZSTOCK IMAGES PTY LTD

Conserving biodiversity

The first and most important benefit of protected areas is saving wildlife and natural ecosystems from extinction. Protected areas have proven successful in this task, when properly established and managed. Key research findings documenting this benefit of protected areas include:

- Ecological performance is significantly higher for protected areas around the world relative to surrounding land uses, although with much spatial variation and variation among IUCN management categories.[31]
- Higher biodiversity was found on northern Australian national parks than on neighbouring land uses—an effect that could be attributed to the difference in management regime, not locational accidents.[32]
- Ecosystems with low levels of inclusion in protected areas are more likely to meet IUCN endangered ecosystem criteria.[33]
- Stabilised or recovering trends for Australian terrestrial threatened species are associated positively with overlap of distributions with highly protected areas (IUCN I–IV), but not with IUCN V–VI categories, recovery actions or natural resource management actions.[34]
- Native mammal abundance and diversity recovered dramatically following removal of livestock from a newly protected area in the Kimberley region.[35]

31 Coetzee B et al, 2014. Local scale comparisons of biodiversity as a test for global protected area ecological performance: a meta-analysis, *PLoS ONE* 9, e105824.

32 Woinarski JC et al, 2013. The effectiveness of conservation reserves: land tenure impacts upon biodiversity across extensive natural landscapes in the tropical savannahs of the Northern Territory, Australia, *Land 2*, 20–36.

33 Taylor MFJ et al, 2014, cited above.

34 Taylor MFJ et al, 2011. What works for threatened species recovery? An empirical evaluation for Australia, *Biodiversity and Conservation 20*, 767–777.

35 Legge S et al, 2011. Rapid recovery of mammal fauna in the central Kimberley, northern Australia, following the removal of introduced herbivores, *Austral Ecology* 36, 791–799.

- The Living Planet Index for terrestrial species on protected areas has changed little, while that for all terrestrial species has declined substantially since 1970.[36]
- Marine protection stops coral decline and results in resurging populations of marine wildlife. [37]

Some threatened species now occur only in national parks or private sanctuaries and are extinct in the wider unprotected and converted landscape. For example, in Queensland, the last wild populations of the Greater Bilby (*Macrotis lagotis*), the Bridled Nail-Tail Wallaby (*Onychogalea fraenata*), and the Northern Hairy-Nosed Wombat (*Lasiorhinus krefftii*) were saved from extinction by new national parks (Astrebla, Taunton, and Epping Forest National Parks, respectively). New colonies have subsequently been established, and these also occur in protected areas.

National park or sanctuary establishment does more than prevent habitat destruction; it also puts in place a permanent commitment to abate ongoing threats to biodiversity, free of conflict with production priorities. Weeds and feral pests – cats and foxes, in particular – must also be removed or reduced, and appropriate fire management put in place on many protected areas to reduce these threats.

- The Australian Wildlife Conservancy has established populations of the burrowing bettong and other endangered marsupials in large fenced exclusion areas on Scotia, Yookamurra and Faure Island sanctuaries.[38]
- In Western Australia, the Peron Peninsula National Park has been fenced, feral pests such as cats and foxes eradicated, and endangered animals such as the banded hare wallaby reintroduced. The project has now been extended to Dirk Hartog Island (see *Dirk Hartog Island National Park* below).
- Bush Heritage Australia has protected the entire habitat of the endangered red finned blue eye and Edgbaston goby and is also establishing captive bred populations. [39]

Beneficial species

Protected areas maintain populations of useful species like pollinators and wild genetic resources for crops and pharmaceuticals. [40] Australia's chief domesticated crop is the macadamia nut, the foundation of a global industry. However, of the four wild *Macadamia* species, only one is well protected (*M. janseni* at 89 per cent). The other three species range from only 8 per cent to 19 per cent of their habitat in highly protected areas (see *Terrestrial species protection analysis* below). Protecting the habitats of these species should be high priority considering they represent the wild genetic base of a $500 million a year global industry. [41] Northern Australian protected areas also harbour wild rice species that may hold the key to overcoming rice diseases.[42]

36 McLellan R et al (eds), 2014. *Living Planet Report 2014: species and spaces, people and places*, WWF, Gland, Switzerland.

37 Selig ER, Bruno JF, 2010. A global analysis of the effectiveness of marine protected areas in preventing coral loss, *PLoS ONE 5*(2): e9278.

38 Australian Wildlife Conservancy, 2014. *Species profile: Burrowing Bettong*, webpage (https://www.australianwildlife.org/wildlife/burrowing-bettong.aspx); WA Department of Parks and Wildlife, 2009. *Shark Bay World Heritage Area: Project Eden*, webpage (http://www.sharkbay.org/project_eden.aspx).

39 Pip Walsh, pers.comm.

40 Dudley N, Stolton S, 2010. *Arguments for protected areas: Multiple benefits for Conservation and Use*, IUCN, Gland, Switzerland. (http://www.iucn.org/about/work/programmes/gpap_home/gpap_solutions/gpap_arguments/?11476/Arguments-for-protected-areas--Multiple-benefits-for-Conservation-and-Use).

41 Williams B, 2010. Future of nut trees in balance, *News Ltd online edition*, 1/6/2010.

42 McKillop C, 2014. Wild rice key to global food security, *ABC Rural online edition*, 13/6/2014.

The role of protected areas in maintenance of beneficial species is perhaps most dramatic for marine protected areas which provide nurseries and genetic resource conservation for commercially exploited marine species. Numerous studies have documented the rebound of fish stocks inside marine and coastal protected areas. [43]

Water and soil conservation

Deforested catchments have higher levels of runoff, higher peak stream flows, flooding and consequent soil erosion compared with naturally forested catchments. Even without deforestation, livestock compact soils and remove ground cover across large areas, which also increases runoff. [44]

By preventing or securing reversals of deforestation and other land use impacts, protected areas also make a major contribution to a stable climate, stable catchment hydrology and soil conservation. For example, highly protected areas added over the decade 2002–2012 are expected, from CSIRO models of soil loss, to prevent over seven million tonnes a year of excess soil erosion in Great Barrier Reef catchments (Box 2).

Soil salinity is also caused by deforestation and loss of deep-rooted trees in some regions. Soil salinity can be prevented or ameliorated by protected areas and forest protection laws. [45]

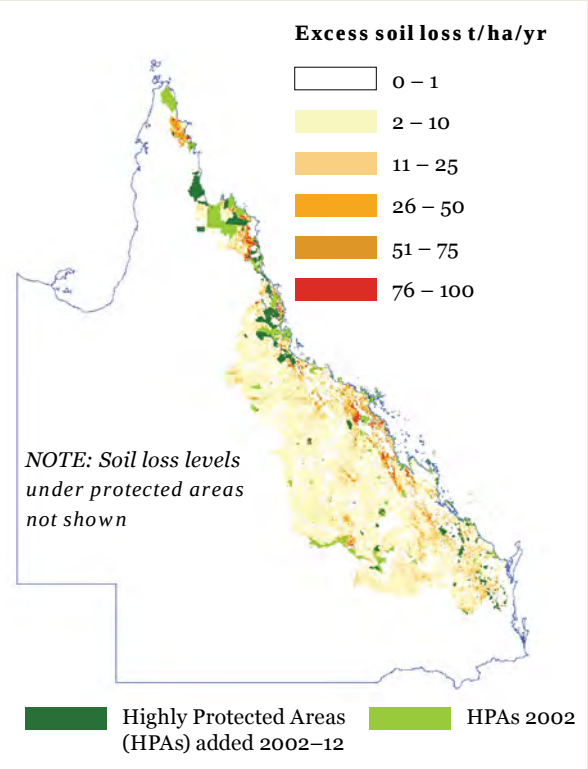
About one-third of the world's largest cities obtain a significant proportion of their drinking water directly from protected areas, and yet the enormous economic value of watersheds is almost always under-estimated or unrecognised. [46]

43 McCook LJ et al, 2010. Adaptive management of the Great Barrier Reef: A globally significant demonstration of the benefits of networks of marine reserves, *PNAS* 107, 18278–18285;
Roberts, C 2012a. Marine ecology: reserves do have a key role in fisheries, *Current Biology 22*, R444–R446;
Barrett NS et al, 2007. Changes in fish assemblages following ten years of protection in Tasmanian marine protected areas, *Journal of Experimental Marine Biology and Ecology* 345, 141–157.

44 Siriwardena L et al, 2006. The impact of land use change on catchment hydrology in large catchments: The Comet River, Central Queensland, Australia. *Journal of Hydrology* 326, 199–214;
Belsky AJ et al, 1999. Survey of livestock influences on stream and riparian ecosystems in the western United States, *Journal of Soil and water Conservation* 54, 419–431.

45 George SJ et al, 2012. A sustainable agricultural landscape for Australia: A review of interlacing carbon sequestration, biodiversity and salinity management in agroforestry systems, *Agriculture, Ecosystems & Environment* 163, 28–36.

46 Dudley N, Stolton S, 2003. *Running Pure: The Importance of Forest Protected Areas to Drinking Water,* World Bank/WWF Alliance for Forest Conservation and Sustainable Use (https://openknowledge.worldbank.org/handle/10986/15006).



Box 2: Protected areas conserving soil in Great Barrier Reef Catchments

Soil erosion and consequent sediment pollution is one of the greatest threats to the Great Barrier Reef. According to the Great Barrier Reef Park Management Authority:

"The total annual average sediment load discharged into the Great Barrier Reef waters is estimated to have increased four to eight-fold since European settlement, the bulk coming from catchments that have large grazing areas. This is due mainly to increased soil erosion in areas cleared to establish pasture, exacerbated by overgrazing."[47]

Since 1985, Great Barrier Reef coral cover halved from 28 to 14 per cent and rate of decline is increasing. Loss of inshore reefs and seagrass beds has been primarily due to smothering, reduction in light penetration, and excessive nutrient loads due to sediment pollution, in turn, due to soil erosion in the catchments. In addition, nutrient pollution, primarily from fertilizers used in sugar cane farming, has been strongly linked to increased outbreaks of crown-of-thorns starfish, which is a major cause of hard coral cover loss. [48]

To estimate the potential reduction in soil loss due to the highly protected areas added, we used the modelled undisturbed and present-day annual hillslope erosion maps published by CSIRO. [49]

We differenced these two layers to produce an excess soil loss layer, expressed in tonnes per hectare of excess soil erosion per year. Excess soil loss is attributed to the land use in 1998, at the time of the study, prior to later conversion to highly protected areas.

We assumed conversion to highly protected areas would eventually lead to recovery to the original undisturbed soil erosion rate and, therefore, reduction of excess soil erosion down to zero. We clipped the excess soil erosion layer by the highly protected areas added from 2002 to 2012, after removing narrow slivers and small areas less than 10 hectares, and added up the estimated excess soil loss on each hectare protected. [50]

We found that in Great Barrier Reef catchments, ~1.74 million hectares of highly protected area additions from CAPAD 2002 to 2012 should prevent up to 7.8 million tonnes of soil erosion per year, as they recover from past uses (See Map, above).

We caution that:

- this is a modelled quantity, not a directly measured estimate, and
- only a fraction of excess soil erosion would normally reach the Great Barrier Reef. Sediments are currently estimated to be in the order of 5–16 million tonnes per year entering the Reef for the entire catchment area.[51] The extent to which soil erosion results in sediment pollution of streams and marine environments depends on flow volumes and rates, distance to streams and estuaries, and sediment retention capacity in the catchment.

47 Great Barrier Reef Marine Park Authority, 2011. *Great Barrier Reef Outlook Report 2009*, Australian Government, Canberra.

48 Ibid.
Brodie J et al, 2013. *2013 Scientific consensus statement: land use impacts on Great Barrier Reef water quality and ecosystem condition*, Queensland Government Reef Water Quality Protection Plan Secretariat;
De'ath G et al, 2012. The 27–year decline of coral cover on the Great Barrier Reef and its causes, *PNAS* 109, 17995–17999.

49 CSIRO, 2001. *Pre-European hillslope erosion and Present annual hillslope erosion*, spatial data;
Lu H et al, 2001. *Prediction of sheet and rill erosion over the Australian continent, incorporating monthly soil loss distribution*, CSIRO technical report (http://www.clw.csiro.au/publications/technical2001/tr13-01.pdf).

50 We did not include other protected areas due to ongoing uncertainty over extent of continuing land use, particularly livestock grazing, which is the major contributor to soil erosion.

51 Kroon F et al, 2009. *Baseline pollutant loads to the Great Barrier Reef*, CSIRO publishing, Melbourne.
This study estimated an anthropogenic delivery of 16 Mt/yr to the Reef. Lower estimates of 5 Mt/yr are given in Great Barrier Reef Marine Park Authority, 2014. *Great Barrier Reef Outlook Report 2014*, Australian Government, Townsville.

Clean air and climate control

Protected areas in regions extensively converted to farms and towns harbour most of the remaining native forest cover. Loss of forest cover increases risk of drought and reduces rainfall, which is detrimental for agriculture and urban communities.[52]

Land clearing laws and protected areas in Australian states and territories have resulted in a more than fourfold decline in Australia's greenhouse gas pollution due to deforestation primarily for conversion to pasture, the dominant replacement land use, from 144.7 megatonnes of CO2 equivalent in 1990 down to 32.6 in 2012. [53]

Protected areas, while mostly confined to places with already intact native vegetation, may also include areas targeted for natural ecosystem recovery, which, in the process, sequesters carbon while preventing further deforestation or forest degradation.

Social and health benefits

Indigenous Protected Areas (IPAs) have undergone significant growth in the 20 years since the inception of the program in 1994. The program has proven popular with Indigenous communities. IPAs are now linked to improved health, education, employment and social cohesion indicators for the communities involved. Importantly, protection of nature and protection and revival of culture are truly integrated on Indigenous Protected Areas. [54]

More generally, contact with nature is associated with improved physical and mental health. [55]

Tourism

Nature-based tourists from overseas spend over $19 billion a year in Australia, one of our largest sources of foreign exchange. [56] However, not all such tourists are here primarily to experience wild nature. Courtesy of Tourism Research Australia, we obtained tourism data from 1999 to 2013. From these data, we excluded visits to zoos, aquariums and botanic gardens to derive a *wild* nature-based segment, who visit national parks, nature reserves and marine parks.

We found that ~2.8 million visitors in 2012–13, about half of all international visitors, were wild nature visitors and these numbers have been rising steadily from the 2 million visitors recorded in 1999. Domestic overnight nature visitors numbered 11.9 million in 2012–13, up from 8.8 million in 1999. Although a larger absolute number than international visitors, domestic overnight wild nature tourists represent only 16 per cent of all domestic overnight tourism numbers.

52 Deo RC, 2011. Links between native forest and climate in Australia, *Weather* 66, 64–69.

53 Australian Government Department of the Environment, 2014d. *Australian Greenhouse Gas Inventory*, webpage (http://ageis.climatechange.gov.au/

54 Australian Government Department of the Environment, 2011. *Indigenous Communities and the Environment: Cultural and social Benefits*, webpage (http://www.environment.gov.au/indigenous/ipa/cultural.html).
Szabo S, Smyth D, 2003. Indigenous protected areas in Australia: incorporating indigenous owned land into Australia's national system of protected areas, in Jaireth H, Smyth D (eds), *Innovative governance: indigenous peoples, local communities, and protected areas*, Ane Books, New Delhi (http://conservationfinance.org/guide/WPC/WPC_documents/Apps_10_Szabo_v4.pdf).

55 Bowler DE et al, 2010. A systematic review of evidence for the added benefits to health of exposure to natural environments, *BMC Public Health* 10, 456.

56 Tourism Research Australia, 2010. *Snapshots 2009: Nature Tourism in Australia,* Australian Government, Canberra (http://www.tra.gov.au/publications/publications-list-Snapshots-2009-Nature-tourism-in-Australia.html).

Wild nature-based tourists stay longer and spend more than other tourists, and their spending represents more than half of all spending by international visitors. Spending by international wild nature visitors has risen steadily to over $11.3 billion in 2012–13 (Figure 3). [57]

The proportion of total international tourism spending by the wild nature segment has remained high and steady (60–70 per cent) for tourists from traditional European and US markets. Spending by wild nature tourists from the growing market of Asian countries has been lower, but rising as a fraction of all spending by such tourists from 46 per cent in 1999 to 53 per cent in 2012–13, as Asian tourists discover more about Australia's wild nature experiences and opportunities.

Wild nature tourists in 2012–13 spent at least $23.6 billion, including both international and domestic visitors, but not including prepaid overseas packages and airfares. All such spending is subject to the 10 per cent Goods and Services Tax (GST). Therefore, wild nature tourism generates over $2.36 billion a year in GST revenues, which is passed on to state and territory governments through the Commonwealth Grants Commission. This exceeds the aggregate annual protected area expansion and management spending by all Australian governments of ~$1.28 billion a year (see *Protected area financing* below).

Not all spending by wild nature tourists can be directly attributed to the existence of protected area destinations, however. It may be that such tourists would visit anyway and spend money in other ways. This attribution fraction is difficult to determine and different studies give very different results, ranging from 17 per cent to 79 per cent of park visitor spending attributable to the presence of the park.[58] Tourism Research Australia has attempted to better quantify attribution. They report 26 per cent of nature-based (including wild nature) visitors are "purposeful", meaning they chose the destination because it offered a nature-based experience. The remaining 75 per cent did not give the nature-based experience as the reason for choice of destination, suggesting an attribution value of 26 per cent. At least $6 billion per year in spending, and thus $600 million per year in GST revenues, is strongly attributable to wild nature tourism. [59]

In the following section, we attempt a general monetised estimate of other ecosystem service values secured in protected areas.

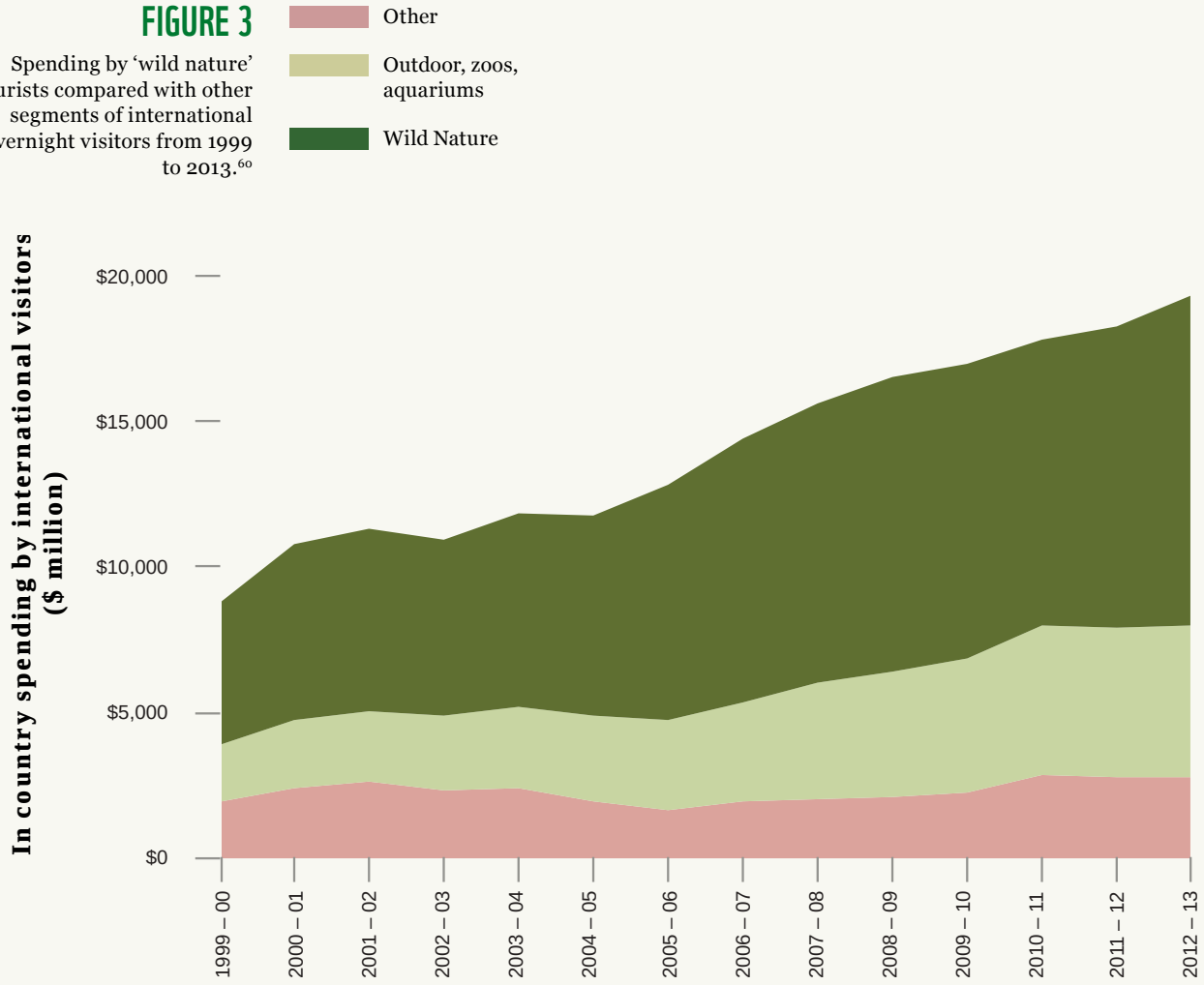
57 This estimate is lower than the $19 billion cited above for two reasons. It does not include flights and package tours paid for in the home country before arrival here, much of which inevitably makes its way to Australian businesses indirectly. It also excludes nature-based activities other than wild nature activities (visits to zoos, aquariums, gardens).

58 For the upper estimate, see Hughes M (ed), 2009. *Estimating the economic, social and environmental value of tourism to protected areas*, Sustainable Tourism Cooperative Research Centre.
For the lower estimate, see Ballantyne R et al, 2008. *Valuing tourism spend arising from visitation to Queensland national parks*, Sustainable Tourism Cooperative Research Centre (http://www.crctourism.com.au/wms/upload/resources/90049BallantyneValuingTourismSpendQPSUM%20(1).pdf).
It is unclear if attribution in the latter report was low because the parks estate is such a low percentage of land area in Queensland.

59 Tourism Research Australia, 2010, cited above.

FIGURE 3

Spending by 'wild nature' tourists compared with other segments of international overnight visitors from 1999 to 2013.[60]



Ecosystem services valuation

Despite many years of research documenting the benefits of protecting wild natural areas to human economies and societies, there is little understanding of the significance of those benefits.

Recent global compilations of ecosystem services valuations allow us, for the first time in the *Building Nature's Safety Net* series, to put indicative dollar figures on the ecosystem service flows secured by Australian protected areas, in addition to the benefits for biodiversity conservation.

DeGroot and others provide averages of the values of ecosystem services, derived by human communities from natural areas, in monetary units of international dollars per hectare per year. They base these estimates on meta-analysis of 1,350 separate studies from around the world, classified into ten 'biomes': oceans, coastal seas, coastal wetlands, inland wetlands, rivers, lakes, tropical forest, temperate forest, woodlands and grasslands.[61]

60 Source: Tourism Research Australia data provided under licence.

61 de Groot R et al, 2012. Global estimates of the value of ecosystems and their services in monetary units, *Ecosystem Services* 1, 50–61; Costanza R et al, 2014. Changes in the global value of ecosystem services, *Global Environmental Change*, 26, 152–158.

BRUSH TAILED BETTONG (BETTONGIA PENICILLATA) © MARTIN HARVEY / WWF-CANON

Protected areas secure flows of these ecosystem services to human communities, and by conserving natural ecosystems ensure the flow of values continues to be provided, rather than lost or diminished due to development, conversion and consumptive or extractive resource use.

Using these data, we derived estimates of the value of ecosystem services secured by protected areas in Australia. We excluded provisioning services because, in Australian protected areas, natural resource use should be small or non-existent. We also excluded cultural services, which we consider to have been captured to a limited extent by tourism value as estimated above. We included regulating and habitat services and used the global averages of values of services to estimate values in the Australian National Reserve System. However, we did exclude erosion prevention services in the marine environment from this set of services because the value estimates had an extreme range and were based on only a few studies. Global averages published by deGroot et al (2012) are not however, readily applicable to Australia. The very wide ranges of estimates for many types of service are also a concern. Accordingly, we also derived a second very conservative estimate, based only the minimum of values estimated for just Australian studies of ecosystem services, or where Australian studies were unavailable, for other middle to high income countries extracted from the database maintained by the Ecosystem Services Partnership. Additionally, wherever these minimum values exceeded the global averages, we substituted the global average (Table 1).[62] Detailed methods are shown in Appendix 1.

Estimates of annual flows of ecosystem services ranged from $38 billion to $204 billion/year secured in the terrestrial National Reserve System and from $197 billion to $441 billion per year for the marine reserve system (Table 1, Box 3).

These regulatory and habitat values are greater than the tourism value ($23.6 billion per year) associated with protected areas and very much greater than the total spending by all governments on growth and maintenance of the National Reserve System (Box 3, $1.28 billion per year as estimated in following section).

62 Ecosystem Services Partnership database downloaded from http://www.fsd.nl/esp August 2014.

Table 1. Estimates of total value of ecosystem services secured in Australia's National Reserve System in 2012 (AUD billions).[63]

		Marine		Terrestrial	
Service	**Example of what protected areas do**	**Australia/High Income countries minimum values**	**Global avg**	**Australia/High Income countries minimum values**	**Global avg**
07 Air quality	Protected forests near cities filter air pollutants			$0.08	$0.06
08 Climate moderation	Protected seagrass beds or forests soak up carbon	$69.92	$76.74	$0.13	$15.93
09 Disturbance regulation	Protected mangrove forests buffer storm or tsunami damage	$94.24	$109.84	$0.16	$12.05
10 Water flows	Protected forests soak up and slow down otherwise excessive runoff			$2.34	$23.79
11 Waste treatment	Protected wetlands filter pollutants from water flowing through	$0.44	$105.41	$2.62	$13.55
12 Erosion prevention	Protected riverside forests prevent soil erosion	*$961.77*[a]	*$3,313.25*[a]	$1.50	$11.94
13 Nutrient cycling	Protected semiarid forests prevent soil salinity	*$198.05*[b]	$0.03	$0.46	$7.66
14 Pollination	Protected habitat near cropland harbour natural pollinators			*$5.71*[b]	$1.80
14 Biocontrol	Protected habitat near cropland harbour insectivorous birds	*$5.43*[b]		$0.94	$6.14
16 Nursery habitat	Protection of key breeding habitat of fish species that are consumed	$21.09	$24.87	$27.38	$72.43
17 Genetic diversity	Protection of habitats of wild relatives of commercial crops	$11.12	$124.28	$0.11	$38.64
TOTAL		**$196.84**	**$441.16**	**$37.51**	**$203.98**

a) These estimates were so much higher than all other estimates, and based on just one study for Caribbean coral reefs. Accordingly they are considered unreliable and excluded from totals.
b) These values are substantially higher than those based on global averages and so are replaced in these cases by estimates using global average values.

Box 3. Ecosystem services secured relative to investment levels in the National Reserve System, 2012

Ecosystem services secured

Terrestrial regulatory and habitat services	$38 – $204 billion/year
Marine regulatory and habitat services	$197 – $441 billion/year
Wild nature tourism associated spending	$23.60 billion/year

Investments by all governments [64]

Growth	$0.07 billion/year
Maintenance	$1.21 billion/year

63 For full methodology see Appendix 1.
64 Table 4.

Caveats on estimates of ecosystem service values

As also cautioned by de Groot et al 2012:[65]

- Expressing ecosystem services in monetary units is only intended as a communication tool to highlight benefits to society that are typically taken for granted, and should not be misconstrued as support for any policy of commodification or privatisation of what are public goods. In particular, the statement of values should not be misinterpreted as support for any regime of payments for ecosystem services.
- Global averages derived from studies in many different countries may not be suitable for application to a particular country at a particular level of development and other contextual differences (in this case, Australia). We have used global averages here for estimation, but the variances among studies around these averages is quite high. For example, the estimates for coastal wetlands span an extreme range from $300 to $887,828 per hectare per year across 139 studies.[66]
- Similarly, the services secured flow differentially to different classes of beneficiaries, depending on context of population distribution, economic level and mode of livelihood.
- Many ecosystem services and some biomes are relatively poorly studied compared with others. Thus, results tend to be dominated by particular better-studied services, such as erosion prevention, and particular biomes, such as coral reefs.
- Values are not distributed homogenously. Bundles of services cannot be assumed to apply equally for all units of what are, in reality, very heterogeneous biomes.
- Ecosystem services may come into conflict with biodiversity objectives if used to guide conservation strategy. Saving biodiversity should remain the principal focus of protected areas, while valuing of ecosystem services provided should be seen as a valuable by-product and a stimulus for greater investment.[67]

GREEN AND GOLDEN BELL FROG © VIEWFINDER AUSTRALIA PHOTO LIBRARY

65 de Groot R et al, 2012.
66 ibid. Table 3.
67 Reyers B et al, 2012. Finding common ground for biodiversity and ecosystem services, *BioScience* 62, 503–507.

PROTECTED AREA FINANCING

- *Government investment and policy settings play a leading role in strategic growth of the National Reserve System in Australia, and provide a critical stimulus for non-government investment. Unprecedented expansion of the National Reserve System followed an historic boost in Australian Government funding under Caring for Our Country 2008–2013.*
- *This expansion was highly economical for the Australian Government, costing an average of only $44.40 per hectare to buy and protect land forever. State governments have contributed ~six times this amount toward the expansion of the National Reserve System, after including in-perpetuity protected area management costs. The growth of Indigenous Protected Areas by the Australian Government has cost ~$26 per hectare on average, including management costs capitalised in-perpetuity, while also delivering Indigenous social and economic outcomes.*
- *The recent aggregate annual investment by all Australian governments has been ~$72.6 million per year on protected area growth and ~$1.21 billion per year on recurrent management costs.*
- *For the first time in almost two decades, however, the Australian Government's National Reserve System Program, comprising a specialist administrative unit and funding allocation, was terminated in late 2012. This program was fundamental in driving significant strategic growth in Australia's protected area estate. It is highly unlikely that Australia can achieve its long-standing commitments to an ecologically representative National Reserve System, and prevent major biodiversity loss, without this dedicated funding pool. The Australian Government has budgeted ~$400 million per year over the next five years (2013-2018) under the National Landcare and related programs. This funding program should give high priority to delivery of national protected area commitments by providing a distinct National Reserve System funding allocation.*

A comprehensive, adequate, representative and well-managed National Reserve System is an important public good, and a central responsibility of governments, which secures ecosystem services that have important economic and social benefits for the Australian community (see *Protected area benefits* above).

Adequate government financing of expansion, establishment and ongoing management of the National Reserve System is essential to secure those benefits for Australian society, prevent loss of Australian biodiversity, and reaffirm Australia's national and international commitments.

Australian Government investments

The period 2008–2013 saw a high point of investment by the Australian Government in the expansion of the National Reserve System, with the commitment of $180 million for the National Reserve System grants program in 2008.[68] In addition, $150

68 Garrett P, 2008. *$180 million to build the National Reserve System*, media release, Australian Government Minister for the Environment, Heritage and the Arts media release, 31 March 2008 (http://www.environment.gov.au/minister/archive/env/2008/pubs/mr20080331.pdf).

SWAMP WALLABY © MARTIN HARVEY/ WWF-CANON

million was committed over five years to Indigenous Protected Area and Indigenous ranger employment programs (Working on Country). However, not all of these Working on Country grants went towards employing rangers on protected areas, and we only show the funding that went to ranger groups for Indigenous Protected Areas, where known.

The Australian Government invested ~$337 million (2012 currency value) into the National Reserve System over the five years of Caring for Our Country, not including ongoing management costs for Commonwealth parks and reserves (Table 2, Figure 4).

In late 2012, the Australian Government ended the dedicated funding for the National Reserve System Program. The discrete administrative unit within the Department of Environment was scaled back to administering past contracts, and other administrative functions were distributed to staff with wider responsibilities than the National Reserve System. The present Australian Government had not yet restored the National Reserve System Program at time of writing, but had increased funding for the Indigenous Protected Area Program (Figure 4). Since Indigenous Protected Areas are largely confined to Indigenous owned land, the capacity of this program to fill many of the major gaps in high priority bioregions to achieve a representative National Reserve System is limited. Nevertheless, the increased funding for Indigenous Protected Areas is welcome and valuable.

Australian Government investments represent remarkable value for money, with an average cost of only $44.40 per hectare to permanently protect land. However, per hectare investment levels vary greatly depending on locations and proponent (Table 2). This estimate has not changed appreciably from the $47 estimate reported in the 2011 *Building Nature's Safety Net* Report.[69] National Reserve System acquisition grants were offered up to two-thirds of the acquisition price of land. Hence, partner contributions to acquisition represent about half of the Australian Government contribution (Table 2). However, as explained in the following section, once the much larger in-perpetuity management commitment is taken into account, the relative contribution of partners is very much in the other direction.

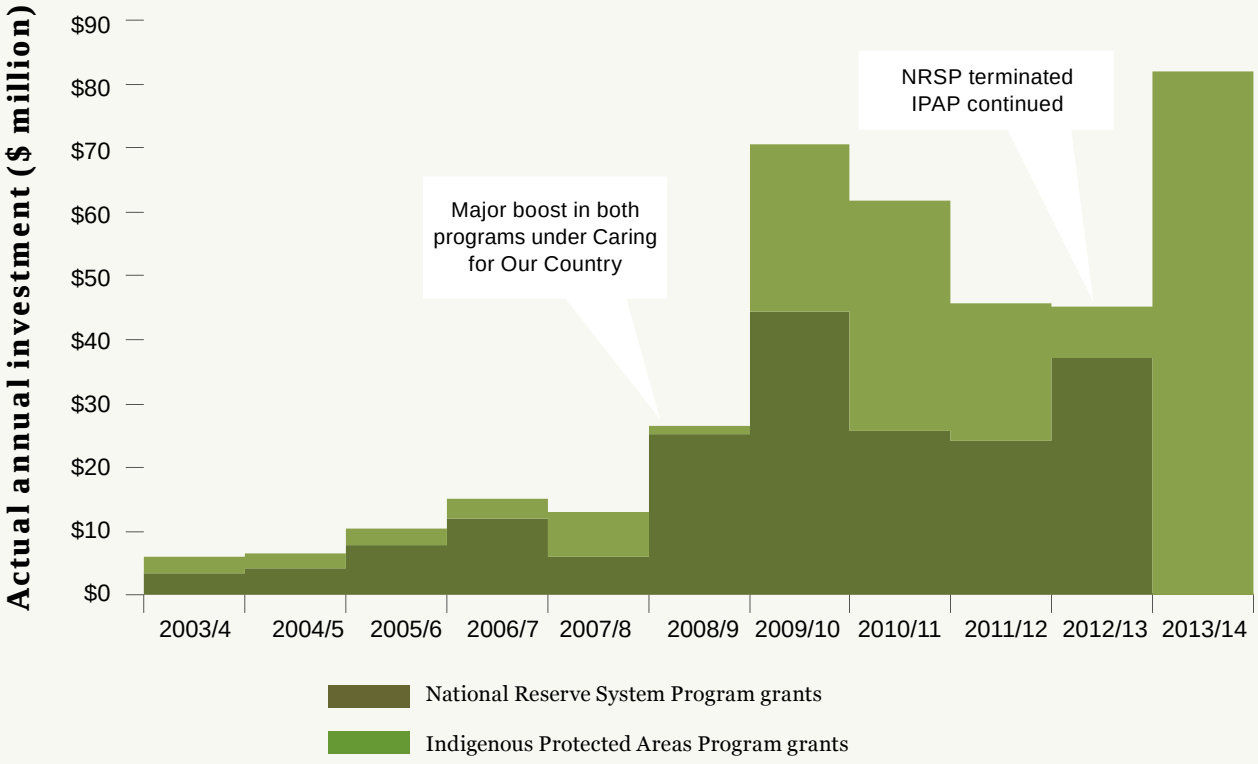
69 Henbury Station was purchased as a National Reserve System property in 2011 to be managed by the RM Williams Agricultural Company. The company was placed into administration shortly afterwards, and before the required covenant was recorded on title. The property was recently sold and largely returned to livestock use, with the Australian Government only recouping part of its investment in the purchase. Only 20% of the formerly 100% protected area is to be placed under a conservation covenant, but this had not been finalised at time of writing. Henbury has been removed from analysis elsewhere in this report, but is retained in the financial table for completeness regarding expenditure (Table 2).

Indigenous Protected Areas cost the Australian Government only $0.27 per hectare to establish and $25.50 per hectare for annual management and ranger employment costs, when capitalised in-perpetuity (Table 2). As for a private land covenant, no land purchase is involved, only an agreement with the community owners. Indigenous managers may secure other streams of revenue, including eco-tourism, to cover costs of management. We were unable to quantify these co-investment amounts with any confidence, however.[70]

The only Australian Government investment in covenants shown is through the PAPL program (Table 2). Other programs that incentivise covenants, such as the Environmental Stewardship Program, are not shown as it is unclear to what extent those covenants form part of the National Reserve System. Moreover, areas secured under covenant under this program are small.[71] Also omitted are federal government tax concessions for conservation covenants, by which covenant holders can claim any loss of property value due to a covenant as an income tax deduction.[72]

FIGURE 4

A decade of Australian Government spending in the two main programs funding expansion of the National Reserve System.[73]



70 For more detail on capitalisation method, see following section.

71 Taylor MFJ et al, 2011a, cited above.

72 Australian Government Department of Environment, 2014e. *Conservation covenents*, webpage (http://www.environment.gov.au/node/13916); Australian tax expenditure statements show no quantified estimates in regard to these concessions: Department of Treasury 2013. *Tax Expenditures statement*, Australian Government, Canberra (http://www.treasury.gov.au/~/media/Treasury/Publications%20and%20Media/Publications/2014/TES%202013/Documents/PDF/TES-13-Consolidated.ashx).
Farmers may claim a tax deduction for certain nominated Landcare capital expenses but only for those portions of a property used for primary production purposes, not for areas under on-farm covenants that have been taken out of production.

73 Sources as in 2011 *Building Nature's Safety Net Report*, updated from the Department of Environment register of grants issued up until January 2014. Note that spending on the Indigenous Protected Areas Program is forward committed for up to five years ahead of the year in which grant is made, whereas spending under the National Reserve System program is within the year as indicated (http://www.environment.gov.au/topics/about-us/accountability-reporting/grants-listing).

Table 2. Australian Government investments in protected areas during the first phase of Caring for Our Country (7/2008–6/2013).[74]

Division	Partners/purpose	Australian Government investment (actual $m)	Partner co-investment (actual $m)[75]	Australian Government investment (2012 $m)	2012 $/ha
National Reserve System	State government	$77.40	$36.90	$82.08	$58.87
	Local government	$6.35	$4.60	$6.82	$9,516.67
	Non-government	$16.89	$2.60	$17.88	$17.36
	Indigenous	$17.19	$8.80	$18.11	$74.59
	Subtotal	*$117.84*	*$52.90*	*$124.91*	*$44.40*[76]
	Protected Areas on Private Land (PAPL)	$5.59		$6.00	
	Policy, science and coordination	$33.17		$33.53	
Indigenous PAs	Establishment grants	$20.43		$21.17	$0.27[77]
	Management grants & Working on Country rangers	$134.99		$141.78	$25.50[78]
	Subtotal	*$155.42*		*$162.95*	*$25.77*[79]
Marine	Marine reserves planning	$9.70		$9.70	[80]
TOTAL		**$321.72**		**$337.09**	

74 Based on grants issued 7/08–6/13 under National Reserve System, IPAP and Working on Country (WoC) programs, with duplicate entries eliminated per advice of Department of Environment (http://www.environment.gov.au/topics/about-us/accountability-reporting/grants-listing). All dollar amounts were adjusted to 2012 dollars using Reserve Bank of Australia's inflation calculator (http://www.rba.gov.au/calculator/). Figures do not include recurrent expenditure for management of Commonwealth National Parks and marine reserves. This is found in Table 2. Blanks indicate unknown or inapplicable, not zero.

75 Per advice from Department of the Environment dated 27/8/14.

76 For 60 purchase contracts, where both area and dollars invested could be matched, for an aggregate of 2.25m ha purchased for $99.8m, with subtotals for different classes of recipients.

77 For 17 IPAs declared or in preparation, where both area and dollar investment could be matched to an aggregate of $7.42m, to establish 27.3m ha.

78 For 40 declared IPAs, where both area and dollar investment in IPA and WoC programs were known, totalling $10.6m/year in 2012 dollars for IPAP management grants and $10.5m/year in Working on Country grants, covering 16.5m ha, capitalised by dividing by 5% interest rate. The per year rate was derived by dividing by contract term and then adding these per year grant amounts across Caring for Our Country phase I wherever multiple grants were made to the same IPA. Per year amounts were then added across all IPAs in the set. Not all IPAs received WoC grants. IPA grants awarded after the IPA declaration date were classified as management, not establishment grants.

79 Sum of two lines above.

80 Marine reserve planning, no management contribution: McCormick B, 2012. *Budget 2011–12: Environment and Natural Resource Management,* Parliament of Australia, Canberra (http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/BudgetReview201112/Environment).

State and territory investments

From state and territory agency Annual Reports and responses to requests for information, we reconstructed the investments in protected area growth and management in three categories: government protected areas on land, support for covenants or Indigenous Protected Areas, and marine parks (Table 3, detailed state by state tables are shown in Appendix 2).

Terrestrial national parks and other government protected areas have received on average $376.61 per hectare (2012 currency value) to purchase, establish and manage in-perpetuity from all government sources (Table 3). This is almost certainly an under-estimate because the estimate includes areas added without purchase, such as through state forest transfers. Moreover, management spending includes marine parks management for most jurisdictions, which are much less costly per hectare for management than terrestrial parks, where known (Table 3).

Since the Australian Government has invested on average $58.87 per hectare toward purchase of state protected areas (Table 2), the overall leverage of state or territory co-investment by the Australian Government purchase grants program is of the order of six-fold, which is greater than our earlier estimate of four to five-fold in the 2011 *Building Nature's Safety Net Report* (Table 4). The high levels of leverage derive almost entirely from the major investment required for in-perpetuity management of protected areas, which is much greater than acquisition costs.

Although we have capitalised recurrent costs as if they were paid out of interest earned on an endowment, [81] we have done this solely for the sake of expressing all protected area investments as equivalent capital costs. This is not how governments actually pay for recurrent management costs. Governments pay for management out of general revenue through the annual budgetary process. There are some instances of an endowment model being used by statutory bodies or private conservancies. For example, the Indigenous Land Corporation funds projects including protected area purchases, such as Fish River, out of interest earned on an endowment (see *Fish River profile*, Box 4).[82]

Table 3 shows an average investment in IPAs and covenants by all governments of $1.02 per hectare for establishment and $26.33 per hectare for in-perpetuity management. However, most of this is attributable to IPAs. IPA and private land covenants are separated in Table 4. The spending by state governments on establishing and managing private land covenants is of the order of $73 per hectare (capitalised), which is more costly, on average, than the National Reserve System and IPA programs (Table 4). However, because of the great spatial variation in all these figures, this most likely reflects different spatial emphasis of covenants as compared with purchases. Data are also likely to be incomplete.

Finally, many non-government agencies invest in securing covenants. No consolidated information on these investments is yet available, as discussed in the following section.

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81 We capitalised management spending in perpetuity, effectively estimating the capital endowment required to be invested so that annual interest earned would cover costs of annual management. For annual interest earned, we used the average cash interest rate as established by the Reserve Bank over the last 20 years (approx. 5% p.a.). Clearly, a higher rate of return on investment means that a smaller initial endowment is needed to generate the recurrent spending needed for management, and vice versa.

82 *Indigenous Land Corporation* website (http://www.ilc.gov.au/).

83 See Appendix 2 for state specific tables. Blank cells may mean zero or no information. All management spending is for the most recent year of 2012/13 unless otherwise noted. Areas added include non-purchase processes, such as state forest transfers.

84 For management entries, annual spending in 2012$/ha is capitalised at 5% interest rate (i.e. the annual recurrent spending for 2012 divided by area managed, divided by 0.05).

85 All monetary units are $1000s in 2012 dollars and 1000ha for areas.

86 From Table 1, excluding National Reserve System program grants to state governments, which are included in figures at right.

87 Incomplete. Only data for 2012/13 made available.

88 Only for additions involving other than state government partners. For state government additions see columns at right.

89 No data for 2008/09.

90 Director of National Parks report 2012–13 http://www.environment.gov.au/resource/annual-report-2012-13-director-national-parks.

91 Grey cells indicate that marine parks management is included under Terrestrial parks figures.

92 Adding PAPL and IPAP establishment grants from Table 1.

93 Ecolink investments not shown here as no data readily available on areas secured.

94 Some of this might actually be for ongoing management.

95 Areas of IPAs added from Table 1, note 4. No information on outcomes of PAPL.

96 No data for 2008/9. South Australian Government Heritage agreements do not require establishment costs, but are able to access ongoing management funding.

97 IPA management and Working on Country $21.1m/year from Table 1, note 5, and area 16.5m ha.

98 $10m allocated for Marine Reserve planning and $100m for fisheries adjustment. Cullen S, 2012. Burke officially declares marine reserves, *ABC News website*, 16/11/2012 (http://www.abc.net.au/news/2012-11-16/burke-officially-declares-marine-reserves/4375644).

99 Area from Table 5.

Table 3. Investments by Australian Government, state and territory governments in protected area growth and management from 7/2008 to 6/2013.[83]

	C'wlth	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Totals	2012$/ha[84]
Terrestrial Parks											
Addition investments[85]	$42,821[86]		$47,198		$77,033	$5,554	$385	$1,014[87]	$21,121	$195,126	$43.67
– Area added	1,270[88]	0.234	408	960.8	1,307.8	135.1	45.4[89]	140.9	200.2	4,468	
Management	*$60,990[90]*	*$108,309*	*$255,507*	*$41,003[91]*	*$200,345*	*$45,275*	*$70,953*	*$259,327*	*$125,855*	*$1,167,564*	*$332.93*
– Area managed	*2,133[89]*	*137.0*	*7,083*	*4,635*	*10,610*	*21,071*	*2,578*	*4,116*	*17,774*	*70,138*	
Covenants/ IPAs											
Incentives	$27,170[92]		$1,053	–[93]	$9,877[94]					$38,100	$1.02
– Area added	27,300[95]		139		1,821	22[96]	13[88]		7,926	37,221	
Management	*$21,100[97]*		*$63*		*$523*	*$396*				*$22,082*	*$26.33*
– Area managed	*16,500[96]*		*146*		*3*	*122*				*16,772*	
Marine Parks											
Establishment	$110,000[98]					$14,010	$324		$5,255	$129,589	$0.50
– Area added	255,582[99]					2,694	12.5		944	259,232	
Management	*$7,200[89]*		*$4,787*	*Marine parks management included under Terrestrial parks above*					*$7,592*	*$19,579*	*$1.37*
– Area managed	*282,773[89]*		*347*						*2,482*	*285,602*	

Table 4. Key financial statistics.

Key statistic		Value
1.	Averaged annual investment by all governments in protected area additions (2012 $millions/year)[100]	$72.6
2.	Total annual investment by all governments in protected area management (2012 $millions/year)[101]	$1,209.2
3.	Australian Government average per hectare investment in protected areas acquisitions (2012 $/hectare, Table 1)	$44.40
4.	Australian Government average per hectare investment in IPA establishment and management capitalised in-perpetuity (2012 $/hectare, Table 1)	$25.77
5.	All governments average per hectare investments in covenant establishment and management capitalised in-perpetuity (2012 $/hectare, PAPL data from Table 1, State data in Table 2)	$73.34
6.	Australian government average per hectare investment in state protected areas acquisitions (2012 $/hectare, Table 1)	$58.87
7.	State governments average per hectare contribution to these acquisitions (2012 $/hectare, Table 1)	$28.06
8.	State governments average per hectare contribution to protected management, capitalised in-perpetuity (2012 $/hectare, Table 2)	$325.44
9.	Total state governments equivalent capital contribution, average per hectare (sum lines 7 and 8)	$353.50
10.	State governments contribution relative to Australian Government contribution (line 9 over line 6)	6 x

100 Sum of the three lines: Addition investments, Incentives and Establishment, in Table 3, divided by 5 years.

101 Sum of all management lines in Table 3.

GOULDIAN FINCHES, A THREATENED SPECIES FOUND ON FISH RIVER THAT BENEFITS FROM RESTORATION OF TRADITIONAL FIRE MANAGEMENT © MIKE FIDLER

Box 4. Fish River protected area purchase, Northern Territory

The ground-breaking purchase of Fish River Station in 2012 marked the first time that the Australian Government National Reserve System program made a grant for, and the first time that a private conservation agency in Australia assisted in purchasing land to be handed back to its Traditional Owners as a protected area.

The 180,000-hectare Fish River Station was formerly a cattle station. But, the property's isolation made grazing difficult, leaving a wide spectrum of ecosystems little affected. From savannah woodlands to rainforest to the Daly River's floodplain wetlands, Fish River Station represents a comprehensive portfolio of northern Australia's habitat types.

The Nature Conservancy, and the Pew Environment Group, worked with the Indigenous Land Corporation (ILC) and the Australian Government's National Reserve System Program to help the ILC purchase Fish River Station. The addition of Fish River increases protection of the under-reserved Daly Basin bioregion from 2.5 per cent to 9.5 per cent, making it a significant contribution to increasing the ecological representation of the National Reserve System. Fish River Station protects an array of important species. These include nearly 400 plant species and at least four nationally threatened animals: the northern masked owl, the northern quoll, the freshwater sawfish and the Gouldian finch. The Daly River is home to more freshwater turtle species than anywhere else in Australia. The property also contains at least 19 species of mammals, including the northern brown bandicoot, agile wallaby, sugar glider and red-cheeked dunnart.

The purchase of Fish River is innovative on a number of fronts: the types and diversity of partners involved in the deal; the fact that the property will be handed back to Traditional Owners for healthy country management; the means of financing its management in the long term; and, the influence the model and outcome have had beyond the borders of Fish River.[102]

Fish River, like much of northern Australia, is a complex mosaic of country traditionally managed by Indigenous custodians over 40,000 years of occupation. Traditional patterns of environmental stewardship are now being restored for the modern age, by employing professional Indigenous Rangers and combining the latest science with traditional knowledge. Recently, Fish River became the first early dry season savannah burning project to be accredited under the Australian Government's Carbon Farming Initiative, and the first to have sold those credits: a practical example of payment for ecosystem services.[103]

102 Fitzsimons JA, Looker M, 2012. Innovative approaches to land acquisition and conservation management: the case of Fish River Station, Northern Territory, in Figgis P et al (eds), *Innovation for 21st Century Conservation*, Australian Committee for IUCN, Sydney, pp 78–85.

103 Walton N, Fitzsimons JA, 2014. Payment for ecosystem services in practice – savanna burning and carbon abatement at Fish River, northern Australia, in Figgis P et al (eds), *Valuing Nature: Protected Areas and Ecosystem Services*, Australian Committee for IUCN, Sydney.

Non-government investments

The contribution of the Indigenous sector to the National Reserve System has been growing dramatically, as noted above, stimulated by Australian Government funding programs (Table 2 and Figure 5 below). However, estimates for matching contributions by the Indigenous proponents and partners, though very significant, are difficult to disaggregate and quantify and, therefore, have not been included in this study. As an example, the long established Dhimurru Indigenous Protected Area in the Northern Territory is managed by the Dhimurru Aboriginal Corporation and includes sea country. In the Dhimurru Aboriginal Corporation 2011–12 Annual Report, $2.84 million in income is reported from a wide range of sources – primarily Australian Government sourced grants from an array of departments, but also state grants – and $193,525 from issuing visitor permits. Nearby, Anindilyakwa Indigenous Protected Area is managed by the Anindilyakwa Land Council and earns revenue from the Dugong Beach tourist resort.[104]

The major private protected area organisations and their annual expenditures are summarised in Table 5. The sector is more diverse than the public protected area sector, with various agencies acting as traditional buy-and-hold conservancies, some as statutory covenant providers and revolving fund managers, and others as funders. Several combine these activities. Their combined budgets are in the tens of millions of dollars including both private and government sources (Table 5).

ULURU-KATA TJUTA © MARTIN HARVEY / WWF-CANON

104 Dhimurru Aboriginal Corporation, 2012. *Dhimurru Aboriginal Corporation Annual Report 2011–2012* (http://www.dhimurru.com.au/uploads/8/9/3/6/8936577/dhimurru_annrep_2011-12_draft04.pdf).
Australian Government Department of Environment, Water, Heritage and the Arts, 2008. *Anindilyakwa: Arnhem Land, Northern Territory* webpage, (http://www.environment.gov.au/indigenous/ipa/pubs/fs-anindilyakwa.pdf).

Table 5. Major non-government protected area organisations in Australia, areas protected and indicative investment levels. [105]

Organisation	Buy and hold	Revolving fund	Covenanting	Funder	Achievements	Total operating expenditure [106]
Australian Wildlife Conservancy	X				Over 3 million ha protected	$10 million
Bush Heritage Australia	X				Nearly 1 million ha protected. BHA also gives material support to management of 3.8 million ha of Indigenous Protected Areas [107]	$11.7 million
Wildlife Land Trust	X				38,766 ha protected	No data
Queensland Trust for Nature		X			101,000 ha purchased since 2004	$0.6 million
Nature Conservation Trust NSW		X	X		protected 27,180 ha across 85 private reserves	~$2 million
Victorian Trust for Nature	X	X	X		53,170 ha protected under covenants, owns 36,094 ha, has sold 6,446 ha	~$2 million
Tasmanian Land Conservancy	X	X			Over 65,650 ha protected, 13,124 currently held [108]	~$2.3 million
National Trust of South Australia	X				Manages 29 nature reserves	No data
Nature Foundation of South Australia	X				500,000 ha	~$1.9 million
National Trust of Australia (WA)			X		over 62,000 ha protected under covenants	~$0.6 million (Average $16/ha)
Birdlife Australia	X				54,925 ha	No data
South Endeavour Trust	X				80,546 ha	No data
The Nature Conservancy Australia				X	Helped secure 29 purchases and 13 million ha of new Indigenous Protected Areas	No data
Foundation for National Parks & Wildlife				X	Provided grants to protect 41,000 ha for the National Reserve System in past decade	$3.8 million

105 For more in-depth treatment, see Booth C, Romero C, 2014. Private and protected: where to for conservation covenanting? *Wildlife Australia Magazine* 51, 32–37.

106 Note that revenue could come from purchase grants and private land covenanting programs of governments (see Tables 1,2 above). Websites used for financial data are: http://www.australianwildlife.org/media/20774/AWC-Concise-Financial-Report-2013-FINAL.pdf ; http://www.bushheritage.org.au/downloads/About_Us/12-13_bha-annual-report.pdf ; http://www.wildlifelandtrust.org.au/; http://www.qtfn.org.au/wp-content/uploads/2013/05/2012-qtfn-financial-accounts.pdf ; http://nct.org.au/media/files/pdf/NCT%20Annual%20Report%202012-13_web.pdf ; http://www.trustfornature.org.au/download/library/76000A007A00E300/tfn-annual-report-2013-pdf/ ; http://www.tasland.org.au/files/1413/8126/8617/TLC_annualreport1213_WEB.pdf ; http://www.nationaltrust.org.au/Assets/14579/1/NTSAAnnualReport2013.pdf ; http://www.naturefoundation.org.au/publications/annual-reports/NF_Annual_Report_12-13.pdf ; http://www.nationaltrust.org.au/Assets/13489/1/2012-2013NTWAAnnualReport.pdf ; http://birdlife.org.au/documents/AR-Annual_report_2013.pdf ; http://www.southendeavour.com.au/about_us.html ; http://www.natureaustralia.org.au/ ; http://fnpw.org.au/

107 Pip Walsh, BHA, pers. comm.

108 Sally Bryant, TLC, pers. comm.

BIODIVERSITY CONSERVATION

- *Under the Convention on Biological Diversity (CBD), Australia has committed to bringing at least 17 per cent of terrestrial and at least 10 per cent of marine areas into ecologically representative, well-connected systems of protected areas by 2020 (Aichi Target 11).*
- *Australia also has an agreed intergovernmental Strategy for developing a comprehensive, adequate and representative National Reserve System on land and sea that, if implemented, would deliver on this CBD target.*
- *Due to dramatic recent growth, the National Reserve System covers 16.5 per cent of Australia's land area, with highly protected areas, such as national parks, covering 8.3 per cent. The marine National Reserve System extends over one-third of Australian waters with highly protected areas such as marine national parks, no-take or green zones covering 13.5 per cent.*
- *Growth has been uneven however, and the National Reserve System is still far from meeting Aichi Target 11, which requires that it also be ecologically representative and well-connected.*
- *On land, 1,655 of 5,815 ecosystems and habitats for 138 of 1,613 threatened species remain unprotected.*
- *Nonetheless, 436 terrestrial ecosystems and 176 threatened terrestrial species attained minimum standards of protection due to growth of the National Reserve System on land between 2002 and 2012. The gap for ecosystem protection on land – the area needed to bring all ecosystems to the minimum standard of protection – closed by a very substantial 20 million hectares (from 77 down to 57 million hectares) between 2002 and 2012, not including threatened species protection gaps.*
- *Threatened species attaining a minimum standard for habitat protection increased from 27 per cent to 38 per cent over the decade 2002–2012. A low proportion of critically endangered species meeting the standard (29 per cent) and the high proportion with no protection at all (20 per cent) are cause for concern, but one which should be relatively easy to amend, as the distributions of these species tend to be small and localised.*
- *Protected area connectivity has increased modestly for terrestrial protected areas in terms of the median distance between neighbouring protected areas, but this progress has been undermined by increasing land use intensity in landscapes between protected areas.*
- *A comprehensive, adequate and representative marine reserve system, which meets a standard of 15 per cent of each of 2,420 marine ecosystems and 30 per cent of the habitats of each of 177 marine species of national environmental significance, would require expansion of marine national parks, no-take or green zones up to nearly 30 per cent of state and Australian waters, not substantially different in overall extent from that of the current marine reserve system, but different in configuration.*
- *Protection of climate change refugia, connectivity and special places for biodiversity is still low and requires high priority attention.*

Commitments, objectives and targets

In the decade 2000–2010, under the Global Plant Conservation Strategy, the target for terrestrial plant diversity was "at least 10 per cent of each of the world's ecological regions effectively conserved" by 2010.[109]

This target nearly doubled for the second decade of the Convention 2010–2020, setting a considerable challenge for parties. Australia, along with other state parties adopted a protected area target for achievement by 2020 at the 2010 Conference of Parties to the Convention on Biological Diversity (CBD) in Aichi, Japan (Aichi Target 11): [110]

> *Target 11: By 2020, at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape.*

Although Target 11 set no standards or metrics for "effectively and equitably managed, ecologically representative and well-connected", Australia has the advantage of having nationally agreed targets for development of a comprehensive, adequate and representative National Reserve System. In the current 2009–2030 National Reserve System strategy, all jurisdictions agreed to:

- include, by 2015, examples of at least 80 per cent of the number of regional ecosystems in each IBRA *bioregion* (comprehensiveness); [111]
- include, by 2025, examples of at least 80 per cent of the number of regional ecosystems in each IBRA *subregion* (representativeness);
- include, by 2030, critical habitats and core areas important for the long-term survival of rare, migratory, threatened or other priority species and ecological communities; and
- include, by 2030, critical areas to ensure the viability, resilience and integrity of ecosystem function in response to a changing climate (refugia, corridors, places of special significance).[112]

What constitutes an adequate 'example' was not specified in the NRS strategy. Further below we propose a minimum requirement for what is an 'example' for these interim targets.

Australia has also developed similar guidance for the marine reserve system, referencing, though not explicitly adopting, the IUCN World Parks Congress 2003 recommendation 5.22 on Marine Protected Areas that strictly protected areas cover 20–30 per cent of each marine habitat. [113]

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109 The Conference of the Parties to the Convention on Biological Diversity, 2002. *CoP6 Decision VI/9: Global Strategy for Plant Conservation*, webpage (http://www.cbd.int/decision/cop/default.shtml?id=7183).

110 The Conference of the Parties to the Convention on Biological Diversity, 2010. *Strategic Plan for Biodiversity 2011–2020*, webpage (http://www.cbd.int/sp/targets/rationale/target-11/).

111 There are 85 mapped bioregions in IBRA version 7, not including external territories, and 410 subregions.

112 National Reserve System Task Group, 2009, cited above.

113 Australian Government Department of Environment, 2006. *Guidance on achieving comprehensiveness, adequacy, and representativeness in the Commonwealth waters component of the National Representative System of Marine Protected Areas*, webpage (http://www.environment.gov.au/resource/guidance-achieving-comprehensiveness-adequacy-and-representativeness-commonwealth-waters).

Growth of protected areas

As of 2012, protected areas on land had grown to 15.3 per cent of Australia's land area, up from 9.5 per cent in 2002 (Table 6, Figure 1). More recent figures indicate this had grown to 16.5 per cent as of 30 June 2013, due almost entirely to rapid recent growth of Indigenous Protected Areas (Table 6, Figure 5).[114] Highly protected areas, primarily national parks, grew from 6.6 per cent to 8.3 per cent on land over the past decade (Table 6).

Jurisdictions continue to be highly uneven in extent protected. In 2012, as in previous reports, the Northern Territory and Queensland had the lowest proportional extent of protected areas on land and the ACT and Tasmania the highest (Table 5). There was an apparent reduction in highly protected areas in South Australia over the decade, while all protected areas increased by just over 4 per cent (Table 5). However, this was not due to genuine downgrading, rather the result of appropriate application of IUCN management categories for which South Australia is to be commended (for more detail, see Box 5).

IPAs showed the most dramatic growth, from just 12 covering 13.8 million hectares in 2002, to 52 covering 36.4 million hectares in 2012. In addition, many national parks (including all Australian Government National Parks of Kakadu, Uluṟu-Kata Tjuṯa and Booderee) are Indigenous owned and/or jointly managed with the government authority (Figure 5). IPAs are established under an Australian Government program and are largely, though not always, managed in IUCN Category VI (Multiple use).[115] However, in 2012, 8.7 per cent by area of IPAs were in Category II (National Park equivalent). As of 2012, 38 per cent of all protected areas fell under Indigenous or joint management, and 6.3 per cent were privately managed, according to CAPAD data, for a total of 44.3 per cent of the National Reserve System non-government or jointly managed.

These estimates of extent of private governance are under-estimates because (for reasons unclear) CAPAD does not as yet include private land covenants for New South Wales, Victoria and Western Australia. Included in CAPAD as National Reserve System protected areas are conservation covenants in the Northern Territory, nature refuges and coordinated conservation areas in Queensland, heritage agreements in South Australia, and covenants, private nature reserves and sanctuaries in Tasmania. A better estimate, developed recently by Booth and Romero (2014),[116] is that private land conservation is slightly above that based on CAPAD, representing ~1.1 per cent of Australia's land area, or 6.8 per cent of the protected estate. In another recent review, Fitzsimons (2014)[117] estimated there were ~5,000 terrestrial properties that could be considered private protected areas.These properties covered 8.9 million hectares as at September 2013, compared with 7.4 million hectares in CAPAD 2012 (Table 6), and the 8 million hectares estimated by Booth and Romero (2014). This includes over 4,900 conservation covenants covering over 4.45 million hectares, ~140 properties owned by private land trusts (but not necessarily covenanted) covering ~4.59 million hectares and a small number of private protected areas owned by other like-minded organisations.[118] There are a number of other covenanting or covenant-like arrangements that may not qualify as private protected areas, but are managed in the same way as other conservation covenants.

114 Data provided by the Australian Government Department of Environment, August 2014.

115 Australian Government Department of the Environment, 2013. *Indigenous Communities and Environment: Indigenous Protected Areas*, webpage (http://www.environment.gov.au/indigenous/ipa/).

116 Booth C, Romero C, 2014, cited above.

117 Fitzsimons J, 2014. Australia, in Stolton S et al (eds), *The Futures of Privately Protected Areas*, IUCN, Gland, Switzerland, pp 54–58.

118 Some of these large properties, held by NGOs, have covenants. Where known, these have been counted only once in deriving the total figure.

SHORELINE OF CAPE HILLSBOROUGH NATIONAL PARK,QUEENSLAND
© MICHELE DEPRAZ / WWF-CANON

Marine parks underwent a nearly fivefold expansion from 7.1 per cent to 35.9 per cent of Australian waters between 2002 and 2012 (Table 6). The global average is 1.6 per cent. [119] Marine national parks and other highly protected areas (IUCN Categories I–III) grew nearly sevenfold from 2 per cent to 13.5 per cent of Australian waters over the decade.

Of special note was the expansion of marine national park zones (also termed no-take or green zones) in the Great Barrier Reef Marine Park from less than 5 per cent to one-third of the park area in 2004, and the declaration of marine national park zones throughout most of the rest of Australian Government waters in 2012 (Table 6, Figure 1).

However, these latter declarations are in doubt, at time of writing, as the zoning schemes and management plans for the recently declared Australian marine reserves, including national parks, have been reopened for review.[120]

The effectiveness of marine national parks depends greatly on good fisheries management throughout the wider seascape, including in marine park IUCN IV–VI zones that allow fishing. Conversely, as much research has shown, marine national park zones also assist in conserving fish stocks and provide significant provisioning ecosystem service benefits for the fishing industry. [121]

State waters, although a very small component of the entire marine area of Australia, also showed substantial protected area growth, with the greatest increases in New South Wales, Victoria and Western Australia over the decade. In the Northern Territory, three quarters of marine protected areas are under Indigenous or joint management, which is in contrast to most of the marine area of Australia, where government management is exclusive.

119 IUCN, 2012. *Protected Planet Report*, webpage (http://www.iucn.org/about/work/programmes/gpap_home/gpap_biodiversity/gpap_protectedplanet/?10866/ProtectedPlanet-Report).

120 Australian Government Department of Environment, 2013a. *Commonwealth marine reserves – Management*, webpage (http://www.environment.gov.au/topics/marine/marine-reserves/overview/management).

121 McCook LJ et al, 2010. Adaptive management of the Great Barrier Reef: A globally significant demonstration of the benefits of networks of marine reserves, *PNAS* 107, 18278–18285;
Roberts C, 2012b, cited above.
Barrett NS et al, 2007. Changes in fish assemblages following ten years of protection in Tasmanian marine protected areas, *Journal of Experimental Marine Biology and Ecology* 345, 141–157.

Box 5. Resolving uncertainties and inconsistencies over application of IUCN protected area guidelines

A key part of the definition of a protected area is that nature conservation must be a primary purpose. Other purposes may be pursued over the same area, as long as they do not compromise the primary purpose of nature conservation.

However, some marine park zones allow recreational fishing and commercial resource exploitation to the extent that there is little to distinguish such areas from regulated fisheries outside of marine parks. [122] Some marine parks, classified as high level IUCN Categories (II), allow recreational fishing, representing a misapplication of the IUCN guidelines.[123] In recognition of this fundamental divide between fished zones and marine national parks, we do not count IUCN IV–VI zones of marine parks toward the ecosystem and species representation targets in the Marine Reserves analysis below.

The issue also arises on land, albeit in a less consistent way. In some instances commercial livestock properties are designated as protected areas under IUCN Category VI, though most or all of the properties are open to livestock. There is little or no evidence that livestock production as practised is compatible with the primary objective of nature conservation. However, the majority of IUCN Category VI areas on land are Indigenous Protected Areas, which are genuinely subject to little if any such commercial use.

Natural resource use permissible under IUCN Category VI must be low-level, nonindustrial, and compatible with the primary purpose of nature conservation according to IUCN guidelines. [124] Demonstrating compliance with standards and guidelines is therefore a special concern for Category VI areas. Research has shown no correlation between terrestrial threatened species stabilisation and overlap with IUCN V–VI protected areas; only with IUCN I–IV (highly) protected areas. However, this could mean only that it was too early or the data too sparse to allow a real effect to be detected. [125]

This is not intended to dismiss the genuine efforts by many natural resource users to reduce environmental side-impacts. There is a clear need for a separate process for recognising such important production-side contributions to conservation without trying to fit them into a protected area category to which they do not belong.

A related issue is that outside of national parks, private protected areas must also contend with state mining laws. These laws allow mining virtually everywhere except in national parks (though, in a few cases, even national parks may be open to mining [126]). A similar constraint on protection arises for conservation organisations acquiring pastoral leases on state land to become protected areas. These properties often remain pastoral leases because the law may not provide a means of declaring protected areas over such leases.

122 For example, see the description of permitted fishing activities in the General Use Zone of the Great Barrier Reef Marine Park (http://www.gbrmpa.gov.au/zoning-permits-and-plans/zoning/commercial-fishing-and-zoning).

123 Fitzsimons JA, 2011. Mislabeling marine protected areas and why it matters, *Conservation Letters* 4, 340–345.

124 Dudley N (ed), 2010. *Guidelines for Applying Protected Area Management Categories,* IUCN.

125 Taylor MFJ et al, 2011b, cited above.

126 Adams V, Moon K, 2013. Security and equity of conservation covenants: Contradictions of private protected area policies in Australia, *Land use policy* 30, 114–119.
Irving J, 2012. Arkaroola—Creating a New Type of Protected Area, in Figgis P et al (eds), *Innovation for 21st Century Conservation*, Australian Committee for IUCN Sydney, pp 88–93 (http://aciucn.org.au/wp-content/uploads/2013/05/Innovation_for_21st_century_conservation_low.pdf).

Box 5 (continued)

In 2011, South Australia showed commendable leadership by reviewing the IUCN protected area management categories applied to all areas protected under the state *National Parks and Wildlife Act 1972*, to better implement IUCN recommendations from the World Conservation Congress in Amman, which stated that mining access should be excluded from IUCN Categories I to IV. This review resulted in change of category to IUCN VI for over eight million hectares of protected areas previously classified as IUCN II where the gazettal allowed for mining. As these protected areas always had a provision for mining, the reclassification was not a downgrade, simply a more accurate reflection of the most appropriate category.

Globally, IUCN has a promising initiative: the *Green List of Protected Areas*.[127] The IUCN has established a process for nomination of protected areas to the Green List. Nominated protected areas will need to meet minimum standards for conservation objectives, legitimate establishment, management effectiveness, and governance, before being accepted to the list.

Private protected areas, depending on their management objectives and allowed activities, may range across the full spectrum of IUCN Categories; however, the application of these categories is inconsistent across the country.[128]

Ideally, issues regarding the application of IUCN Categories would be addressed nationally. A cross-jurisdictional partnership among all protected area agencies should be developed and tasked with, among other things, resolution of issues regarding the fit of protected areas to IUCN management categories and auditing to ensure management commitments are being met and are effective at achieving biodiversity conservation goals.

127 IUCN, 2014a. *IUCN Green List of Protected Areas*, webpage (http://www.iucn.org/about/work/programmes/gpap_home/gpap_quality/gpap_greenlist/).

128 Fitzsimons JA, 2006. Private Protected Areas? Assessing the suitability for incorporating conservation agreements over private land into the National Reserve System: A case study of Victoria, *Environmental and Planning Law Journal* 23, 365–385;
Fitzsimons JA, 2014. Australia, in Stolton S et al (eds), *The Futures of Privately Protected Areas*, IUCN, Gland, Switzerland, pp 54–58.

Table 6. National Reserve System extents on land and sea by jurisdiction, and by IUCN management categories for 2002 and 2012. [129]

			All protected areas		Highly protected areas [130]	
Realm	**Jurisdiction**	**Area (km²)**	**2002**	**2012**	**2002**	**2012**
Land	Australian Government [131]	582	82.7%	83.0%	82.4%	83.0%
	Australian Capital Territory	2,358	53.9%	55.0%	53.9%	55.0%
	New South Wales [132]	799,307	6.6%	9.3%	6.6%	9.2%
	Northern Territory [133]	1,340,996	3.7%	18.4%	3.6%	5.2%
	Queensland	1,718,819	4.0%	7.5%	3.8%	5.2%
	South Australia [134]	983,349	25.6%	29.8%	14%	9.8%
	Tasmania	67,920	36.6%	40.0%	24.8%	26.7%
	Victoria	226,206	13.7%	17.1%	13.4%	16.3%
	Western Australia	2,520,863	10.7%	14.5%	6.6%	9.7%
	Total	7,660,399	9.5%	16.5% [135]	6.6%	8.3%
Sea	Australian Government [136]	8,719,475	7.1%	36.4%	1.9%	13.8%
	New South Wales	10,891	15.9%	33.8%	2.5%	8.8%
	Northern Territory	78,970	4.3%	6.2%	4.1%	4.3%
	Queensland	54,892	21.8%	29.7%	3.4%	4.8%
	South Australia	61,122	3.0%	44.7%	1.0%	5.1%
	Tasmania	23,959	6.0%	8.2%	4.5%	5.8%
	Victoria	11,310	7.5%	14.5%	0.1%	6.7%
	Western Australia	122,112	10.1%	23.9%	7.1%	11.0%
	Total	9,082,730	7.1%	35.9%	2.0%	13.5%

129 See Appendix 3 for methods. Base data acquired from CAPAD (http://www.environment.gov.au/topics/land/National Reserve System/science-maps-and-data/capad).

130 IUCN I–IV for terrestrial and IUCN I–III for marine areas.

131 External territories only.

132 Includes Jervis Bay Territory and Booderee, an Australian Government National Park.

133 Includes Kakadu and Uluṟu-Kata Tjuṯa, which are Australian Government National Parks, but not the recently reversed Henbury Station purchase.

134 This total was corrected corrected values provided in email from SA DEWNR, August 2014.

135 CAPAD 2012 figure was 15.6%. This has been updated to June 2013 per email from the Department of Environment, of 23 September 2014.

136 Includes the Great Barrier Reef Marine Park and Jervis Bay Territory marine area.

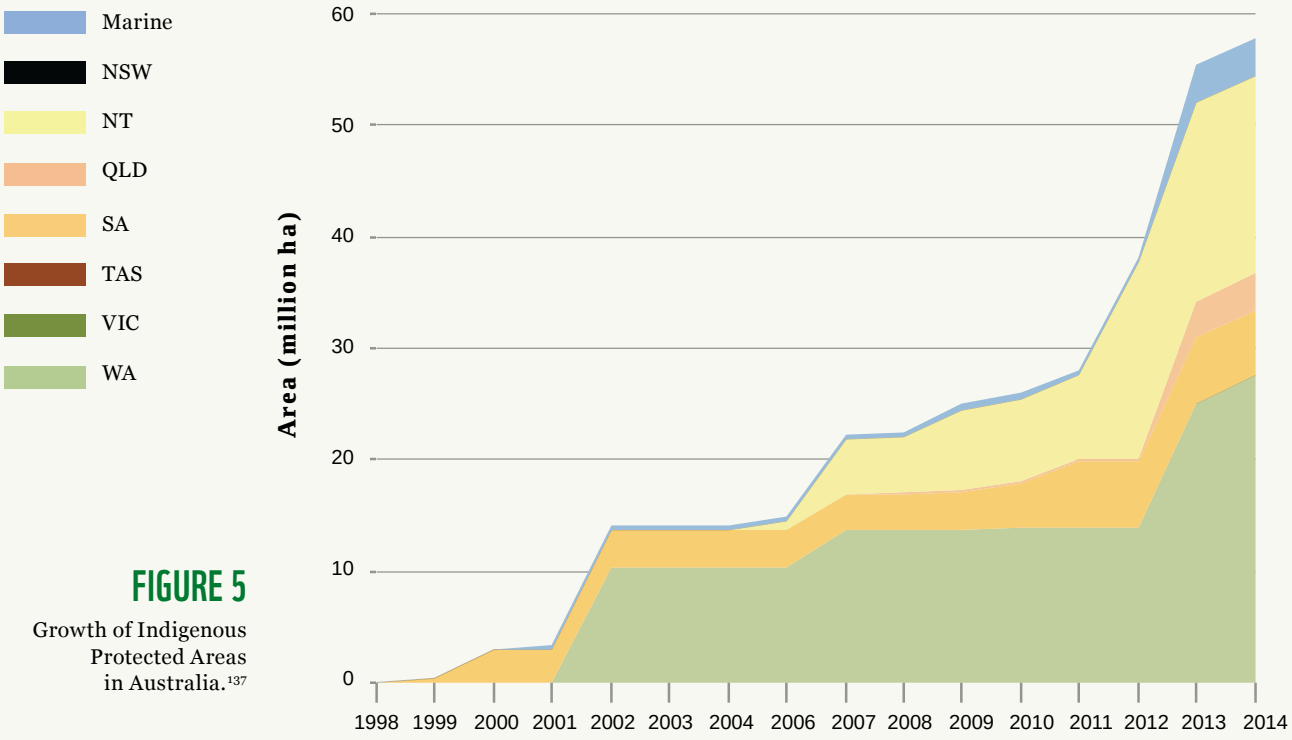

FIGURE 5

Growth of Indigenous Protected Areas in Australia.[137]

Terrestrial ecosystem protection

We set a standard for a comprehensive, adequate and representative National Reserve System as one that protects at least 15 per cent by area of the pre-clearing extent of each of 5,815 mapped terrestrial ecosystems. This standard was also applied in the 2011 *Building Nature's Safety Net* report and was chosen on the basis of earlier targets for forest protection known as the JANIS criteria. In modified form, these criteria are applied here, more generally, to terrestrial ecosystems nationwide.[138]

Modifications of this standard for small ecosystems were also applied as follows: if 15 per cent of the original total area is less than 1000 hectares, a minimum of 1000 hectares should be protected; and, if the original total area is less than 1000 hectares, all of the original, pre-clearing area should be protected and, if necessary and practicable, restored. This standard is considered a minimum to prevent ecosystems being converted or degraded to the point they become endangered, or if endangered can recover to the point they are no longer. As proxies for ecosystems on land we used 5,815 intersections of sub-bioregions and major vegetation subgroups 100ha or greater in extent. [139]

137 Australian Government Department of Environment, 2014. *Indigenous Protected Areas (IPA) – Declared,* spatial data current to July 2014 (http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7B282529E7-6C76-4C15-9C1C-B1F7325C6B7C%7D). Note that areas in some states (New South Wales, Tasmania and Victoria) are too small to be discerned on the graph.

138 For more detail, see the 2011 *Building Nature's Safety Net* report and Joint ANZECC / MCFFA National Forest Policy Statement Implementation Sub-committee (JANIS), 1997. *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia,* Australian Government, Canberra.
JANIS proposed protection of "at least 15% of the pre-1750 distribution of each forest ecosystem." However, JANIS also recommended at least 60% of the remaining extent of a vulnerable forest ecosystem be protected, defined as one where less than 30% of original extent remains or is otherwise vulnerable, which calculates to at most 18% of preclearing extent. JANIS recommended further that "all remaining occurrences of rare and endangered forest ecosystems" be protected, as also proposed here, where JANIS defined rare ecosystems as those with total areas of 1000 hectares or less, among other things, and defined endangered ecosystems as those reduced below 10% of original extent. Requiring 15% of pre-clearing extent be protected and restored as per the criteria proposed here is stronger than JANIS, which did not include any restoration effort in its criteria. JANIS also recommended 60–100% of old growth forests be protected depending on depletion level. Lacking maps of 'old growth' vegetation more broadly, we could not implement this criterion.

139 Taylor MFJ et al, 2014, cited above.

This analysis deals only with vegetation-based ecosystems and, importantly, does not attempt to characterise inland aquatic ecosystems or gaps in their protection. Inland aquatic ecosystems require a separate analysis of the linear features of aquatic systems, as well as catchment integrity or condition. Other, more comprehensive studies have generally found poor representation of aquatic ecosystems.[140]

Using the rules above, we calculated for each ecosystem the area required to be protected to meet the standard. We estimated from intersections with the National Reserve System in 2002 and 2012, the area of each ecosystem protected at that time. Many ecosystems are represented above this standard in the National Reserve System. Because they were considered to have met the standard, any area excess to the standard was not counted toward the total area. This does not mean that the area above the standard is an unnecessary surplus that should be sold off to pay for better-targeted expansion.[141] Areas above the minimum standard for representation may represent significant additional value for biodiversity conservation, principally through enhancing connectivity. More detailed operational-level work may require a more ecologically realistic standard for a given ecosystem than the generic 15 per cent standard we have applied.

Attainment of this ecosystem protection standard has risen substantially over the past decade, from 32 per cent in 2002 to 50 per cent in 2012. The total ecosystem protection gap on land has correspondingly contracted by 20 million hectares, from 77 in 2002 to ~57 million hectares in 2012 (Figure 6, Figure 8). As a result, bioregional priorities have changed substantially over the decade, although some bioregions remain top priority (Figure 2). At a coarse level, forest ecosystems are the best protected, while woodland and grassland ecosystems are the least well protected, relative to the standard. Wetlands in the arid and semi-arid zones are also high priority. Nonetheless, every state and broad vegetation type has gaps for ecosystem protection (Figure 6).

Filling ecosystem protection gaps, as defined here, would require more than protection of uncleared or remnant ecosystems. Many ecosystems, like the Brigalow endangered ecological community,[142] have been cleared below 15 per cent already. In this case, to achieve a 15 per cent protection standard would require protection of 100 per cent of remaining uncleared areas, as well as naturally regenerating areas, and possibly replanting of some lost areas.[143] We estimate that 4.5 million hectares of the 57 million hectare gap have been cleared, at some stage, based on NVIS maps of clearing, and thus would need encouragement of natural regeneration or active restoration effort to meet the standard.

In addition, ecosystems not extensively cleared may be threatened by degradation and other non-clearing related causes. In order for such ecosystems to meet the protection standard, they may require investment in regeneration and recovery as part of protected area management. For example, in Queensland, which has a comprehensive system of mapping ecosystems and assessing their conservation status, 90 of 1,383 regional ecosystems are considered endangered due to past land clearing. However, an additional 135 ecosystems are also considered endangered due to degradation and threats other than land clearing.[144]

Jurisdictional estimates are discussed under individual profiles further below.

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140 Fitzsimons JA, Robertson HA, 2005. Freshwater reserves in Australia: directions and challenges for the development of a comprehensive, adequate and representative system of protected areas, *Hydrobiologia* 552, 87–97;
Kingsford RT, Nevill J, 2006. Urgent need for a systematic expansion of freshwater protected areas in Australia, *Pacific Conservation Biology,* 12, 7.

141 Fuller RA et al, 2010. Replacing underperforming protected areas achieves better conservation outcomes, *Nature* 466, 365–367.

142 Department of Environment, 2014. *Brigalow (Acacia harpophylla dominant and co-dominant),* webpage (http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=28).

143 JANIS did not require reforestation. See note above. In this analysis we differ from JANIS in requiring that all ecosystems be recovered to at last 15% of original cover if they have been cleared below that percentage. That is, that they may no longer be considered endangered.

144 Queensland Government Department of Environment and Heritage Protection, 2014. *Biodiversity Status of Regional Ecosystems of Queensland version 8.1*, database (https://www.ehp.qld.gov.au/ecosystems/biodiversity/regional-ecosystems/how_to_download_redd.html).

FIGURE 6

Proportions by area attained of the standard of 15% of each terrestrial ecosystem protected as of 2002 and 2012 (left) and gaps remaining (right).[145]

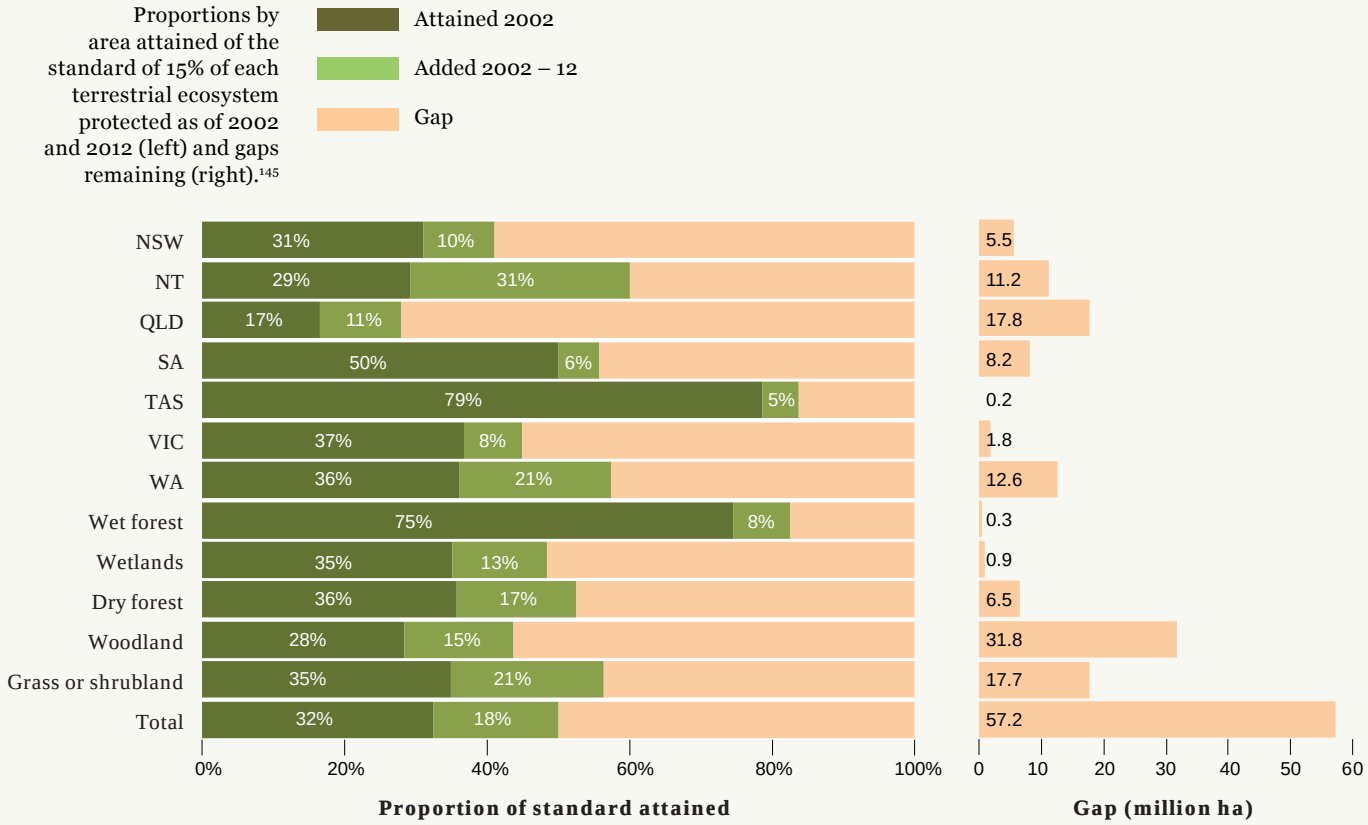
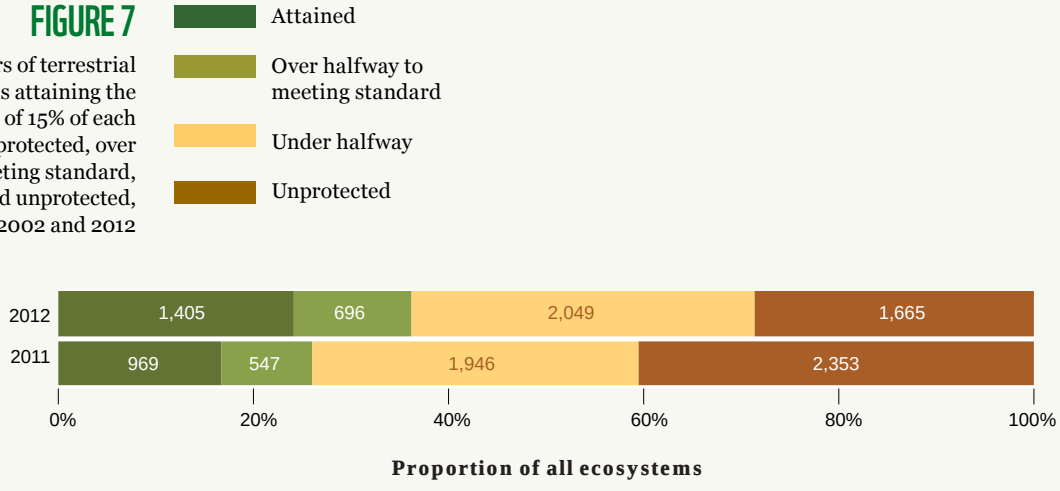


FIGURE 7

Numbers of terrestrial ecosystems attaining the standard of 15% of each ecosystem protected, over halfway to meeting standard, under halfway and unprotected, as of 2002 and 2012

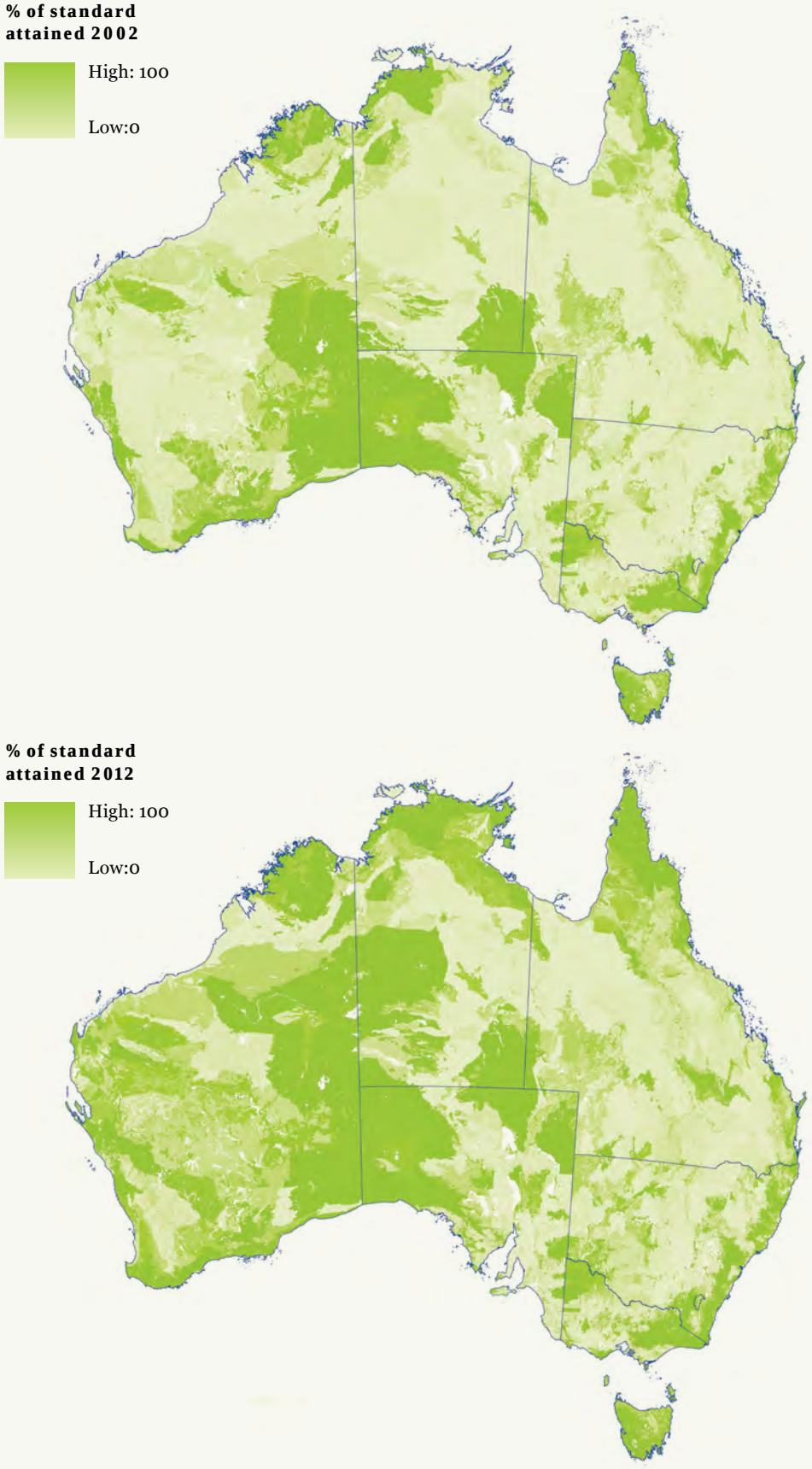


145 ACT figures included in NSW for this analysis.

FIGURE 8

Terrestrial ecosystems of Australia, percentages of the 15% protection standard attained as of 2002 and 2012.

By 'terrestrial ecosystems' we mean the NVIS version 4.1 major vegetation subgroups nested within IBRA version 7 subregions, in turn nested within bioregions. These are used as proxies for 'regional ecosystems' for the purposes of the comprehensiveness and representativeness targets of the National Reserve System 2009–2030 Strategy. The area needed to meet the minimum standard is 15% of the original extent of each of 5,815 terrestrial ecosystem proxies (or if 15% is below 1000 ha, then 1000 ha, or if original extent is below 1000 ha, then 100%). Shown is the percentage of this area protected in 2002 and 2012 respectively.



Terrestrial species protection

In the 2011 *Building Nature's Safety Net* report, we identified gaps in protection for 1,447 terrestrial species listed under Australian Government law as threatened, as of 2006.[146] In this report, we update that gap analysis for the National Reserve System in 2012, for 1,613 terrestrial species listed as threatened under Australian, state and territory legislation.

We set a standard for a minimally adequate National Reserve System, as one which includes at least 30 per cent by area of 'known' or 'likely to occur' distributions for 1,613 threatened species using the Australian Government distribution maps for such species.[147] This distribution is roughly the same as the extent of occupancy and extent of occurrence, respectively, not the original distribution of that species.[148] If 30 per cent of this distribution is less than 1000 hectares, a minimum of 1000 hectares should be protected. If the distribution itself is less than 1000 hectares, 100 per cent should be protected and, if necessary and practicable, restored. Finally, if 30 per cent of the distribution is larger than 10 million hectares, the protected area should be, at most, 10 million hectares.[149]

Note that this standard does not include other important aspects of adequacy, such as connectivity, configuration, habitat quality, or complementary management of surrounding land. These are addressed further below. Target based conservation has been rightly criticised.[150] However, without quantitative targets and standards, it would be impossible to estimate the resourcing needed to achieve, for example, adequate protection of biodiversity.

The gap analyses produced here are only intended for that purpose, and are not intended as a guide for operational work in selecting individual properties for protected areas. Standards need to be refined for specific protected area decisions and operation plans – for bioregions, localities, ecosystems and species – as better, more biologically meaningful information comes to hand.

We counted species whose distributions were protected to the 30 per cent minimum standard, as detailed above. We allocated species to jurisdictions where the majority of their distribution fell; otherwise, species were classified as multi-jurisdictional.

Most species were found to have some part of their distribution captured in the National Reserve System. Almost 60 per cent had attained the standard, or were more than halfway to attaining the standard, in 2012 (Figure 9).

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146 Watson JEM et al, 2011. The capacity of Australia's protected area system to represent threatened species, *Conservation Biology* 25, 324–332.

147 The 30% standard is an evidence-based average from Svancara LK et al, 2005. Policy-driven versus evidence-based conservation: a review of political targets and biological needs, *BioScience* 55, 989–995. In the 2011 report, we only counted strictly protected areas toward meeting the standard. We have relaxed that constraint in this analysis and note the issues surrounding IUCN V–VI protected areas in Box 5. In the 2011 report, we also required 100% of critical habitats protected; however, so few critical habitats have been mapped and registered, this standard could not be implemented for most species. Species distributions are those mapped in Queensland Government Department of Environment, 2014. *Australia – Species of National Environmental Significance,* spatial data (http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7BF4714B81-C92C-46EE-B19D-08D8AB9ACC33%7D&loggedIn=false).
We used the 'known to occur' and 'likely to occur' portions of mapped distributions as the species 'distribution'. The 'may occur' components were deemed too low in confidence to be useful.

148 IUCN, 2014b. *The IUCN Red List for Threatened Species* (http://www.iucnredlist.org/static/categories_criteria_2_3).

149 Gaps for very large species would dominate the gap analysis unless caps were put on large range species. For example, the Australian Painted Snipe has an enormous nominal likely-to-occur distribution covering approximately half the area of Australia. However, only the wetlands within that range are the actual habitats used by this migratory wading bird. In the absence of better government habitat mapping, this cap was the only method available to us to reduce biases in over-estimation of actual distributions and hence over-estimation of gaps.
Australian Government Department of Environment, 2013b. *Rostratula australis – Australian Painted Snipe,* webpage (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=77037).

150 Carwardine J et al, 2008. Hitting the target and missing the point: target-based conservation planning in context, *Conservation Letters* 2, 3–10.

Proportion of species meeting the standard was 38 per cent (616) in 2012, up from 27 per cent (440) in 2002, while 138 species (9 per cent) have no habitat protected as of 2012. Among major taxa, fish had the lowest proportions meeting the standard (29 per cent, up from 18 per cent in 2002), while frogs had the highest and the greatest improvement over the decade (65 per cent, up from 36 per cent in 2002) (Figure 9).

Only 29 per cent of critically endangered species met the standard, while higher percentages of endangered (34 per cent) and vulnerable (43 per cent) species met the standard, in 2012 (Figure 12). Some 29 critically endangered species lack any representation in protected areas. Almost all are plants. The cause for this lack in representation is unclear, as is any causative connection. Has a species become critically endangered because it has lacked sufficient habitat secured in protected areas in the past? Or, is it that they have tended to 'miss out' on protection decisions driven by ecosystem representation priorities, simply by virtue of having a small, restricted distribution?

Regardless, this situation should be easy to fix, as critically endangered species tend to have small remnant distributions. In the case of the Dawson yellow chat (Box 1), none of the sites where remaining populations occur were highly protected in 2012 and all were subject to livestock grazing, which is listed as a threat. The recent disappearance of the population on Curtis Island may be linked to livestock grazing in their habitat. Although the marine plain habitat was in a Conservation Park, the park was actually overlaid by a grazing lease. As little as 3,157 hectares of 'known' or 'likely to occur' habitat would need to be protected to meet the standard used here.[151] A recent offset for an industrial plant on Curtis Island in central Queensland means that its marine plain habitat will be strictly protected and livestock removed (see *Curtis Island National Park* below).

All jurisdictions have committed to protecting critical habitats of threatened species in the existing National Reserve System strategy.[152] This priority needs much greater attention, in light of the known correlation between proportion of range protected and population trends (see above *Conserving biodiversity*).

Another recent global study also lamented the lack of attention in protected area planning around the world to conserving threatened species.[153]

Individual jurisdictions are discussed further below.

151 Australian Government Department of Environment, 2013. *Epthianura crocea macgregori — Yellow Chat (Dawson)*, webpage (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67090).

152 Australian Government Department of Environment, 2014. *Strategy for Australia's National Reserve System 2009–2030*, webpage (http://www.environment.gov.au/node/21198).

153 Venter O et al, 2014. Targeting global protected area expansion for imperiled biodiversity, *PLOS Biology* (http://www.plosbiology.org/article/info%3Adoi%2F10.1371%2Fjournal.pbio.1001891).

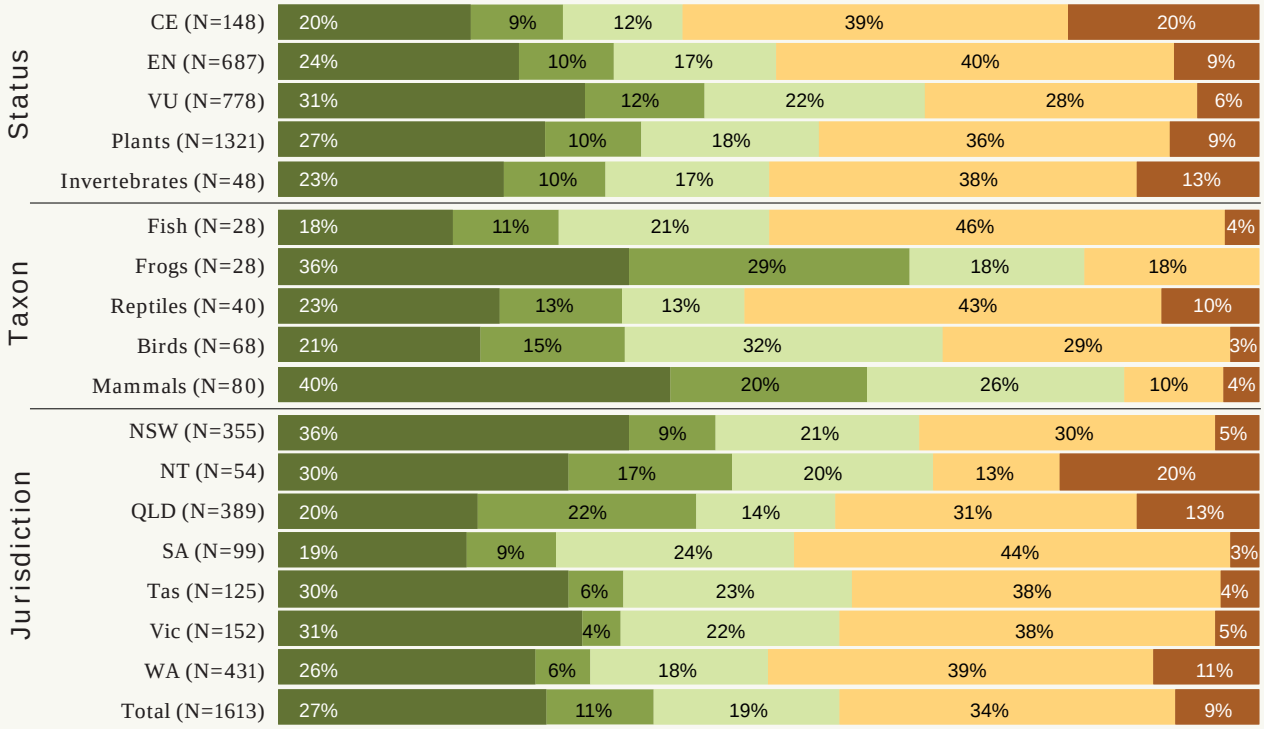


FIGURE 9

Proportions of threatened species meeting the 30% habitat protection standard by taxon, conservation status and jurisdiction. [154]

Species were sorted into those that had attained the standard as of 2002, those that had not met the standard in 2002 but had done so in 2012, those that are halfway to meeting the standard, those that are less than halfway, and those with no protection at all.

154 ACT was included in NSW for this analysis. CE = Critically Endangered, EN = Endangered, VU = Vulnerable. Under 'Jurisdiction', there were eight species considered multi-jurisdictional due to extensive range. These figures are not shown separately, but are included in totals. For Tasmanian Government comparison estimates, see the Tasmania profile below.

Areas of special importance

Aichi Target 11 emphasises the inclusion in protected areas of "areas of particular importance for biodiversity and ecosystem services." The IUCN Protected Planet reports use Alliance for Zero Extinction sites (AZE, 22 per cent completely protected worldwide)[155] and Important Bird Areas (IBA, 28 per cent completely protected worldwide) as indicators for "areas of particular importance".[156] All AZE point locations fall within protected areas in Australia. However, this analysis was only based on the publicly available point locations, not on areas.

While 48.7 per cent, by area, of all Australian IBAs are located in protected areas, the distribution is very unequal, with 16.8 per cent, by number, of IBAs having no protection at all.[157]

We also analysed overlap of the National Reserve System in 2012 with the Centres of Plant Diversity and found only 22 per cent, by area, are protected in Australia. The largest such area is the Southwest Australia global biodiversity hotspot.[158]

Other areas of special importance include refuges from climate change, or other habitats of importance for native species shifting in response to climate change, such as corridors. Several recent studies have examined the extent to which climate change adaptation habitats are captured in the National Reserve System.

Dunlop et al, 2012,[159] modelled plant community change in response to a changing climate, and report that:

> "the degree to which the National Reserve System is representative of the continent's habitats 'of the day' changes very little, even following very significant environmental change. In other words, climate change does not notably alter the environmental representativeness of the National Reserve System. Dunlop and Brown (2008) argued that the framework for the National Reserve System, effectively targeting representativeness at three different scales, was likely to lead to a highly robust conservation strategy in the face of climate change when implemented. This analysis demonstrates that with the current level of implementation, the National Reserve System retains very similar overall levels and patterns of environmental representativeness (including significant gaps), supporting the proposition that representative reserve networks in general, and the National Reserve System in particular, are a highly robust conservation strategy in the face of climate change."

However, they also warn that due to uneven implementation, "many environments, especially in northern Australia, are currently not well represented in the National Reserve System."[160] In summary, the uneven ecological representation of the current reserve system means that it is also likely to be uneven in a future climate, though not greatly more or less so than at present.

155 American Bird Conservancy, 2013. *Alliance for Zero Extinction,* spatial data (http://www.zeroextinction.org/index.html).

156 IUCN, 2012, cited above.

157 Thanks to Samantha Vine at Birdlife Australia for this analysis.

158 UNEP-WCMC, 2013. *Centres of Plant Diversity*, Version 1.0 spatial data. (http://www.unep-wcmc.org/system/dataset_file_fields/files/000/000/072/original/Centres_of_plant_diversity_2013_metadata.pdf).

159 Dunlop M et al, 2012. *The implications of climate change for biodiversity conservation and the National Reserve System: final synthesis.* CSIRO Climate Adaptation Flagship, Canberra (http://www.csiro.au/~/media/CSIROau/Flagships/Climate%20Adaptation/NationalReserveSystem/National Reserve System_Report_2012.pdf).

160 Ibid.

THE AUSTRALIAN SHORT-BEAKED ECHIDNA © GLOBAL WARMING IMAGES / WWF-CANON

Reside et al, 2013,[161] mapped climatic refugia as the areas of greatest overlap of future and transitional distributions for 1700 vertebrate species. These mapped refugia are not well protected at present, with:

> "only 14 per cent of refugia identified by our analyses fall within the current protected areas. For better quality refugia — those ranked four and above — less than 1 per cent exist within protected areas. No area ranked with the highest refugia score fell within a protected area. Interestingly, only 17 per cent of the current protected areas have no refugia value."

The authors also found that the Einasleigh Highlands of northern Queensland, long-recognised as a high priority bioregion for ecosystem representation, had extensive areas of high estimated refuge value, with little protection.[162]

Maggini et al, 2013,[163] modelled range shifts for 504 nationally threatened species in response to different climate change scenarios. Like Dunlop et al, 2012, they found that the current National Reserve System overlapped future predicted habitats of these species in ~the same average proportions (21 per cent) as it overlapped the current habitats (19 per cent). They found that the highest priority areas for protection of future threatened species habitats are concentrated along the Great Dividing Range and eastern coastal strip of Australia, vindicating the focus of the Great Eastern Ranges Initiative (Figure 13).[164]

161 Reside AE et al, 2013. *Climate change refugia for terrestrial biodiversity: Defining areas that promote species persistence and ecosystem resilience in the face of global climate change,* National Climate Change Adaptation Research Facility, Gold Coast (http://www.nccarf.edu.au/publications/climate-change-refugia-terrestrial-biodiversity).

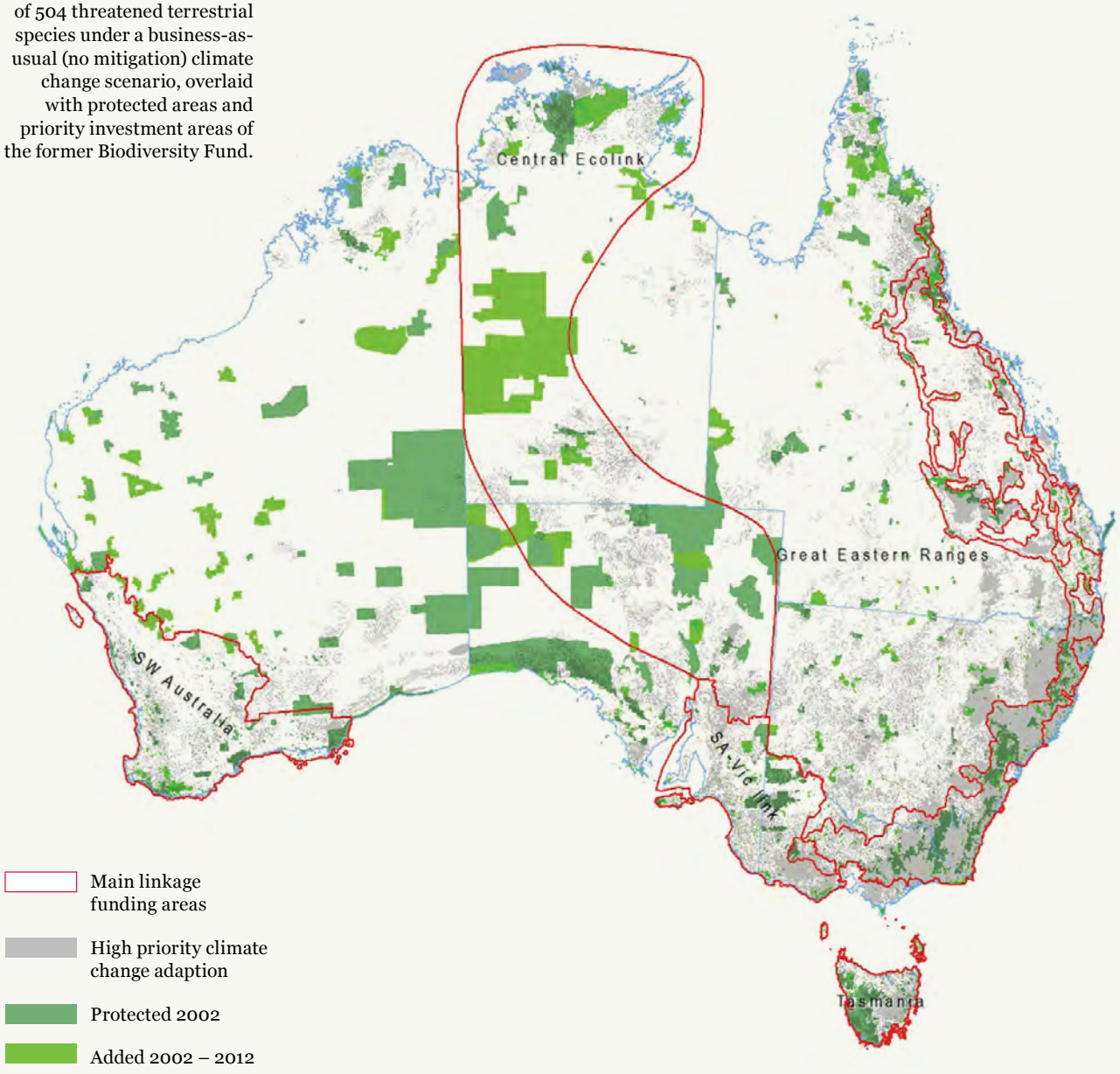
162 Fig. 32 in Reside et al, 2013, cited above.

163 Maggini R et al, 2013. *Protecting and restoring habitat to help Australia's threatened species adapt to climate change*, National Climate Change Adaptation Research Facility, Gold Coast (http://www.nccarf.edu.au/publications/habitat-australias-species-adapt-climate).

164 Great Eastern Ranges website (http://www.greateasternranges.org.au/).

FIGURE 10

High priority areas for climate change adaptation of 504 threatened terrestrial species under a business-as-usual (no mitigation) climate change scenario, overlaid with protected areas and priority investment areas of the former Biodiversity Fund.



Connectivity and integration

The National Reserve System Strategy 2009–2030 sets a target for "protecting critical sites for climate change resilience", in particular to:

> "Include critical areas to ensure the viability, resilience and integrity of ecosystem function in response to a changing climate, such as large and small refuges, critical habitats, broad landscape-scale corridors, places of species and ecosystem richness, sites of endemism and sites that support threatened species and/or ecological communities, and places important for the stages in the life cycle of migratory or nomadic species, to act as core lands of a broader whole of landscape approach to biodiversity conservation."

The whole of landscape approach requires changes outside of the National Reserve System, in the form of:

> "complementary land management practices, sustainable use and property planning on a whole of landscape basis to build ecosystem resilience and protect key biodiversity assets in the face of rapid change, especially climate change."[165]

Consistent with the National Strategy, Aichi Target 11 requires the National Reserve System to be "well-connected" and "integrated into the wider landscape and seascapes." However, no benchmarks or standards have yet been agreed for measuring progress on these elements of Aichi Target 11.[166]

Australia has seen rapid growth in the establishment of networks of lands managed for connectivity conservation across tenures, at landscape and sub-continental scales, and is now one of the leaders in this field. Such networks go under a variety of names, including biosphere reserves, biolinks, wildlife corridors and conservation management networks. Their establishment has varied from state government-led initiatives to those initiated by non-government organisations and interested landholders.[167]

In response to this growth, the Australian Government released a *National Wildlife Corridors Plan* in 2012.[168] This plan provides a framework for landscape scale conservation with a vision for "diverse, connected, and healthy landscapes that support and sustain biodiversity, communities and wellbeing". It aims to retain and restore ecological connections and emphasises a "new, collaborative, whole of landscape approach to biodiversity conservation".

The plan conceived the role of the Australian Government as to "enable and coordinate the efforts of all participants".[169] However, there were no dedicated budget funds to implement the plan and it has effectively become moribund as of 2014. This is unlikely to impact on existing connectivity initiatives as they were largely established with little to no Australian Government involvement. However, it should be noted that the National Reserve System Program had an important role in initiating a number of these connectivity initiatives with land acquisitions protecting stepping stones, or core areas, for later corridors to build around.[170]

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165 National Reserve System Task Group, 2009, cited above.

166 Woodley S et al 2012. Meeting Aichi target 11: what does success look like for protected area systems, *Parks* 18, 23–36.

167 Fitzsimons JA et al, 2013. Lessons from large-scale conservation networks in Australia, *Parks* 19, 115–125;
Fitzsimons JA et al (eds), 2013. *Linking Australia's Landscapes: Lessons and Opportunities from Large-scale Conservation Networks,* CSIRO Publishing, Melbourne.

168 Department of Sustainability, Environment, Water, Population and Communities, 2012b. *National Wildlife Corridors Plan: A framework for landscape-scale conservation,* Australian Government, Canberra.

169 Ibid.

170 Fitzsimons JA, Wescott G, 2005. History and attributes of selected Australian multi-tenure reserve networks, *Australian Geographer* 36, 75–93.

However, emphasis on connectivity can represent a trade-off with protection of core habitat to meet standards for inclusion of ecosystem and species diversity. Although corridors, particularly those needed to adapt to climate change, may reasonably be argued to be a type of core habitat, their protection does raise the size and cost of reserve design.

Here we present for the first time simple measures of connectivity and integration into the landscape for the terrestrial National Reserve System. These include a linkage distance measure and a measure of the mean species abundances in the linkages among protected areas as a function of land use. This provides some measure of the extent to which land uses in the linkages among protected areas are conducive to movement of natural wildlife populations (Methods in Appendix 3).[171]

We mapped minimum straight line linkages among all protected areas in 2002 and 2012 (Figure 11). We found that the median length of unprotected linkages between protected areas reduced by ~1 kilometre over the decade from 6.6 kilometres in 2002 to 5.5 kilometres in 2012 (Figure 12).

However, preliminary analysis suggests that mean species abundances estimated on the basis of mapped land uses under these straight line linkages, declined over the same period from 53 per cent to 40 per cent, due largely to a major shift downward in uncleared grazing land matched by a major increase in land converted to pastures (Figure 12). This preliminary result must be treated with caution, as existing land use mapping appears to be quite poor in regard to the distinction between cleared cropping, cleared pastures and uncleared grazing land.[172]

Despite a reduction in average distance between protected areas, land use has intensified in the areas between protected areas, indicating that landscape integration remains a major challenge for the future growth of the National Reserve System.

171 Soulé ME et al, 2004. The role of connectivity in Australian conservation, *Pacific Conservation Biology* 10, 266.

172 Taylor MFJ et al, 2014, cited above.

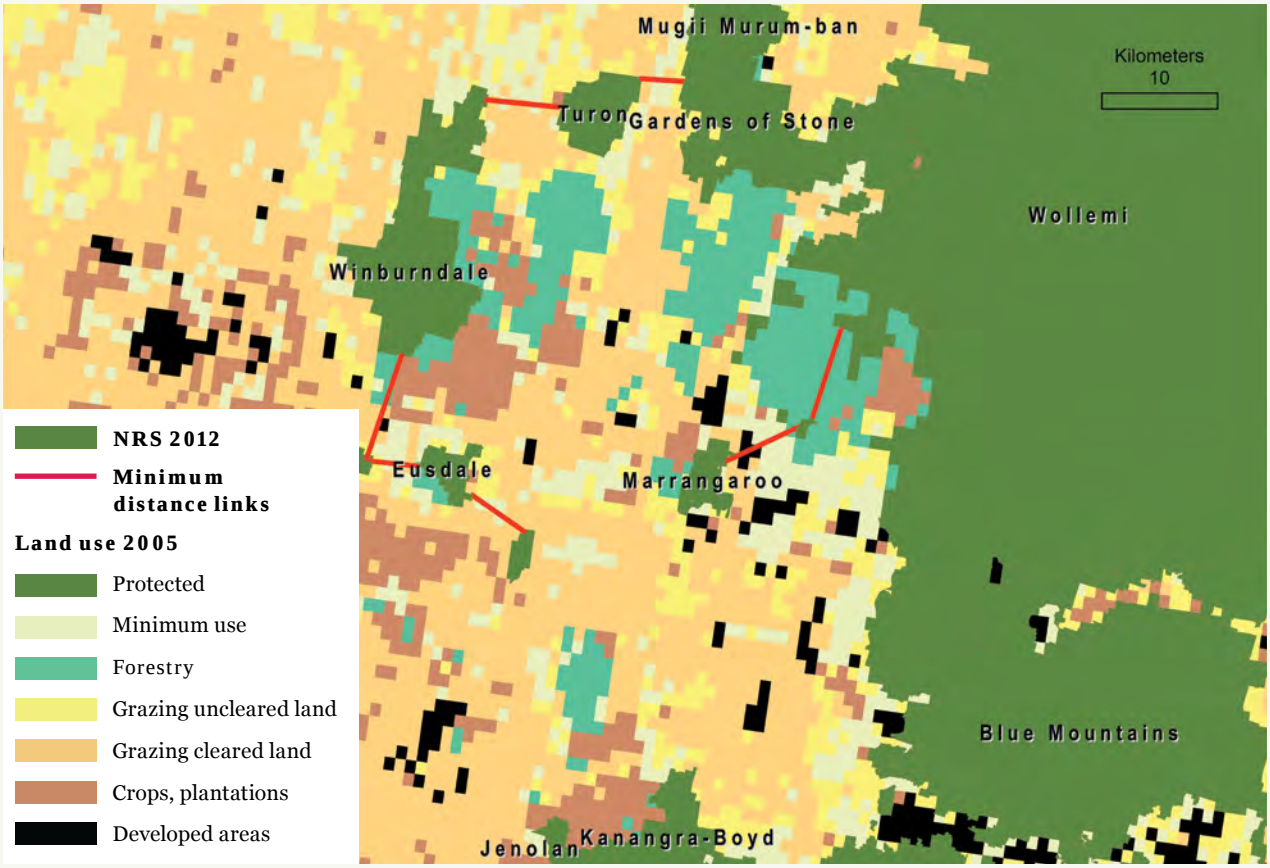

FIGURE 11

Example of mapping of minimum distance links among protected areas in 2012 overlaid on maps of land use.

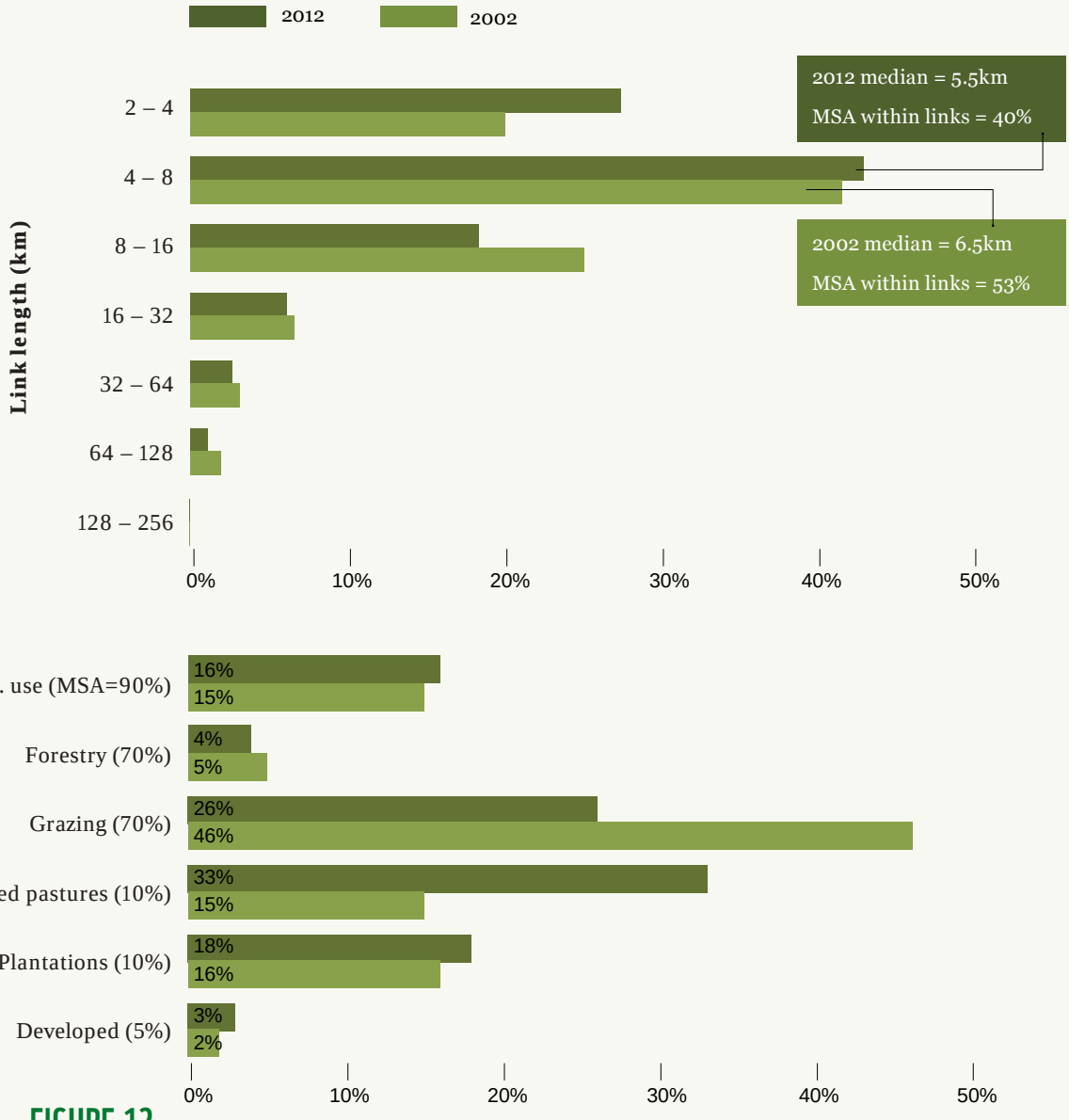

FIGURE 12

Top: Distributions of minimum neighbour linkages among terrestrial protected areas in 2002 and 2012, median linkage lengths and estimated mean species abundances along the links. Bottom: Distributions of land uses along the minimum neighbour linkages in 2002 and 2012.[173]

173 For methods, see Appendix 3.

Management performance

Aichi Target 11 requires that National Reserve System be "effectively and equitably managed." This relates to another commitment by CBD parties to "work towards assessing 60 per cent of the total area of protected areas by 2015 using various national and regional tools and report the results into the global database on management effectiveness maintained by the World Conservation Monitoring Centre of the United Nations Environment Programme (UNEP WCMC)".[174] However, no other guidance is given the extent to which protected areas may be considered to have attained an "effectively and equitably managed" standard by 2020.

Management planning and effectiveness monitoring vary widely. All Indigenous Protected Areas and lands purchased under the National Reserve System Program are required to develop management plans as a condition of funding.

However, jurisdictions vary widely in management planning requirements for government protected areas or private land conservation covenants. The existence of a management plan provides no assurance that management is effective and well integrated with landscape scale catchment plans, NRM strategic plans, bioregional plans and recovery plans for threatened species and communities.

Effectiveness of management is still poorly characterised for Australia. As in the 2011 *Building Nature's Safety Net* report, the definitive work is still the global analysis by Leverington et al, 2010, which found that outcome measures were mostly less than sound, with funding adequacy ranked next to last.[175]

The ultimate effectiveness of protected areas should be measured by retention or improvement of biodiversity condition, relative to trends in the wider landscape. Many studies have demonstrated effectiveness at a categorical level, albeit not at an individual protected area level (see *Conserving biodiversity*).

Equitability of management has grown considerably in Australia, especially for Indigenous communities. Indigenous Protected Areas or national parks with Indigenous co-management now represent 38 per cent of all protected areas and nearly 6 per cent by area of Australia's land area. Indigenous management and co-management also extends to marine protected areas. The Australian Government Indigenous Protected Areas Program has a specific funding stream to encourage co-management with Indigenous communities with a traditional connection to a national park.

These changes are mirrored in global protected area governance, which has also considerably diversified since 1990. Solely government-managed protected areas declined as a proportion from 96 per cent to 77 per cent from 1990 to 2010, while co-managed areas rose from 0.1 per cent to 13.5 per cent.[176]

The importance of equitability of management is underlined by studies showing that community natural resource management can be as effective as conventional government-run protected areas. However, the success of community natural resource management is highly variable and depends greatly on particular circumstances.[177]

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174 Conference of Parties to the Convention on Biological Diversity, 2010. *COP10 decision X31, webpage* (http://www.cbd.int/decision/cop/?id=12297).

175 Leverington F et al, 2010. A global analysis of protected area management effectiveness, *Environmental Management* 46, 685–698.

176 Fig. 5.2 from IUCN, 2012, cited above.

177 Porter-Bolland L et al, 2012. Community managed forests and forest protected areas: An assessment of their conservation effectiveness across the tropics, *Forest Ecology and Management* 268, 6–17;
McClanahan TR et al, 2006. A comparison of marine protected areas and alternative approaches to coral-reef management, *Current Biology* 16, 1408–1413;
Kellert et al, 2010. Community Natural Resource Management: Promise, Rhetoric, and Reality, *Society & Natural Resources: An International Journal* 13, 705–715.

Box 6. Bush Heritage Australia's management approach[178]

The world's leading conservation organisations, including The Nature Conservancy and WWF, collaborated to pool their experiences and develop a 'best practice' process for conservation projects called the *Open Standards for the Practice of Conservation* (Miradi). Bush Heritage formally adopted this process several years ago and has now fully integrated the Open Standards into its business processes.

A management plan is prepared, for each Bush Heritage reserve, which identifies habitats, plants and animals and sets conservation goals. Resources and practical actions needed to achieve these goals are identified and scheduled. All planning and budgeting information is stored in the Miradi database, allowing staff to link their annual budgets and workplans to longer term goals. Progress is reported monthly to allow clear assessment of whether planned works are on track.

Building on the regular information collected, Bush Heritage initiates a major review of each plan on a 5-year cycle to evaluate the impact of its activities on conservation goals. This disciplined process of planning and reflection means Bush Heritage can demonstrate where its work is making a difference and clearly decide where to focus time and money in the future.

Reserve effectiveness scorecards are then published online to share this information more widely with supporters.[179]

BANDED STILTS ON THE RICH WETLANDS OF NAREE NATURE RESERVE, A BUSH HERITAGE PROPERTY © PETER MORRIS

178 Thanks to Annette Stewart of Bush Heritage for this information.

179 Bush Heritage Australia, 2014. *Reserve scorecards*, webpage (http://www.bushheritage.org.au/what_we_do/conservation-science/reserve-scorecards).

A comprehensive, adequate and representative marine reserve system

Static ecosystem and species gap analyses, such as the foregoing for terrestrial protected areas, are only suitable when dealing with one kind of conservation feature with no overlaps. It cannot be used to estimate gaps with multiple overlapping conservation features and objectives. Static gap analysis gives indicative estimates only and cannot be used to identify which particular parcels should be selected to fill the identified gaps. Marxan is a simulation program specifically developed to find efficient spatially explicit solutions in such cases, while also taking into account costs of protection.[180]

In this report, we simulate a comprehensive, adequate and representative (CAR) marine national park system that meets the minimum standards for 2,420 marine ecosystems and 177 marine species of national environmental significance as for terrestrial ecosystems and species, of 15 per cent and 30 per cent respectively, with higher proportions for small areas.

For ecosystems, we used an updated version of the ecosystem map used in the 2011 *Building Nature's Safety Net* report. We also used 'known' and 'likely to occur' distributions for 177 marine species of national environmental significance (SNES), as mapped by the Australian Government. These include species not listed as threatened, such as Patagonian Toothfish or Blue Wharehou. It also includes many species which breed or forage on land: seabirds, penguins, marine turtles, sea snakes, seals and sea-lions.

We set, as an additional constraint, 17 per cent of each marine bioregion protected, equivalent to the terrestrial Aichi Target 11. We found a solution that minimises the costs of structural adjustment to fisheries, while excluding mining leases deemed too costly to buy out (Methods in Appendix 4).

In order to meet these standards, we estimate that another 15.8 per cent of Australian waters, ~137 million hectares, would need to be included in highly protected areas, in addition to the 13.4 per cent highly protected now (Figure 13, Figure 14). Of this, 4.4 per cent would involve upgrading marine park zones, where commercial resource use is still allowed, to become marine national parks or equivalent no-take zones. Commonwealth marine reserve zoning is presently under review and this presents an opportunity to expand highly protected areas strategically, and at minimum cost, to secure protection for all ecosystems and species to minimum standards.

The vast bulk of this change would involve Australian Government waters, while ~9 million hectares of state waters would need to be highly protected to meet the standard (Figure 13, Figure 14). Some caution is needed with the figures for state waters, because planning units were 100 km^2 and spanned across state waters into Commonwealth waters. Consequently, a planning unit may have been selected in state waters on the basis of species and ecosystems in Commonwealth waters. A finer scaled analysis for state waters may give quite different estimates of gap areas.

A CAR marine reserve system as modelled here would still leave over two thirds of Australia's marine jurisdiction open to commercial resource use outside of marine parks and reserves or in the multiple use zones of existing marine parks.

180 Thanks to Paul Gamblin, Joel Turner, Lucinda Douglass and Daniel Beaver for this analysis and commentary. The University of Queensland, 2008. *Marxan*, website (http://www.uq.edu.au/marxan/).

Based on Australian Government fisheries data, we estimate that implementing this CAR marine reserve system would require an additional $246.4 million (2012 currency value) in assistance to fisheries affected by the changes, an average of only $1.46 per hectare added.[181]

The standards could not be fully met for 48 marine ecosystems, as a result of locking existing mining or petroleum leases out of the solution. However, only 16 ecosystems were sampled below 98 per cent of the standard due to this constraint, and only five below 50 per cent. Connectivity was adjusted to a reasonable level that did not excessively inflate costs using standard methods (Appendix 4).

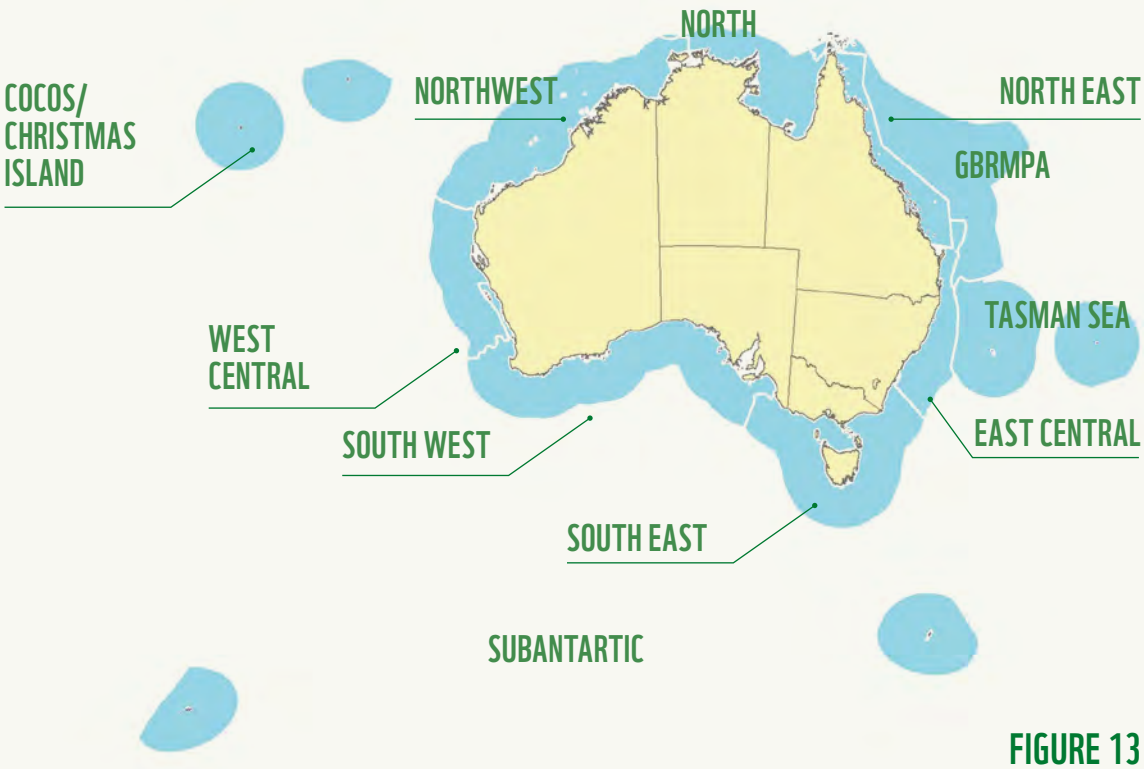


FIGURE 13

Proportions of Australian waters (right) changing status and total gap areas to be filled by major marine regions (inset above), to implement a comprehensive, adequate, representative marine reserve design at lowest fisheries adjustment cost.

HPA = marine national parks, no-take or green zones, OPA = other marine parks zones in IUCN IV–VI categories.

181 Actual figure is $182 million at the 2001 currency value. Using the Reserve Bank inflation calculator, this represents $246.4 at the 2012 currency value. Reserve Bank of Australia, 2014. *Inflation Calculator,* website (http://www.rba.gov.au/calculator/).

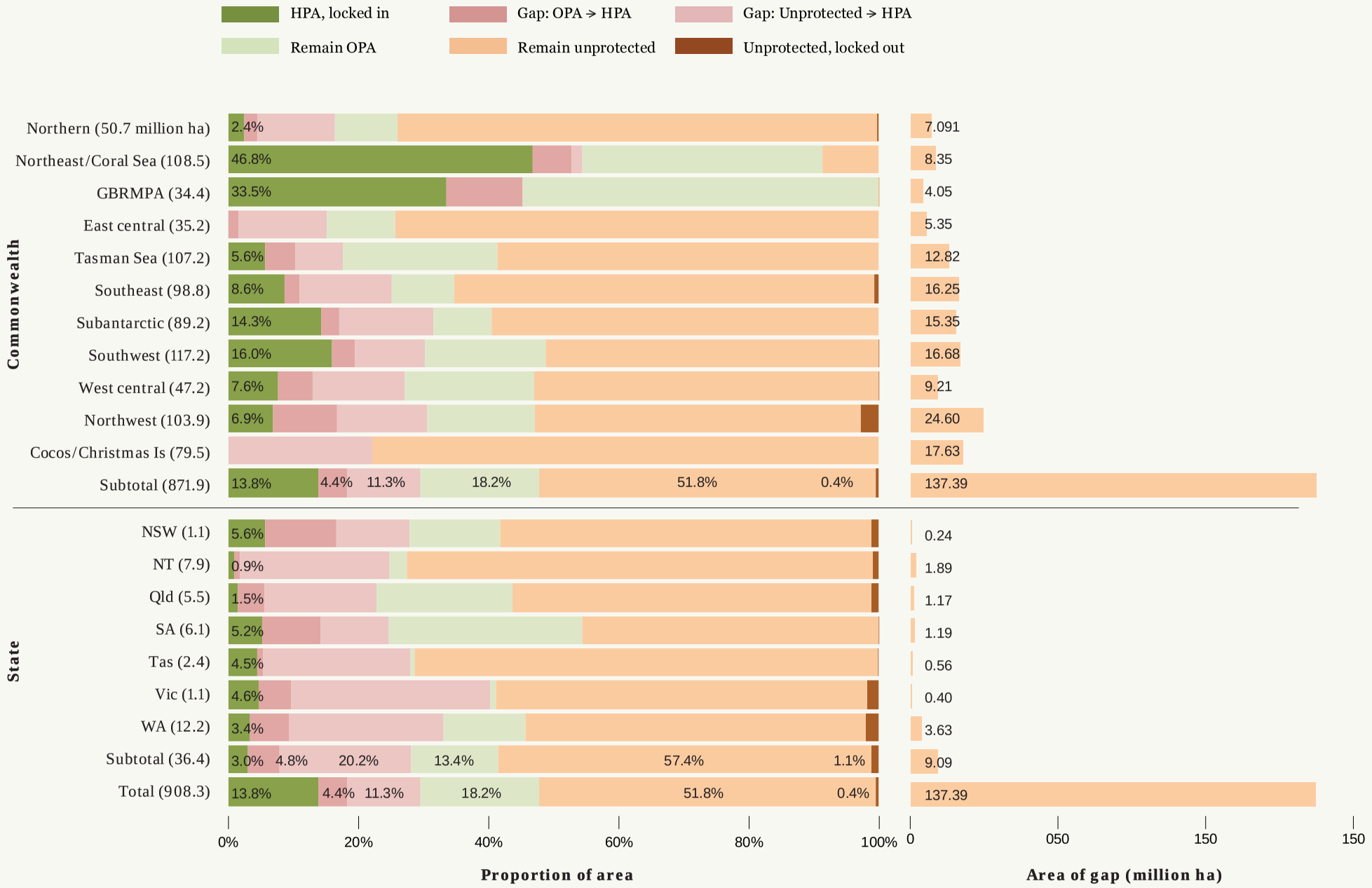
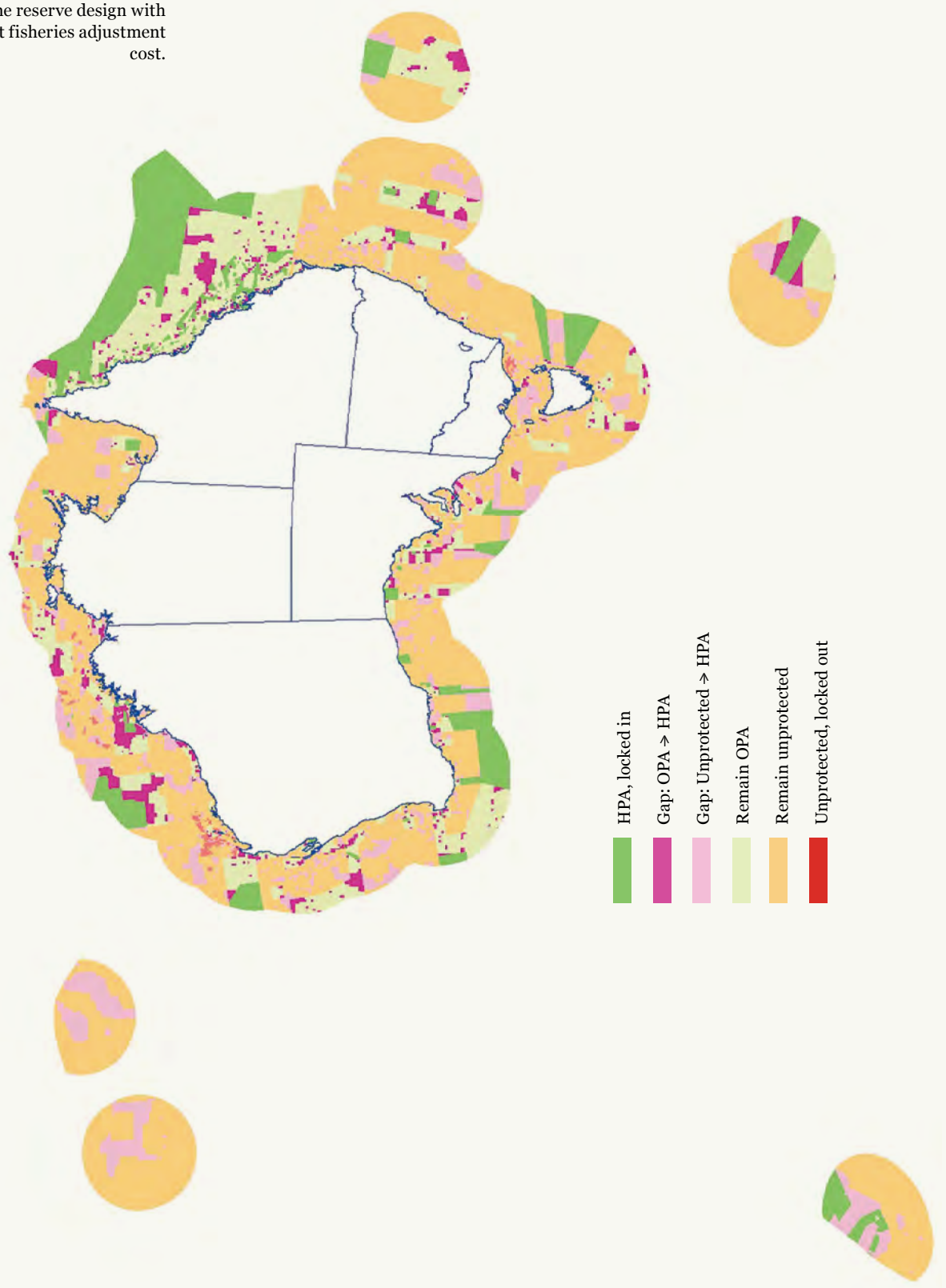

HPA, locked in
Gap: OPA → HPA
Gap: Unprotected → HPA
Remain OPA
Remain unprotected
Unprotected, locked out
Commonwealth
Northern (50.7 million ha)
Northeast/Coral Sea (108.5)
GBRMPA (34.4)
East central (35.2)
Tasman Sea (107.2)
Southeast (98.8)
Subantarctic (89.2)
Southwest (117.2)
West central (47.2)
Northwest (103.9)
Cocos/Christmas Is (79.5)
Subtotal (871.9)
2.4%
46.8%
33.5%
5.6%
8.6%
14.3%
16.0%
7.6%
6.9%
13.8% 4.4% 11.3% 18.2% 51.8% 0.4%
7.091
8.35
4.05
5.35
12.82
16.25
15.35
16.68
9.21
24.60
17.63
137.39
State
NSW (1.1)
NT (7.9)
Qld (5.5)
SA (6.1)
Tas (2.4)
Vic (1.1)
WA (12.2)
Subtotal (36.4)
Total (908.3)
5.6%
0.9%
1.5%
5.2%
4.5%
4.6%
3.4%
3.0% 4.8% 20.2% 13.4% 57.4% 1.1%
13.8% 4.4% 11.3% 18.2% 51.8% 0.4%
0.24
1.89
1.17
1.19
0.56
0.40
3.63
9.09
137.39
0%
20%
40%
60%
80%
100%
Proportion of area
0
050
150
150
Area of gap (million ha)

FIGURE 14

Map of a comprehensive, adequate, representative marine reserve design with lowest fisheries adjustment cost.



MEETING AICHI TARGET 11: OPTIONS AND FINANCING

- *If the 'comprehensiveness' and 'representativeness' targets in the agreed terrestrial National Reserve System Strategy were met by 2020, Australia would be likely to have met the 'ecologically representative' requirement of Aichi Target 11. This would require expanding the terrestrial reserve system by at least 25 million hectares. Considering that the terrestrial ecosystem protection gap has closed by 20 million hectares over the past decade, this required expansion would be feasible with a major boost in investment and focus on long-standing priorities.*
- *A realistic mix of purchases, Indigenous Protected Areas and private land covenants would require an Australian Government National Reserve System investment of ~$170 million per year over the five years to 2020, representing ~42 per cent of the $400 million per year which the Australian Government has budgeted for conservation over the next five years.*
- *State, territory and local governments, private and Indigenous partners would likewise need to boost financial commitments to both expand and maintain new protected areas to meet agreed National Reserve System strategic objectives.*
- *The total cost of Australia achieving a comprehensive, adequate and representative marine reserve system that would satisfy Aichi Target 11 is an estimated $247 million.*

Meeting Aichi Target 11: terrestrial

Australia made significant progress over the past decade in meeting the previous Global Plant Conservation Strategy target of 10 per cent of each terrestrial bioregion. The number of bioregions with 10 per cent or more of their area protected, rose from 37 to 52 of 85 (Figure 15).

Australia began the present decade in a good position with regard to the new Aichi Target 11, with 32 of 85 bioregions already at or over 17 per cent (Figure 16). Meeting Aichi Target 11 on land using the conventional test proposed by Woodley et al, 2012,[182] – bringing each bioregion to at least 17 per cent – would take an additional 50.3 million hectares of land protected and expand the National Reserve System to nearly 22 per cent of Australia's land area (Table 7).

However, meeting this test for Aichi Target 11 would not necessarily result in all ecosystems being protected in a balanced or adequate way (Table 7). Meeting the more rigorous CAR test – bringing each ecosystem to at least 15 per cent of area protected – would require 57.2 million hectares of land reserved (Table 7). Taking climate change, connectivity, threatened species and aquatic ecosystems into account would likely require larger areas again, although other research suggests that only 17.8 per cent of Australia would be required to bring all terrestrial threatened species up to a minimum standard of habitat protection.[183]

182 Woodley S et al, 2012, cited above.

183 Watson JEM et al, 2011.The capacity of Australia's protected area system to represent threatened species, *Conservation Biology* 25, 324–332.

Accepting that Aichi Target 11 is an interim target on the way to a fully CAR National Reserve System, we propose a more precise and efficient test for meeting Aichi Target 11, which would also attain the National Reserve System 2009 – 2030 Strategy targets for comprehensiveness and representativeness (see *Commitments, objectives and targets*). We propose that the National Reserve System may be considered to be ecologically representative for the purposes of Aichi Target 11 to the extent that the comprehensiveness and representativeness targets of the National Reserve System Strategy are also met (Test 2 in Table 7).

We determined, for each ecosystem, the area required to be protected so that all ecosystems are at least halfway toward meeting the 15 per cent ecosystem protection standard.[184] This would mean that 2,049 ecosystems under halfway to meeting the standard and 1,665 ecosystems lacking protection, as of 2012, would move into the category of those that are at least halfway to meeting the standard in Figure 7.

We then selected, within each IBRA bioregion, the top 80 per cent of ecosystems that had either already attained the target or, alternatively, had the poorest levels of protection. This rule was chosen to implement the National Reserve System Strategy 'comprehensiveness' target for bioregions, mentioned above, defining 'examples' in the National Reserve System Strategy to mean 'at least halfway toward the 15 per cent ecosystem protection standard'. We repeated this for subregions, selecting the top 80 per cent of ecosystems within each subregion that had either already attained the target or, alternatively, had the poorest levels of protection, and added these to those already selected at the bioregion level above. This additional rule was chosen to implement the National Reserve System Strategy 'representativeness' target for subregions mentioned above.

We found that this more fine-scaled test would require the addition of at least 24.8 million hectares of new protected areas from 2015–2020 to meet Aichi Target 11 and would bring the National Reserve System to at least 18.3 per cent of Australia's land area, compared with 50 million hectares required to bring all bioregions up to at least 17 per cent protected (Table 7). However, this is necessarily still a minimum figure, because, in adding new protected areas property by property, areas protected will contain portions of ecosystems already meeting the test criteria on the same property. It would be undesirable, unnecessarily costly and in most cases impractical, to protect only the subset of targeted ecosystems on properties being added to the National Reserve System.

Over the past decade, the terrestrial ecosystem representation gap has reduced by a remarkable 20 million hectares (from 77 to ~57 million hectares). Reaching Aichi Target 11, as proposed (Table 7), is therefore achievable with sufficient investment and a strong focus on advancing ecological representation.

If the gap were filled by land purchase alone, the Australian Government would need to invest over one billion dollars based on current average investment levels of $44.40 per hectare, or ~$220 million per year over the five years 2015–2020. This amount is similar to that recommended in the 2011 *Building Nature's Safety Net* report.[185]

184 With small area modifications such that at least 1000ha of the gap would be filled, if the gap is over 1000ha, and 100% of the gap to be filled if it is below 1000ha.

185 In the 2011 *Building Nature's Safety Net* report, we called on the Australian Government to meet long-standing commitments to an ecologically representative National Reserve System by increasing the "National Reserve System purchase grants program commitment to $240 million per year for the decade 2011–2020, allowing grants for up to 75% of total cost of acquisition of new highly protected areas."

THE MISTY MOUNTAINS, SOUTH JOHNSTON FORESTRY CAMP, QUEENSLAND © GEORGE GORNACZ

However, a more realistic approach requires a mix of purchases, Indigenous Protected Areas and private land covenants. The example offered here, to estimate the scale of the investment required, comprises: 12 million hectares of the gap filled via purchase at $44.40 per hectare; another 10 million hectares filled via new Indigenous Protected Areas, at an average of $25.77 per hectare and the remaining three million hectares filled via new covenants at a nominal $20 per hectare, in the form of incentives offered by the Australian Government [186] (see Table 4, in *Protected Area Financing*). We believe this is highly feasible and also approximates patterns of recent growth of the reserve system.

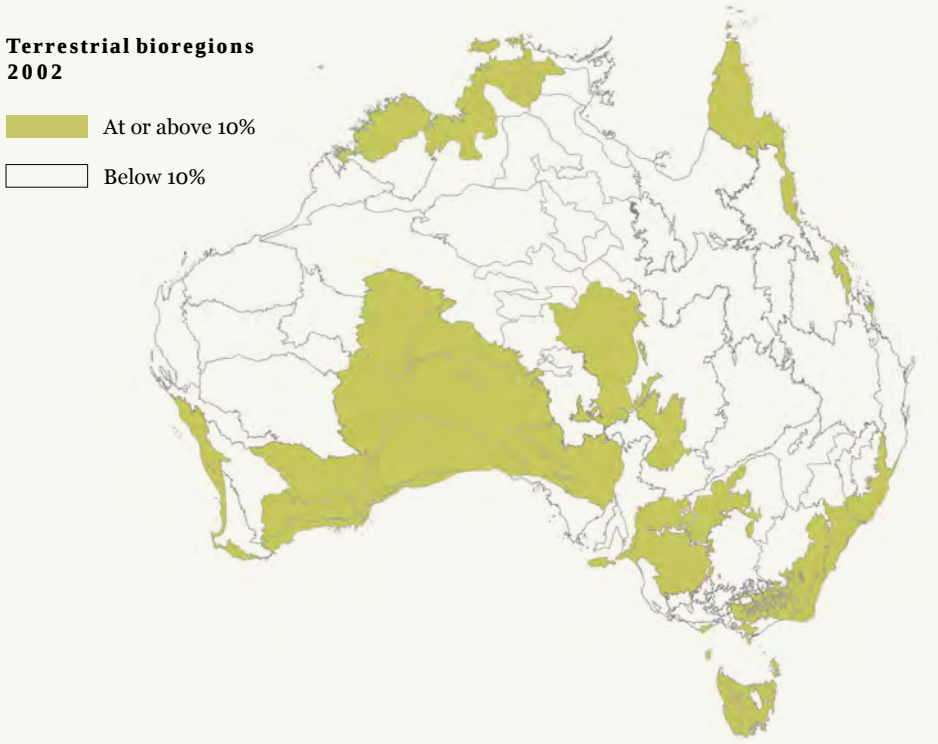
This example, if implemented, would require an Australian Government National Reserve System program investment of ~$170 million per year, over the five years to 2020, to achieve an ecologically representative reserve system covering at least 17 per cent of Australia that meets both Aichi Target 11 and the National Reserve System Strategy comprehensiveness and representativeness targets according to Test 2 in Table 7.

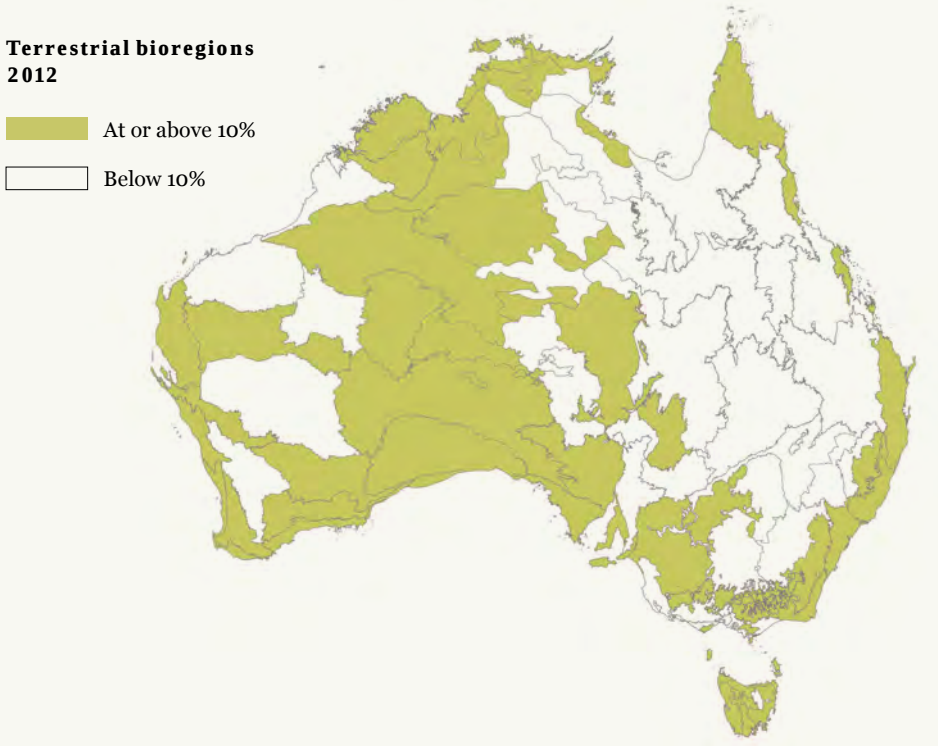
186 Currently, investment in covenants is almost entirely by states at the overall average of approximately $73/ha including in perpetuity management (Table 4). We propose the National Reserve System program directly invest an average of $20 per hectare to directly incentivise covenant uptake. Covenant investments should clearly be less costly per hectare on average than land purchase.

FIGURE 15

Terrestrial bioregions with 10 per cent by area in the National Reserve System in 2002 (top) and 2012 (bottom).

These maps are relevant to Australia's progress toward the 2000–2010 targets adopted under the Convention on Biological Diversity Global Plant Biodiversity Strategy, which state that by 2010 "at least 10 per cent of each of the world's ecological regions effectively [is] conserved". [187]



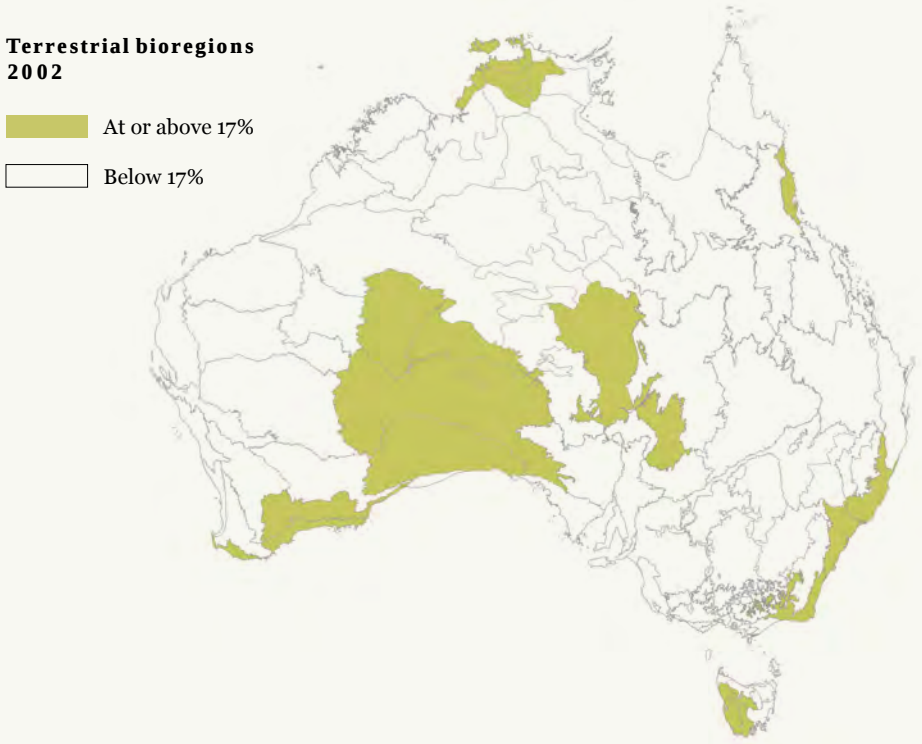


187 CBD COP 6 Decision VI/9 (http://www.cbd.int/decision/cop/default.shtml?id=7183). Other targets adopted were:
"(v) Protection of 50 per cent of the most important areas for plant diversity assured;
(vi) At least 30 per cent of production lands managed consistent with the conservation of plant diversity;
(vii) 60 per cent of the world's threatened species conserved in situ;
(viii) 60 per cent of threatened plant species in accessible ex situ collections, preferably in the country of origin, and 10 per cent of them included in recovery and restoration programmes;
(ix) 70 per cent of the genetic diversity of crops and other major socio-economically valuable plant species conserved, and associated indigenous and local knowledge maintained;
(x) Management plans in place for at least 100 major alien species that threaten plants, plant communities and associated habitats and ecosystems;"

FIGURE 16

Terrestrial bioregions with 17% by area in the National Reserve System in 2002 and in 2012.

These maps are relevant to attainment of Aichi Target 11, which recommends 17% of lands and inland waters be included in an ecologically representative protected area system by 2020.



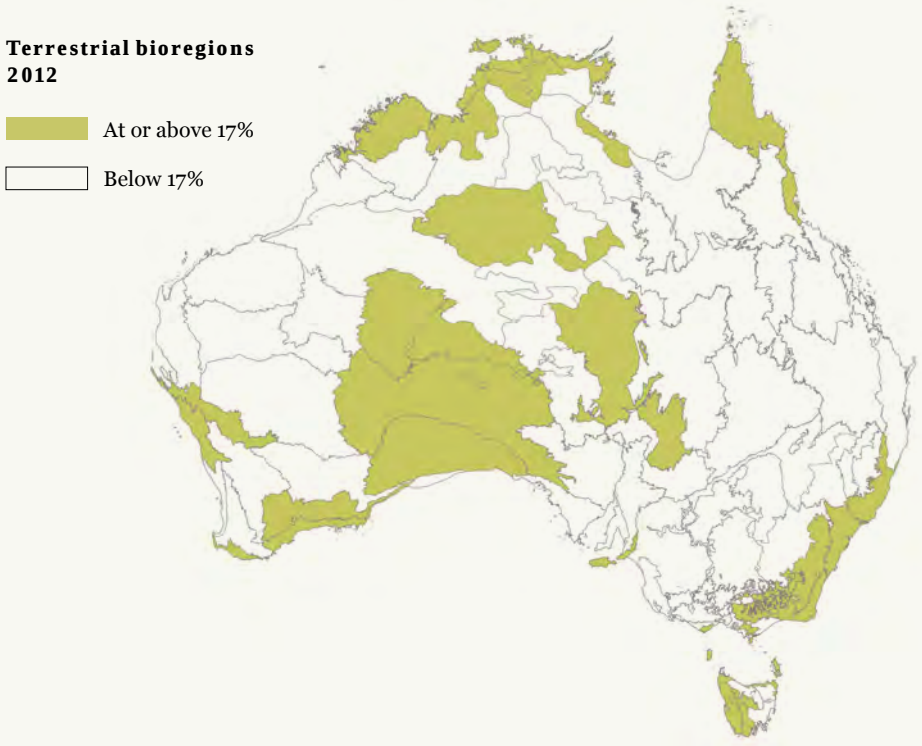


Table 7. Shortfalls or gaps relative to targets and goals for the terrestrial National Reserve System.

Target/Goal	Test	Area required to meet test in 2012 (gap area)	Total land area protected if gap filled by 2020 (%)	Outcome of test
Aichi Target 11	1. Each terrestrial bioregion at least 17% protected [188]	50.3 million ha	21.9%	Will result in poor or unbalanced representation of actual ecosystems
	2. 80% of ecosystems in each bioregion and each subregion at least halfway to 15% standard (3 below), but none below 1000 ha protected [189]	24.8 million ha	18.3%	Achieving representation for every ecosystem will require more than this minimum area, because properties inevitably contain other ecosystems already at or over their target. Also, this test does not include threatened species and connectivity considerations
A Comprehensive, Adequate, Representative National Reserve System	3. Each terrestrial ecosystem at least 15% protected, with small area modifications [190]	57.2 million ha [191]	22.8%	Same as Test 2, above

Meeting Aichi Target 11: marine and coastal

Australia's marine reserve system, in the early years of the Aichi Target decade 2011–2020, is already in a very good position with regard to the new Aichi Target 11, with 35 of 41 marine provincial bioregions already at or over 10 per cent (Figure 17). Using the conventional test to meet Aichi Target 11 would take an additional 9.6 million hectares of new marine parks, bringing the marine reserve system on all jurisdictions to 38 per cent of Australian waters (Table 8).

However, meeting this test for Aichi Target 11 would not necessarily result in all ecosystems and species protected in a balanced and adequate way.

Australia's dramatic progress in expanding marine reserves is a result of the low cost due to the comparatively minor issues of competing extractive or consumptive interests which must be settled to allow protection to proceed, and the fact that there is no change of tenure required, as there is on land. Declaration of marine reserves is largely a government planning exercise.

188 This is the test applied in the IUCN *Protected Planet Report* and Woodley et al, 2012, cited above.

189 Unless total extent is below 1000 hectares. This test is designed to also meet National Reserve Strategy 2015 and 2025 targets for comprehensiveness and representativeness, defining an 'example' as at least halfway toward the CAR standard on the next line.

190 With modifications for small ecosystems: If 15% of ecosystem original extent is below 1000 ha, then at least 1000 hectares protected. If original extent is below 1000 ha, then 100% protected.

191 From Figure 7.

AURORA AUSTRALIS, MACQUARIE IS © ALEKS TERAUDS

Accordingly, Australian governments can feasibly achieve Aichi Target 11 by meeting the higher test of a comprehensive, adequate and representative marine National Reserve System, as modelled above (Figure 13, Figure 14). This would add ~97 million hectares of new marine parks. It would also entail upgrading of management categories within marine parks. Marine parks and reserves would then make up almost half of all Australian waters, leaving two thirds of Australian waters open to regulated fishing access both inside and outside of the marine parks (Table 8).

Filling this ecosystem and species gaps on sea is estimated to require investment of $247 million in the form of assistance to affected fisheries (see *A comprehensive, adequate and representative marine reserve system*).

FIGURE 17

Marine provincial bioregions with 10% or more of area in marine parks or reserves in 2002 (top) and 2012 (bottom).

These maps are relevant to attainment of Aichi Target 11, which recommends 10% of marine and coastal areas be included in an ecologically representative protected area system by 2020. Note that Heard and Macdonald Islands are not included in IMCRA bioregional maps, but are included in the Marxan analysis above in Figure 13 and Figure 14.

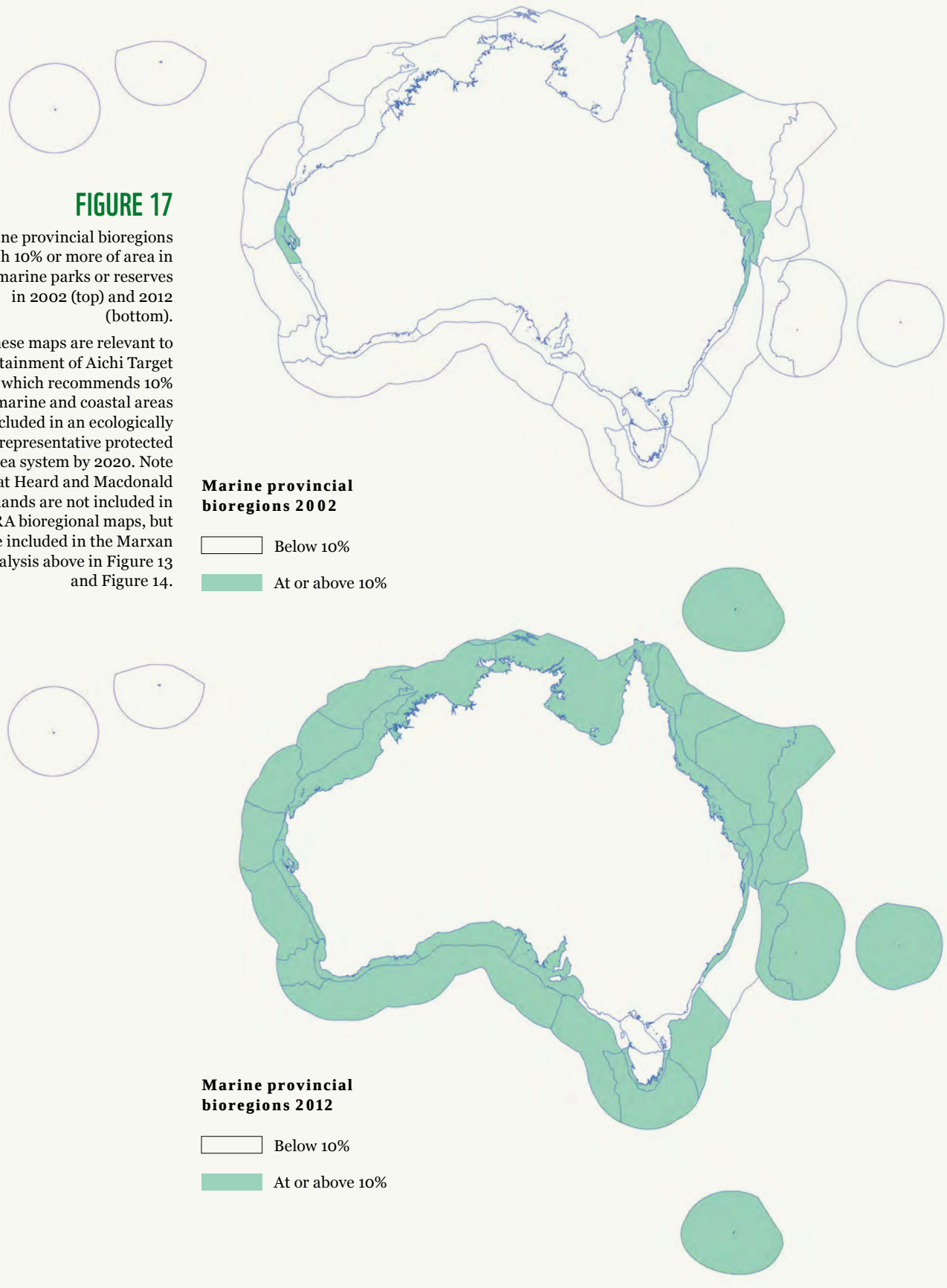


Table 8. Shortfalls or gaps relative to targets and goals for the marine National Reserve System.

Target/Goal	Test	Area required to meet test in 2012 (gap area)	Total area in marine parks if gap filled (% of Australian waters)	Outcome of test
Aichi Target 11	1. Each marine provincial bioregion at least 10% protected[192]	9.6 million ha	38%	Will result in poor and/or uneven representation of actual ecosystems
A Comprehensive, Adequate, Representative Marine Reserve System	2. Each marine ecosystem at least 15% highly protected, and habitats of each nationally significant species at least 30% highly protected, with small area modifications[193]	98.6 million ha[194]	48%	May meet 'well connected' requirement, depending on design

192 See Figure 17 for those bioregions below 10%. This is the test applied in the IUCN *Protected Planet 2012* report and Woodley et al, 2012, cited above.

193 If 15% of ecosystem original extent is below 1000 ha, then at least 1000 ha protected. If original extent is below 1000 ha, then 100% protected. If, for species, 30% of habitat is over 10 million hectares, then 10 million ha maximum protected. Only highly protected areas in IUCN I–III classes are counted toward meeting the standard.

194 The component of moving unprotected waters into highly protected areas, from Figure 13.

EUCALYPTUS FOREST, NSW © MICHÈLE DÉPRAZ / WWF-CANON

PART II: JURISDICTIONAL PROFILES

AUSTRALIAN CAPITAL TERRITORY

The Australian Capital Territory's reserve is regarded as well advanced, with extensive highly protected areas such as Namadgi National Park.

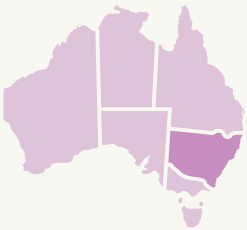
The chief remaining priority ecosystem for protection is the critically endangered Yellow Box-Red Gum grassy woodland.

Additions to the parks estate occur incrementally through development planning decisions and offsets. For example, a recent box gum woodland was added in the Molonglo Valley.[195]

The ACT invests heavily in parks management, although figures may be lower in practice for nature reserves due to the inclusion of urban parks in the parks management system (Appendix 2).

195 ACT Government, 2014. *Namadgi National Park*, webpage (http://www.tams.act.gov.au/parks-recreation/parks_and_reserves/namadgi_national_park); Australian Government Department of Environment, 2014h. *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland*, webpage (http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=43); ACT Planning and Land Authority, 2011. *Molongo Valley plan for the protection of matters of national environmental significance (NES PLAN)*, ACT Government, Canberra (http://www.environment.act.gov.au/__data/assets/pdf_file/0007/600964/NES_Plan.pdf).

NEW SOUTH WALES



New South Wales has made a strong contribution to growth of the National Reserve System. Its highly protected areas expanded from 6.6 per cent of the state in 2002 to 9.2 per cent in 2012 on land, and from 2.5 per cent to 8.8 per cent on sea. One-third of New South Wales waters are in marine parks (Table 6). Recently, changes have been introduced for marine parks with management of all the state's waters vested in a Marine Estate Management Authority. Some marine parks are under review on a pilot basis following a 2012 audit of the marine parks system. It is expected that this process, if based on best available science, will recommend retention and expansion of marine highly protected areas or no-take zones.[196]

New South Wales is a high priority state for strategic growth of the National Reserve System and for meeting Aichi Target 11 on land (Figure 2, Figure 6, Figure 9). New South Wales made best use of the 2008 boost in National Reserve System program grants, successfully securing nearly $47 million in Australian Government assistance to buy 17 new properties for protection. New South Wales also has a program of additions of suitable state land to the parks estate, as well as funding and programs that also increase biodiversity protection such as through Biobanking and Property Vegetation Plans under the *Native Vegetation Act*.[197]

$47M SECURED TO BUY 17 NEW PROPERTIES FOR PROTECTION SINCE 2008

Despite the demise of the National Reserve System grants program in 2013, New South Wales has continued its commitment to strategic growth of the National Reserve System through both government and private enterprise. The most recent addition, at time of writing, was the 12,298-hectare Warrambool State Conservation Area, which was added in August 2013 in the high priority Darling Riverine Plains bioregion.[198]

New South Wales recognises the critical importance of protected areas to threatened species recovery. For example, the state announced feral pest exclusion fencing on selected national parks to secure reintroductions of state extinct species as part of a new Saving our Species initiative.[199] New South Wales has among the highest proportions of threatened species protected to minimum standard on land, of 45 per cent, up from 36 per cent in 2002 (Figure 9).

Significant gaps exist for ecosystem protection of over five million hectares, on land (Figure 6); in the marine realm, we estimate it will take ~242,000 hectares of new marine highly protected areas to meet standards proposed here for a comprehensive, adequate and representative marine reserve system (Figure 13).

196 NSW Government, 2014b. *Marine Protected Areas*, webpage (http://www.marine.nsw.gov.au/nsw-marine-estate/marine-protected-areas);
NSW Government, 2014c. *Marine Estate Management Authority*, webpage (http://www.marine.nsw.gov.au/advisory-bodies/marine-estate-management-authority);
Beeton RJS et al, 2012. *Report of the independent scientific audit of marine parks in New South Wales*, NSW Department of Primary Industries and Office of Environment and Heritage, NSW, pp 1–124 (http://www.marineparksaudit.nsw.gov.au/imagesDB/wysiwyg/MPksAuditReport_2012_web_witherratum.pdf).

197 Taylor, MJF, Dickman CR, 2014. *NSW Native Vegetation Act saves Australian wildlife*, WWF-Australia, Sydney (http://www.wwf.org.au/news_resources/resource_library/?9540/NSW-native-vegetation-act-saves-Australian-wildlife).

198 NSW Government Office of Environment and Heritage, 2014a. *Warrambool State Conservation Area*, webpage (http://www.environment.nsw.gov.au/NationalParks/parkHome.aspx?id=N1190).

199 Parker R, 2014. *Extinct mammals to return to NSW national parks,* NSW Minister for the Environment media release, 13/4/2014 (http://www.environment.nsw.gov.au/resources/MinMedia/MinMedia14041301.pdf);
NSW Government Office of Environment and Heritage, 2014b. *Saving our species*, webpage (http://www.environment.nsw.gov.au/savingourspecies/about.htm).

Significant recent additions to the National Reserve System

Toorale National Park and State Conservation Area

The addition of the 85,000-hectare Toorale Station was a landmark collaboration between the New South Wales Government, the Australian Government National Reserve System program and the National Water Initiative, which helped secure the water rights.[200]

Toorale represents the most significant advance of National Reserve System principles in the past five years in New South Wales. Toorale protects extensive floodplains along the Darling River that are important stopping points for migratory wading birds. Toorale stretches across three previously poorly protected bioregions: the Darling Riverine Plains, Cobar Peneplain and the Mulga Lands. Ten land systems captured in Toorale had no previous representation in the National Reserve System. Toorale conserves the nationally threatened Coolibah–Black Box Woodlands ecological community. Toorale also protects the state endangered aquatic ecological community of the lower Darling River. [201]

Toorale harbours 284 native plants and 216 native animals including 162 bird species and mammals, such as the Major Mitchell's Cockatoo (vulnerable in New South Wales). [202]

The parks service has developed a plan to guide regional tourism for Toorale National Park and neighbouring Gundabooka State Conservation Area. [203]

MAJOR MITCHELL'S COCKATOO (LOPHOCHROA LEADBEATERI), LISTED AS THREATENED IN NSW © MOLLY GRACE PHOTOGRAPHY

200 NSW Government Office of Environment and Heritage, 2014c. *Toorale National Park*, webpage (http://www.nationalparks.nsw.gov.au/toorale-national-park-and-state-conservation-area)

201 Australian Government Department of Environment, 2014j. *Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions*, webpage (http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=66).

202 NSW Government Office of Environment and Heritage, 2014d. *Major Mitchell's Cockatoo – profile,* webpage (http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10116); http://www.mollygraceimages.com/index.html (photo).

203 National Parks and Wildlife Service, 2012. *Toorale and Gundabooka Nature Tourism Action Plan*, NSW Government, Sydney (http://www.environment.nsw.gov.au/resources/parks/tourism/120271tooralentaP.pdf).

Box 7. New South Wales parks establishment plan

New South Wales is home to Australia's first national park, the 16,000-hectare coastal Royal National Park declared in 1879.[204]

New South Wales has also been a national leader in developing a comprehensive and transparent National Parks Establishment Plan and forward strategy with community consultation in 2008.[205]

The plan formalises the state commitment to building a fully comprehensive, adequate and representative public reserve system that provides the community with opportunities to experience nature-based recreation in a diverse range of environments across New South Wales.

The Plan identifies priorities for building the terrestrial reserve system in each biogeographic region of New South Wales over 10 years (2008–2018).

The following priorities are identified:

- targeting as yet unprotected environments, with the establishment of new reserves in many parts of far western and central western New South Wales, where reservation currently protects less than 5 per cent of the landscape
- creating more robust and viable reserves through a building-up of existing reserves on the western slopes and tablelands, and
- improving boundary related management efficiencies through the fine-tuning of reserve boundaries along the coast and coastal ranges, where nearly 30 per cent of the landscape is presently protected.

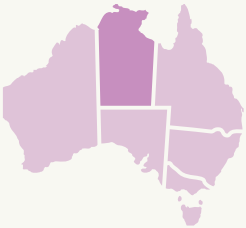
204 NSW National Parks and Wildlife Service, 2014. *Royal National Park*, webpage (http://www.nationalparks.nsw.gov.au/royal-national-park).

205 NSW National Parks and Wildlife Service, 2012. *National Parks Establishment Plan*, webpage (http://www.environment.nsw.gov.au/protectedareas/npestabplan.htm).

BUTTERFLY FALLS IN THE WET, LIMMEN NATIONAL PARK © JACO VENTER

NORTHERN TERRITORY

The proportion of land under protected areas in the Northern Territory has increased fivefold, from 3.7 per cent in 2002 to 18.4 per cent in 2012, mostly due to the growth of Indigenous Protected Areas under the Australian Government program.



One important Northern Territory Government addition was the declaration of Limmen National Park in 2012, profiled below.

Despite being home to some large, high-profile parks, such as Ulu□u-Kata Tju□a and Kakadu, Gregory and Litchfield National Parks, the Northern Territory has a surprisingly low proportion of land under highly protected areas as percentage of land area, while marine parks are in early stages of development. Important decisions, such as the recent declaration of Limmen Bight Marine Park, are very welcome signs of progress (Table 6).

Evidence of declines in the population of small- to medium-sized mammals in Northern Territory parks, including the Australian Government-managed Kakadu National Park, is of continual concern. Nevertheless, other evidence shows that national parks still provide the best tenure option for biodiversity conservation.[206] The downward mammal trend indicates a need for redoubled efforts to identify and apply appropriate park management, including more effective pest, weed and fire control.

In 2009, the Northern Territory Government unveiled a proposal to focus effort into linking existing protected areas –stretching from Arnhem Land to Ulu□u-Kata Tju□a National Park, running down the western side of the Territory. Together with the South Australian Nature Links program, this forms a Central or Trans-Australia Eco-link project (Figure 10).[207] From 2008 to 2012, when the Eco-link project ended, we estimate an increase of 13.8 million hectares of new protected areas in the Eco-link footprint – 92 per cent of which was due to declarations of new Indigenous Protected Areas, 2 per cent to private protected areas, and 6 per cent due to the declaration of Limmen National Park.

The Northern Territory has high levels of Indigenous, joint and privately governed protected areas, with 16.5 per cent of state area in these governance classes. Unlike other jurisdictions, marine protected areas are nearly all Indigenous or jointly managed, representing 5 per cent of territory waters.

Of threatened species, 47 per cent (25) meet the minimum standard of protection, on land, up from 30 per cent in 2002, while 11 species (20 per cent) have no representation in protected areas (Figure 9).

Terrestrial ecosystem protection has increased from 29 per cent to 60 per cent over the past decade, leaving a gap of ~11 million hectares, on land (Figure 6). We estimate ~1.9 million hectares of new marine highly protected areas would be needed to meet standards proposed here for a comprehensive, adequate and representative marine reserve system (Figure 13).

NORTHERN TERRITORY CAMPING OUT © JACO VENTER

206 Woinarski JC et al, 2011. The disappearing mammal fauna of northern Australia: context, cause, and response, *Conservation Letters* 4, 192–201; Woinarski JC et al, 2013.cited above.

207 Bridges A, 2012. Territory Eco-link: large framework, small budget, in Figgis P et al (eds), *Innovation for 21st Century Conservation.* Australian Committee for IUCN, Sydney, Australia, Ch 10 (http://www.nature.org/cs/groups/webcontent/@web/@australia/documents/document/prd_062376.pdf).

BARRANYI NORTH ISLAND © JACO VENTER

Significant recent additions to the National Reserve System

Limmen National Park and Limmen Bight Marine Park

With a vast, remote and rugged landscape, this 960,846-hectare national park, declared in 2012, lies in the heart of northern Australia's tropical savannah country.

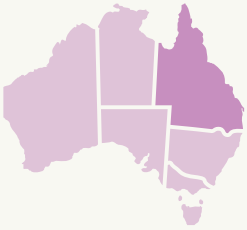
The park is the principal protected area within two bioregions – protecting ~10.6 per cent of the Gulf Coast and 5.9 per cent of the Gulf Fall and Uplands bioregions. The Limmen Bight and associated floodplains represent one of 67 sites of particular importance for biodiversity in the Territory. Some 365 vertebrate species and 1,430 plant species have been recorded there.[208]

The park, on land, is partnered offshore by the new Limmen Bight Marine Park.[209] This new marine park protects 88,400 hectares of relatively pristine and diverse marine habitats, including extensive seagrass beds or meadows. Seagrass beds are important for maintaining marine turtles, threatened pipefish and dugongs. The park protects important safe havens for commercially harvested prawn, mud crab and barramundi.

208 Northern Territory Parks and Wildlife Commission, 2012a. *Limmen National Park*, webpage (http://www.parksandwildlife.nt.gov.au/__data/assets/pdf_file/0019/125542/Information-on-Llimmen-National-Park-.pdf).

209 Northern Territory Parks and Wildlife Commission, 2012b. *Limmen Bight Marine Park*, webpage (http://www.parksandwildlife.nt.gov.au/__data/assets/pdf_file/0007/125548/LB-Marine-Park_PRINT.pdf).

QUEENSLAND



Queensland is the top priority state for strategic growth of the National Reserve System on land (Figure 2, Figure 6, Figure 9).

Queensland secured nearly $22 million in Australian Government assistance for purchasing 12 new properties to become national parks since 2008. Local governments and Indigenous proponents in Queensland were also successful in securing nearly $10 million in grants, bringing highly protected areas up from 3.9 per cent of the state in 2002 to 5.2 per cent in 2012. Over 3.5 million hectares of Queensland (2 per cent) are under private governance through the Nature Refuge program (Table 6).

New national parks bring added tourism value to a state with over $4 billion a year in tourism spending by visitors to national parks.[210] New protected areas can also benefit the Great Barrier Reef by conserving soil and preventing sediment pollution in the catchments (Box 2) as well as providing other ecosystem services.

Despite the cessation of the Australian Government National Reserve System grants program in 2012, Queensland has maintained a funding commitment to strategic protected area growth, through purchases of properties, including for koala reserves, and private land covenants, termed Nature Refuges. In the 2014–15 budget, the state government allocated $16.6 million for land acquisition.[211] Queensland continues a long history of steady progress in developing an ecologically representative reserve system that stretches over the nearly four decades since the Parks Service was founded (Box 8).

Queensland has been relatively well served for marine protection, primarily due to the Great Barrier Reef Marine Park, as well as the Great Sandy and Moreton Bay Marine Parks. Although the Great Barrier Reef Marine Park is highly protected over a third of its extent, it remains under serious threat due to climate change, industrial activities and shore-based farm pollution. There is an ongoing joint state and federal program to reduce these threats.[212]

Attainment of the protection standard for threatened species has doubled over the last decade, from 20 per cent (79 species) in 2002 to 42 per cent (adding another 87 species) in 2012, the most dramatic growth in threatened species protection in Australia (Figure 9).

Ecosystem protection has also grown, from 17 per cent in 2002 to 28 per cent in 2012, while the gap in protection has correspondingly fallen from over 20 million hectares in 2002 to 17.8 million hectares in 2012 (Figure 6).

In the marine realm, we estimate it will take an additional 1.2 million hectares of new marine highly protected areas to meet standards proposed here for a comprehensive, adequate and representative marine reserve system (Figure 13).

210 Ballantyne R et al, 2008, cited above.

211 Queensland Government, 2014. *Service Delivery Statements: Department of Environment and Heritage Protection, State Budget Papers 2014–2015*, Queensland Government, Brisbane (http://www.budget.qld.gov.au/budget-papers/2014-15/bp5-ehp-2014-15.pdf).

212 Great Barrier Reef Marine Park Authority, 2014. *Great Barrier reef Outlook Report,* Australian Government, Canberra (http://www.gbrmpa.gov.au/outlook-for-the-reef/great-barrier-reef-outlook-report);
Queensland Government, 2014. *Reef Water Quality Protection Plan*, Queensland Government, Brisbane (http://www.reefplan.qld.gov.au/).

THE CURTIS ISLAND COAST LOOKING INTO THE GREAT BARRIER REEF MARINE PARK © QUEENSLAND PARKS AND WILDLIFE SERVICE

Most significant additions to the National Reserve System

Curtis Island National Park expansion

In 2013 and 2014, there were significant additions to Curtis Island National Park. Curtis Island is one of the largest barrier islands in Queensland and home to large areas of marine plain habitats, including that of the critically endangered Dawson Yellow Chat among other unique species (Box 1).

As an offset for a Liquefied Natural Gas (LNG) industrial site on the southwest corner of the island, facing Gladstone Harbour, 2,900 hectares of new national and regional parks were added in 2013. In 2014, a larger offset package was announced that included:

- the purchase of a 3,562-hectare grazing inholding sandwiched between regional parks and state forests;
- 8,700 hectares of new conservation park or national park;
- upgrading of existing regional parks to national park;
- removal of livestock grazing leases from acquired areas – from the existing Curtis Island Conservation Park and Curtis Island State Forest; and
- a $34.5 million contribution over 25 years for the management of the protected areas.

As a result, over 59 per cent of Curtis Island will be protected and managed under a well-funded conservation management plan. The total footprint of the three LNG projects on Curtis Island is ~2 per cent.[213]

213 Powell A, Dickson S, 2013. *Curtis Island land becomes protected area*, Queensland Government Minister for Environment and Heritage Protection and Minister for National Parks media release, 30/8/2013 (http://statements.qld.gov.au/Statement/2013/8/30/curtis-island-land-becomes-protected-area); QGC, 2014. *Natural gas industry funds expansion of Curtis Island conservation area*, media release, 22/8/2014 ((http://www.qgc.com.au/news-media/NewsDetails.aspx?Id=5464);
Thanks to Queensland Parks and Wildlife Service for additional information and photos.

GREEN TURTLE, PROTECTED BY NATIONAL PARKS ON LAND AND SEA © QUEENSLAND PARKS AND WILDLIFE SERVICE

Moreton Bay Marine National Parks

As featured in the 2011 *Building Nature's Safety Net* report, the national parks area in Moreton Bay Marine Park increased significantly from 0.5 per cent protected to 16 per cent in 2009. It was underpinned by a commercial fishing licence surrender program – which cost $15.1 million – as well as an artificial reef program to increase bottom structure and enhance recreational fishing opportunities. Moreton Bay contains the most southerly population of dugongs on the east coast. These dugongs now enjoy a much larger extent of habitat highly protected.

The Queensland Government is to be congratulated for maintaining marine national park boundaries, after recent reviews, in Great Sandy Marine Park and in Moreton Bay, as well as retaining Scott's Point National Park on the Redcliffe Peninsula in Moreton Bay. [214]

214 Crawley M, 2014. No changes to Great Sandy Marine Park recreational fishing, *Fraser Coast Chronicle*, 5/3/2014 (http://www.frasercoastchronicle.com.au/news/the-state-government-will-not-make-changes-to-allo/2188465/);
Williams B, 2013. Green zone ban to stand for recreational fishers, *The Courier-mail*, 18/1/2013 (http://www.couriermail.com.au/news/queensland/green-zone-ban-to-stand-for-recreational-fishers/story-e6freoof-1226556122610);
Dickson S, 2014. *Balance for the Bay*, Queensland Government Minister for National Parks media release, 9/5/2014 (http://www.stevedicksonmp.com.au/Community/CommunityAnnouncements/tabid/88/articleType/ArticleView/articleId/606/categoryId/1/Balance-for-the-Bay.aspx).

Box 8. Four decades of parks achievement in Queensland[215]

Queensland has seen several decades of steady progress in strategic expansion of the protected estate, through several changes of government. As the second largest state, progress is challenging due to the size of the areas of land and sea involved (Figure 6, Figure 13).

Significant milestones, some of which were world-leading at the time, included:

- founding of the National Parks and Wildlife Service in Queensland in 1975;
- tripling of the parks area in the decade 1975–1985 (Table 9);
- nearly six-fold expansion of parks area and more than doubling of ecological representation in the 25 years from 1975 to 2000 (Table 9);
- reorientation of parks strategy from scenic or iconic considerations to protection of biodiversity – long before the 1992 Rio Earth summit and founding of the National Reserve System;
- first implementation of a systematic bioregional parks system, using the latest optimisation tools;
- painstaking mapping of regional ecosystems of Queensland as the foundation for parks planning and the *Native Vegetation Act*; and
- birth of, and major enhancements to, what are now tourism icons, such as the many parks on Cape York Peninsula, Fraser Island, Moreton Bay islands, Cooloola (now Great Sandy), the Wet Tropics, Great Barrier Reef, Carnarvon Gorge. The establishment of a host of new icons in the Queensland outback, such as Lawn Hill, Welford, Idalia, Currawinya, Culgoa Floodplains, Astrebla and Diamantina in the high reservation priority semi-arid inland of Queensland.

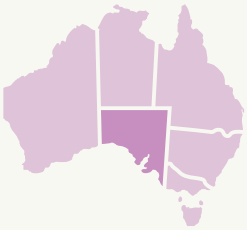
Table 9. Expansion of Queensland Parks system and increasing ecological representation 1975–2000.

Year	Area (million ha)	% of land area	% Representation
1975	1.153	0.64	32%
1985	3.417	1.98	44%
1993	6.329	3.66	63%
2000	6.667	3.86	69%

215 Sattler PS (forthcoming) *Five Million Ha – a conservation memoir 1972–2008,* Royal Society of Queensland (http://www.royalsocietyqld.org/index.htm).

BLACK-WINGED STILTS (*HIMANTOPUS HIMANTOPUS*). PROTECTED IN KUNGARI CP © BILL BREED, UNIVERSITY OF ADELAIDE

SOUTH AUSTRALIA



South Australia has developed an extensive marine parks system rising from ~3 per cent in 2002 to ~45 per cent of state waters in 2012. The extent of marine national parks is 5.1 per cent (Table 6).

South Australia has continued to advance the National Reserve System on land, from ~26 per cent in 2002 to nearly 30 per cent in 2012 (Table 6). South Australia has high levels of Indigenous, joint and privately governed protected areas, with nearly 9 per cent of state area in these governance classes.

A significant and unusual recent decision was the legislated exclusion of mining from the privately owned Arkaroola Wilderness Sanctuary in the Flinders Ranges, which in effect creates the first private national park, an example that other jurisdictions could usefully pursue.[216]

Threatened species meeting the minimum standard of protection increased from 19 per cent (19 species) in 2002 to 28 per cent (9 species added) in 2012 (Figure 9).

The ecosystem representation gap reduced from 9.2 million in 2002 to 8.2 million hectares in 2012 gaps (Figure 6).

We estimate ~1.2 million hectares of new marine highly protected areas would be needed to meet standards proposed here for a comprehensive, adequate and representative marine reserve system (Figure 13).

216 Irving J, 2012, cited above.

SWAMP BUTTONS (*CRASPEDIA PALUDICOLA*, VULNERABLE SA), IN KUNGARI CP © CLAIRE HARDING, SA DEWNR

Most significant additions to the National Reserve System

Kungari Conservation Park

The 564 hectare Kungari Conservation Park was purchased with Australian Government National Reserve System program assistance in 2010–11. The park increased protection for the under-protected and biologically rich Naracoorte Coastal Plain bioregion, which was below 10 per cent protected. Ecosystems particularly benefitting include the vulnerable *Gahnia filum* sedgeland and the rare *Melaleuca halmaturorum* closed floodplain shrubland. Floodplains and wetland habitats have been 93 per cent converted and this park protects important remnants. Threatened species benefitting include swamp buttons (*Craspedia paludicola*, South Australia Vulnerable) and six other rare species. The park is also habitat to rare and listed birds like the Painted Snipe, the Freckled Duck, Blue-winged Parrot, Latham's Snipe, the Shoveller and Beautiful Firetail.

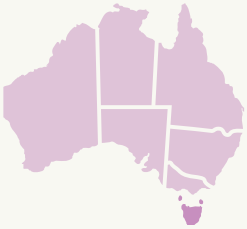
Whole of state Marine Park system

2009 was a landmark year for South Australia with establishment of a marine park network covering over 40 per cent of state waters, 6 per cent of which is closed to mining (Table 6).

LEAFY SEADRAGON (*PHYCODURUS EQUES*) IN ENCOUNTER MARINE PARK, SOUTH AUSTRALIA © ROBYN MORCOM, DEWNR.

TASMANIA

Tasmania has the second most extensive protected area system, covering 40 per cent of the state. 84 per cent of ecosystems meet the minimum standard of protection, up from 79 per cent in 2002 (Figure 6).



Highly protected areas grew from almost 25 per cent to almost 27 per cent of Tasmania, over the decade 2002–2012. Marine national parks have also continued to grow from 4.8 to 5.8 per cent of state waters (Table 6). Growth of national parks has mostly involved state forest transfers. Under a 2012–13 multi-lateral agreement, between state and federal governments, the timber industry and the conservation sector, an additional 500,000 hectares of production forests would have converted to protected areas. However, the new state government terminated the agreement following the 2013 Tasmanian election.[217]

Private land conservation has seen major growth, with over 1 per cent of state land area now under private protected areas (Table 6).

Threatened species protection has risen from 30 per cent to 36 per cent over the decade. Almost 60 per cent of species are at least halfway to meeting the protection standard (Figure 9). Most threatened species are found in the Tasmanian Midlands, which have long been recognised as a high priority for the National Reserve System.

Tasmania has provided other data suggesting the threatened species gap analysis based on Australian Government distributional data is an underestimate. Tasmania reports that for 165 threatened species, 52 per cent were found to have more than 30 per cent of recorded point locations falling in the National Reserve System, as opposed to the 36 per cent estimated here for 125 threatened species.[218]

Ecosystem representation gaps have fallen from ~210,000 hectares in 2002 to 168,000 hectares in 2012 (Figure 6).

We estimate about half a million hectares of new marine highly protected areas would be needed to meet standards proposed here for a comprehensive, adequate and representative marine reserve system (Figure 13).

SKULLBONE PLAINS © MATT NEWTON

217 Australian Government Department of Environment, 2014k. *Tasmanian Forests*, webpage (http://www.environment.gov.au/topics/land/forests/intergovernmental-agreement);
Sky News, 2014. Tasmania's forestry bill repealed, *Sky News*, 3/9/2014 (http://www.skynews.com.au/news/top-stories/2014/09/03/tasmania-s-forestry-bill-repealed.html).

218 Information provided by the Tasmanian Department of Primary Industries, Parks, Water & Environment.

SKULLBONE PLAINS © MATT NEWTON

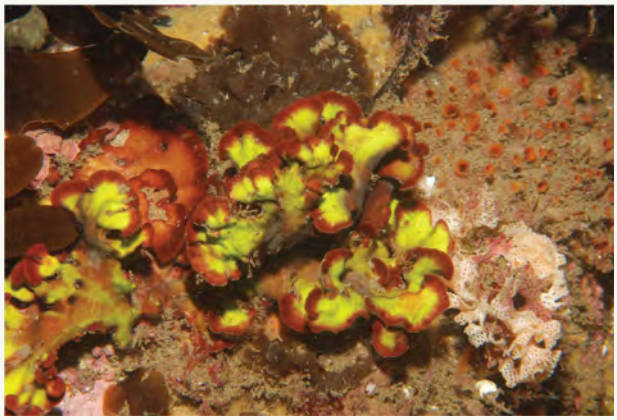
Most significant additions to the National Reserve System

Skullbone Plains

Skullbone Plains comprises 1,618 hectares of land, situated in the Central Highlands region of Tasmania, at an elevation of ~965 metres. The area receives over 2,500 mm of rainfall per year, together with prolonged frost and heavy snowfalls in winter. The area is rich in cultural heritage, scenically spectacular and contains a mix of highland forests, marshes, grasslands, sphagnum bogs, wild rivers and alpine wetlands, including habitat for many threatened flora and fauna species. With financial assistance from private donors and the Australian Government's National Reserve System program, the Tasmanian Land Conservancy purchased Skullbone Plains in 2011. In 2013, a *Nature Conservation Act* conservation covenant was registered, binding successors in title in-perpetuity. Also that year, Skullbone Plains received World Heritage Area status as an extension to the Tasmanian Wilderness World Heritage Area.

Skullbone Plains is managed in IUCN Protected Area Category IV, with the primary management objective to maintain, conserve and restore species and habitats. The area will be managed as a permanent reserve to protect its conservation values into the future. This management is being supported, in partnership with BHP Billiton and Conservation International, through the Five Rivers Project. This partnership is based on a sustainable business model to protect and sustainably manage over 11,000 hectares of conservation-significant land in this area. The model includes such innovative programs as carbon sequestration and threatened species monitoring. [219]

219 Thanks to Louise Gilfedder (Manager Conservation Science, Department of Primary Industries, Parks, Water & Environment) and Sally Bryant (Manager Conservation Science & Planning, Tasmanian Land Conservancy);
Tasmanian Land Conservancy, 2014. *Skullbone Plains*, webpage (http://www.tasland.org.au/permanent/skullboneplains/).



Red alga (*Sonderopelta coriacea*) is generally entirely red; however, in the Ninepin Point area, it is commonly a striking combination of yellow and red.

Ninepin Point Marine Nature Reserve

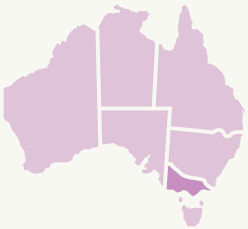
In December 2009, Ninepin Point Marine Nature Reserve was expanded twelvefold from 59 to 732 hectares. Ninepin protects an unusual marine environment: a mixing zone with tannin-rich freshwater from the nearby Huon River. This dark water restricts light penetration. The typical light-loving brown and green algae, which commonly occur to depths of 15 metres, are restricted here to the top few metres. In their place a flourishing and diverse community of red algae and invertebrates occur. Many such species, usually encountered in deeper waters, are found close to the surface in Ninepin. Ninepin Point is one of a few places in the world where this natural phenomenon occurs.[220]

A brownstriped leatherjacket (*Meuschenia australis*) swims amongst a variety of colourful sponges within Ninepin Point Marine Nature Reserve. Brownstriped leatherjackets are only found in waters of eastern South Australia, Victoria and Tasmania. They are uncommon off the mainland; however, commonly seen on reefs in Tasmania.

220 Tasmania Parks and Wildlife Service, 2014. *Ninepin Point Marine Park*, webpage (http://www.parks.tas.gov.au/?base=2926).

CANOEING BARMAH NATIONAL PARK © MEL MITCHELL, VEAC

VICTORIA



Victoria has seen considerable growth of protected areas in the past decade 2002–2012, with highly protected areas rising from 13.4 per cent to 16.3 per cent of the state. Victoria's marine protected areas saw the creation, in 2002, of marine national parks and marine sanctuaries totalling 6.7 per cent of state waters. Additions to Victoria's protected areas have primarily come via conversion of state forests to national parks and other protected areas. However, there have also been significant purchases, with $1.1 million in grants from the National Reserve System grants program. NGOs such as the Trust for Nature also made significant purchases with the award of nearly $1.4 million in National Reserve System grants. Although there have been notable increases in private and Indigenous protected areas, most protected areas are state managed.

As of 2012, 35 per cent of threatened species of national significance meet the minimum 30 per cent standard, up from 31 per cent in 2002 (Figure 9).

Terrestrial ecosystem representation gaps have fallen from ~2 million hectares in 2002 to 1.76 million hectares in 2012 (Figure 6).

We estimate ~403,000 hectares of new marine highly protected areas would be needed to meet standards proposed here for a comprehensive, adequate and representative marine reserve system (Figure 13).

Victoria invests at a high per hectare level in protected area management and has a well-developed system of State of the Parks reporting. Unlike many other jurisdictions, Parks Victoria manages urban parks as well as national parks on sea and land (Appendix 2).

ANCIENT RIVER RED GUM © MEL MITCHELL, VEAC

LACE MONITOR, KINGS BILLABONG © MEL MITCHELL, VEAC

Most significant additions to the National Reserve System

River Red Gum Parks

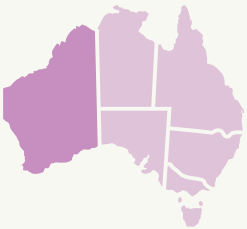
The most significant recent contribution to the National Reserve System by Victoria was not through acquisition; it was via transfer of state lands into national and other parks. An additional 81,000 hectares of River Red Gum forests along the Murray River and tributaries were given park protection in 2009–10 when new national parks (Barmah, Gunbower, Lower Goulburn and Warby-Ovens) and other parks (Gadsen Bend, Kings Billabong and Nyah-Vinifera) were created and additions made to several existing parks.

The River Red Gum Parks protect some of the largest waterbird breeding areas in Australia. Barmah and Gunbower wetlands are both Ramsar sites. The protected red gum forests provide habitat for many endangered species, such as the squirrel glider.

THE VULNERABLE ENDEMIC AUSTRALIAN FLATBACK TURTLE (*NATATOR DEPRESSUS*) © DAVE & FIONA HARVEY, NATURALIST VOLUNTEERS

WESTERN AUSTRALIA

Western Australia terrestrial protected areas grew from 10.7 per cent in 2002 to 14.5 per cent in 2012. Marine parks have more than doubled in area, and marine national parks increased from 7.2 per cent in 2002 to 11 per cent in 2012 (Table 6).



Attainment of the minimum protection standard for ecosystems is second only to Tasmania, rising from 33.3 per cent in 2002 to 51.3 per cent in 2012 (Figure 6).

Threatened species of national significance, including those listed under state law, have seen progress in proportions meeting the minimum protection standard, from 26 per cent to 32 per cent in 2012 (Figure 9).

Western Australia secured nearly $2 million in National Reserve System program grants under Caring for Our Country, to purchase over 400,000 hectares of new parks within the Southwest Australia biodiversity hotspot.

Terrestrial ecosystem representation gaps have fallen substantially, from ~19 million hectares in 2002 to 12.6 million hectares in 2012 (Figure 6).

We estimate ~3.6 million hectares of new marine highly protected areas would be needed to meet standards proposed here for a comprehensive, adequate and representative marine reserve system (Figure 13).

Most significant additions to the National Reserve System

Dirk Hartog Island National Park

Part of the Shark Bay World Heritage area, this 62,928-hectare island was declared a national park in 2009. Falling in a transition between the southwestern and Eremean botanical provinces, it protects many threatened and locally endemic species or subspecies, such as the Dirk Hartog Black and White Fairy Wren, the Dirk Hartog Southern Emu-Wren, the Dirk Hartog Rufous Field Wren and Western Spiny Tailed Skink, as well as species at the extremes of their range. It also contains one of the largest known nesting beaches for the endangered Loggerhead Turtle. The dominant vegetation type on the island was completely unprotected prior to its declaration as national park.

The national park is the focus of the *Return to 1616* ecological restoration project, which aims to eradicate all sheep, goats and feral cats from the island, re-establish healthy vegetation and re-introduce mammal species once known to exist there. [221]

Eighty Mile Beach Marine Park

Eighty Mile Beach, the longest uninterrupted beach in Western Australia, was gazetted as a marine park in January 2013. It is a key feature of the Western Australian Government's Kimberley Wilderness Parks Initiative, which aims to secure a massive interconnected National Reserve System in the region on land and sea, jointly managed with Traditional Owners of land and sea country.

The park protects the entire Eighty Mile Beach meso-scale bioregion, as well as a variety of other habitats that are representative of the Pilbara Nearshore bioregion. Of the entire park, nearly a quarter is proposed for marine national park. The park protects nesting habitat for Australia's only endemic sea turtle, the Flatback, as well as feeding and roosting habitat for many migratory shorebirds. The beach is a recognised Ramsar wetland site. The marine park also provides for the recognition and protection of Indigenous culture and heritage through a new zoning category for cultural heritage protection. [222]

221 WA Department of Parks and Wildlife, 2014a. *Dirk Hartog Island National Park*, webpage (http://parks.dpaw.wa.gov.au/park/dirk-hartog-island); WA Department of Parks and Wildlife, 2014b. *Return to 1616*, webpage (http://www.sharkbay.org/DHIERP.aspx).

222 WA Department of Parks and Wildlife, 2014c. *Marine Parks*, webpage (http://marineparks.dpaw.wa.gov.au/dive-in-to-marine-parks/126-eighty-mile-beach-marine-park.html).

COMMON WOMBAT © MARTIN HARVEY / WWF CANON

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GREAT BARRIER REEF

WWF has helped secure new highly protected areas that help recovery of fish populations and which build the resilience of the reef system.

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NINGALOO

WWF has played a pivotal role in securing sanctuaries within Ningaloo waters.

EARTH HOUR

Earth Hour was co-founded by WWF-Australia and has evolved into one of the most recognised campaigns in history.

ANTARCTICA & THE SOUTHERN OCEAN

WWF continues to promote sustainable fisheries and to protect seabirds from fishing and pest animals.

SOUTHWEST AUSTRALIA ECOREGION

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Appendix 1. Ecosystem services methods

De Groot et al (2012) sorted estimates of ecosystems services in 1,350 published studies into ten biomes.

These biomes had not been mapped for Australia.[1] To generate a biome map for Australia aligned with these biomes, we used the following data sources[2]:-

- Major Vegetation Subgroups pre-1750 version 4.1 (MVG)
- Directory of Important Wetlands (DIW)
- Marine Benthic Substrate database (MBD)
- Climate zones overlay file from MCAS data package (CZ)

We mapped distinct biomes using these base data sources using criteria as shown in Table A1.1 and the biome definitions as provided in de Groot et al 2012, excluding Deserts and Polar regions which were not covered by those authors. We took a conservative view of the forest biome, only including major vegetation groups (MVG) that were all forest. Any "Forests and woodlands" categories or low closed forests we treated as woodlands (Table A1.1).

We clipped the biome map to the National Reserve System map in 2012, both land and sea, and estimated the area of each biome secured in protected areas (Table A1.1, Fig A1.1).

We developed two estimates, one based on global averages and one based on minimum values for Australia or other high income countries.

The first used the average estimates of ecosystem service values in 22 categories of service for each of ten biomes in Table 2 of de Groot et al (2012). For each biome and each regulatory and habitat category (7 – 17), but not including *12 Erosion Prevention* for marine biomes because of the extreme range of values from a small number of studies. We converted international dollars to Australian dollars using the Purchasing Power Parity for the nominated year of 2007. We then converted these 2007 AU dollars to 2012 dollars using the Reserve Bank of Australian inflation calculator.

For the second estimate, we downloaded the Ecosystem Services Valuation database maintained by the Ecosystem Services Partnership, as also used by de Groot et al (2012).[3] For each biome by services combination, we selected the minimum value for any Australian studies. Where an Australian study was not available, we picked the minimum estimate for all studies involving high or upper middle income countries, as defined in the database. We only considered studies where service flows expressed as value per hectare per year were estimated. We converted the currency of the study to Australian dollars using the various published estimates of exchanges rates for June of the year of the study. We then converted to 2012 Australian dollars using the Reserve Bank historical inflation rates series.

We multiplied the two estimates of the Australian dollar values per hectare per year for each biome by service type combination by the area protected in each biome (Table A1.1). We these added these values across values within biomes, and across biomes within values to arrive at aggregate estimates. Table A1.2 shows these calculations.

[1] de Groot R et al, 2012. Global estimates of the value of ecosystems and their services in monetary units, *Ecosystem Services* 1, 50-61.
[2] MVG http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7B23454B96-741A-4F5E-95ED-15CD530F722E%7D4
DIW http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7B3F179472-DE1F-4C6C-B7CA-535DF2896656%7D
MBD http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7BEFA7A7DB-7C20-4D3F-B7A8-6CBCBEA30196%7D
CZ http://data.daff.gov.au/anrdl/metadata_files/pb_mcas09g9ablm03111a01.xml
[3] http://www.fsd.nl/esp/80763/5/0/50

Figure A1.1 Mapping of biomes for ecosystem services valuation, and area in each biome in the National Reserve System in 2012.

Biome	How mapped	Area in NRS 2012 (million ha)
0 Marine	MBD: Off shelf benthic areas 200m or deeper	257.8
1 Reef	MBD: Reefs	4.2
2 Coastal seas	MBD: All other benthic categories apart from those above, OR MVG: Sea and estuaries	62.5
3 Coastal wetland	MVG: Mangroves	0.4
4 Inland wetland	DIW: all categories but excluding MVG: Inland aquatic - freshwater, salt lakes, lagoons; Mangroves.	2.6
5 Rivers and lakes	MVG: Inland aquatic - freshwater, salt lakes, lagoons	0.3
6 Tropical forest	CZ: Tropical or subtropical categories and hot grasslands AND MVG: Eucalypt Open Forests; Eucalypt Tall Open Forests; Rainforests and Vine Thickets; Unclassified Forest	3.6
7 Temperate forest	CZ: other than those for Tropical Forests above AND MVG: Eucalypt Open Forests; Eucalypt Tall Open Forests; Rainforests and Vine Thickets; Unclassified Forest	6.8
8 Woodland	MVG: Acacia Forests and Woodlands; Acacia Open Woodlands; Acacia Shrublands; Callitris Forests and Woodlands; Casuarina Forests and Woodlands; Eucalypt Low Open Forests; Eucalypt Open Woodlands; Eucalypt Woodlands; Low Closed Forests and Tall Closed Shrublands; Mallee Open Woodlands and Sparse Mallee Shrublands; Mallee Woodlands and Shrublands; Melaleuca Forests and Woodlands; Other Forests and Woodlands; Other Open Woodlands; Other Shrublands	35.6
9 Grassland	MVG: Chenopod Shrublands, Samphire Shrublands and Forblands; Heathlands; Hummock Grasslands; Other Grasslands, Herblands, Sedgelands and Rushlands; Tussock Grasslands	13.9
Deserts (excluded)	CZ: Deserts OR MVG: Naturally bare - sand, rock, claypan, mudflat, Unclassified native vegetation, Unknown/no data	

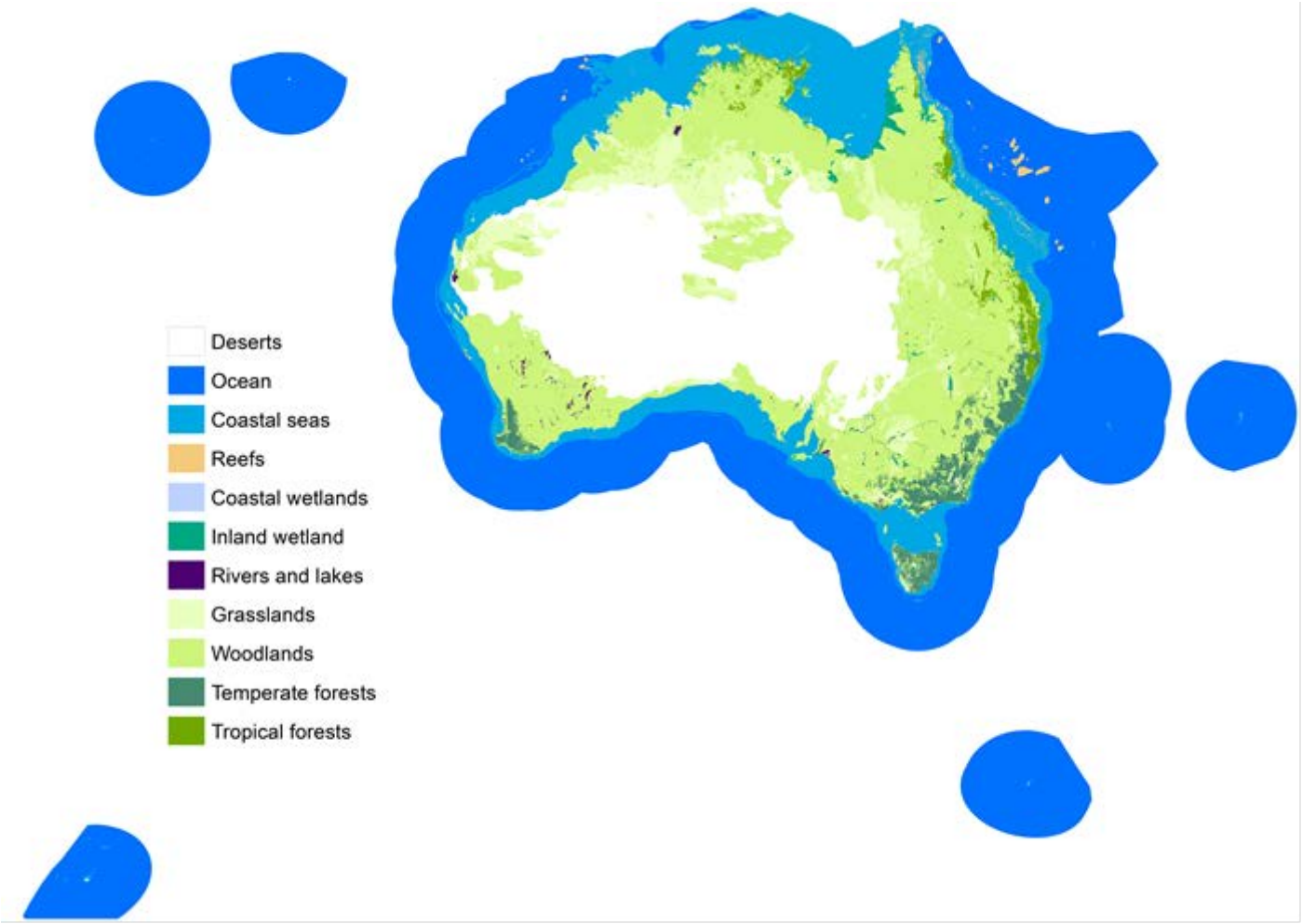

Figure A1.1 Biomes used to estimate ecosystem service values.

Table A1.2 Derivation of two estimates of ecosystem services values for each biome and type of service.

Biome	Service	Country	Year	Value	Units	Exchange rate [1]	Inflation [2]	Australia/ high income minima, 2012AU$/ha/yr [3]	Estimate 1: Global Average 2012AU$/ha/yr [4]	Estimate 2: Consensus Australia/ high income minima, 2012AU$/ha/yr [5]	ESVD ID [6]
0 Marine	08 Climate moderation	UK	2004	39.30	GBP/ha/yr	2.60	1.25	$127.99	$96.43	$96.43	1230
0 Marine	17 Genetic diversity	South Africa	2001	0.64	USD/ha/yr	1.56	1.35	$1.35	$7.42	$1.35	758
1 Reef	08 Climate moderation	French Polynesia	2005	90.00	USD/ha/yr	1.33	1.22	$146.32	$1,762.40	$146.32	454
1 Reef	09 Moderate extremes	Jamaica	2000	2.13	USD/ha/yr	1.75	1.40	$5.20	$25,206.15	$5.20	245
1 Reef	12 Erosion prevention	Jamaica	1999	152,241.00	USD/ha/yr	1.56	1.43	$339,767.31	$227,292.97	$227,292.97	653
1 Reef	17 Genetic diversity	French Polynesia	2005	50.00	USD/ha/yr	1.33	1.22	$81.29	$24,047.54	$81.29	456
2 Coastal seas	08 Climate moderation	USA	2005	452.00	US$/ha/yr	1.33	1.22	$734.87	$710.60	$710.60	1253
2 Coastal seas	09 Moderate extremes	Netherlands	1981	500.00	USD/ha/yr	0.87	3.46	$1,507.83		$1,507.83	849
2 Coastal seas	13 Nutrient cycling	Spain	2004	1,787.00	USD/ha/yr	1.42	1.25	$3,169.16		$3,169.16	357
2 Coastal seas	15 Biocontrol	Spain	2004	49.00	USD/ha/yr	1.42	1.25	$86.90		$86.90	358
2 Coastal seas	16 Nursery habitat	Australia	2001	133.23	US$/ha/yr	1.56	1.35	$281.36	$287.80	$281.36	1254
2 Coastal seas	17 Genetic diversity	South Africa	2000	476.00	ZAR/ha/yr	0.25	1.40	$166.57	$267.03	$166.57	209
3 Coastal wetland	08 Climate moderation	UK	2007	33.08	GBP/ha/yr	2.38	1.14	$90.20	$96.43	$90.20	1345
3 Coastal wetland	09 Moderate extremes	USA	1980	0.98	US$/ha/yr	0.86	3.80	$3.23	$7,938.21	$3.23	1250
3 Coastal wetland	11 Waste treatment	Sweden	1993	412.00	USD/ha/yr	1.49	1.64	$1,006.57	$240,512.44	$1,006.57	1294
3 Coastal wetland	12 Erosion prevention	UK	2000	7,151.00	GBP/ha/yr	2.61	1.40	$26,023.60	$5,828.67	$5,828.67	1336
3 Coastal wetland	13 Nutrient cycling	UK	2008	3,301,505.80	GBP/ha/yr	2.07	1.10	$7,551,803.64	$66.76	$66.76	1340
3 Coastal wetland	16 Nursery habitat	Australia	2007	5,846.52	USD/ha/yr	1.20	1.14	$8,050.83	$15,796.31	$8,050.83	1467
3 Coastal wetland	17 Genetic diversity	Malaysia	1999	24.00	USD/ha/yr	1.56	1.43	$53.56	$9,627.92	$53.56	1290
4 Inland wetland	08 Climate moderation	Canada	2002	4.60	CAD/ha/yr	1.15	1.32	$6.99	$723.95	$6.99	40
4 Inland wetland	09 Moderate extremes	Denmark	1998	103.45	DKK/ha/yr	0.24	1.46	$36.20	$4,429.73	$36.20	1132
4 Inland wetland	10 Water flows	Brazil	1994	378.81	USD/ha/yr	1.37	1.60	$833.26	$8,316.50	$833.26	148
4 Inland wetland	11 Waste treatment	Malaysia	1994	29.93	USD/ha/yr	1.37	1.60	$65.85	$4,472.75	$65.85	953

[1] 1st of June of the year in http://www.xe.com/currencytables/
June of the year Reserve Bank of Australia historical exchange rate data http://www.rba.gov.au/statistics/historical-data.html#exchange-rates
[2] Reserve Bank of Australia historical inflation rate data http://www.rba.gov.au/inflation/measures-cpi.html
[3] The minimum value for available studies after corrections to 2012 AU$, for Australian studies, or if Australian studies unavailable, middle to high income countries.
[4] Corrected by Purchasing Power Parity conversion of 1.29 times inflation correction of 1.15 from 2007 to 2012 AU$
[5] Where the Australian/High Income minimum value exceeds the Global Average (unless no data), the global average is substituted.
[6] The identification number of the study in the Ecosystem Services Valuation Database as of October 2014.

Biome	Service	Country	Year	Value	Units	Exchange rate [1]	Inflation [2]	Australia/ high income minima, 2012AU$/ha/yr [3]	Estimate 1: Global Average 2012AU$/ha/yr [4]	Estimate 2: Consensus Australia/ high income minima, 2012AU$/ha/yr [5]	ESVD ID[6]
4 Inland wetland	12 Erosion prevention	Brazil	1994	63.41	USD/ha/yr	1.37	1.60	$139.48	$3,867.48	$139.48	150
4 Inland wetland	13 Nutrient cycling	Brazil	1994	22.37	USD/ha/yr	1.37	1.60	$49.21	$2,541.24	$49.21	151
4 Inland wetland	14 Pollination	Brazil	1994	12.27	USD/ha/yr	1.37	1.60	$26.99		$26.99	154
4 Inland wetland	15 Biocontrol	Brazil	1994	11.29	USD/ha/yr	1.37	1.60	$24.83	$1,406.36	$24.83	155
4 Inland wetland	16 Nursery habitat	Sweden	2007	10.12	USD/ha/yr	1.20	1.14	$13.94	$1,909.26	$13.94	1475
4 Inland wetland	17 Genetic diversity	Australia	2005	11.66	AUD/ha/yr	1.00	1.22	$14.21	$1,732.73	$14.21	1140
5 Rivers and lakes	11 Waste treatment	USA	1980	9.22	USD/ha/yr	0.86	3.80	$30.24	$277.41	$30.24	881
6 Tropical forest	07 Air quality	Australia	2002	16.20	AUD/ha/yr	1.00	1.32	$21.30	$17.80	$21.30	487
6 Tropical forest	08 Climate moderation	Australia	2002	15.96	AUD/ha/yr	1.00	1.32	$20.99	$3,032.27	$20.99	488
6 Tropical forest	09 Moderate extremes	Australia	2002	12.91	AUD/ha/yr	1.00	1.32	$16.98	$97.91	$16.98	493
6 Tropical forest	10 Water flows	Australia	2002	2.58	AUD/ha/yr	1.00	1.32	$3.39	$507.36	$3.39	489
6 Tropical forest	11 Waste treatment	Australia	2002	11.97	AUD/ha/yr	1.00	1.32	$15.74	$8.90	$15.74	497
6 Tropical forest	12 Erosion prevention	Australia	2002	17.13	AUD/ha/yr	1.00	1.32	$22.53	$22.25	$22.53	490
6 Tropical forest	13 Nutrient cycling	Australia	2002	2.35	AUD/ha/yr	1.00	1.32	$3.08	$4.45	$3.08	498
6 Tropical forest	14 Pollination	Australia	2002	8.45	AUD/ha/yr	1.00	1.32	$11.11	$44.51	$11.11	500
6 Tropical forest	15 Biocontrol	Australia	2002	14.84	AUD/ha/yr	1.00	1.32	$19.51	$16.32	$19.51	492
6 Tropical forest	16 Nursery habitat	Australia	2002	20.19	AUD/ha/yr	1.00	1.32	$26.55	$23.74	$26.55	501
6 Tropical forest	17 Genetic diversity	Australia	2002	7.75	AUD/ha/yr	1.00	1.32	$10.19	$34.12	$10.19	503
7 Temperate forest	08 Climate moderation	Canada	2002	3.27	CAD/ha/yr	1.15	1.32	$4.97	$225.49	$4.97	251
7 Temperate forest	10 Water flows	Mexico	1989	0.14	USD/ha/yr	1.32	1.88	$0.36	$-	$0.36	805
7 Temperate forest	11 Waste treatment	Australia	1999	85.00	AUD/ha/yr	1.00	1.43	$121.58	$10.38	$121.58	62
7 Temperate forest	12 Erosion prevention	Spain	2004	122.00	USD/ha/yr	1.42	1.25	$216.36	$7.42	$7.42	368
7 Temperate forest	13 Nutrient cycling	Spain	2004	12.00	USD/ha/yr	1.42	1.25	$21.28	$137.97	$21.28	369
7 Temperate forest	14 Pollination	Spain	2004	400.00	USD/ha/yr	1.42	1.25	$709.38		$709.38	371
7 Temperate forest	15 Biocontrol	Spain	2004	5.00	USD/ha/yr	1.42	1.25	$8.87	$348.62	$8.87	372
7 Temperate forest	17 Genetic diversity	Canada	2002	0.05	CAD/ha/yr	1.15	1.32	$0.08	$1,278.78	$0.08	36
8 Woodland	12 Erosion prevention	Peru	2006	16.00	PEN/ha/yr	0.41	1.18	$7.70	$19.29	$7.70	1413
8 Woodland	16 Nursery habitat	Peru	2006	1,589.85	PEN/ha/yr	0.41	1.18	$764.63	$1,888.50	$764.63	628
8 Woodland	17 Genetic diversity	South Africa	2001	0.46	USD/ha/yr	1.56	1.35	$0.97	$4.45	$0.97	755
9 Grassland	08 Climate moderation	USA	1997	0.05	USD/ha/yr	1.34	1.49	$0.10	$59.34	$0.10	1025
9 Grassland	10 Water flows	Spain	2004	5.00	USD/ha/yr	1.42	1.25	$8.87		$8.87	378
9 Grassland	11 Waste treatment	Spain	2004	109.00	USD/ha/yr	1.42	1.25	$193.31	$111.26	$111.26	381

Biome	Service	Country	Year	Value	Units	Exchange rate [1]	Inflation [2]	Australia/ high income minima, 2012AU$/ha/yr [3]	Estimate 1: Global Average 2012AU$/ha/yr [4]	Estimate 2: Consensus Australia/ high income minima, 2012AU$/ha/yr [5]	ESVD ID[6]
9 Grassland	12 Erosion prevention	USA	2007	37.82	USD/ha/yr	1.20	1.14	$52.08	$65.27	$52.08	1492
9 Grassland	13 Nutrient cycling	Spain	2004	7.00	USD/ha/yr	1.42	1.25	$12.41		$12.41	380
9 Grassland	14 Pollination	Spain	2004	32.00	USD/ha/yr	1.42	1.25	$56.75	$-	$56.75	382
9 Grassland	15 Biocontrol	Spain	2004	30.00	USD/ha/yr	1.42	1.25	$53.20	$-	$53.20	383
9 Grassland	17 Genetic diversity	South Africa	2001	0.01	USD/ha/yr	1.56	1.35	$0.02	$1,800.97	$0.02	756

Appendix 2. State/territory investments in protected areas

Australian Capital Territory	2008/9	2009/10	2010/11	2011/12	2012/13
Area added (ha)				234 [1]	
Management spend ($1000) [2]	$80,411 [2]	$93,601	$93,233	$91,488	$ 108,309
Area managed (ha)	136,814	136,814	136,814	136,814 [3]	137,048 [4]

NOTES

1 Box Gum woodland offset, p. 22 ACT Planning and Land Authority (2011) Molonglo Valley Plan for the Protection of Matters of National Environmental Significance, NES Plan (http://www.environment.act.gov.au/__data/assets/pdf_file/0005/236336/NES_Plan.pdf)

2 Total actual costs in Output 1.4 Land management in successive Annual Reports, Territory and Municipal Services v2 http://www.tams.act.gov.au/about-us/annual_report

3 based on 2012/13 figure provided per note 8 below, adjusted backwards by subtracting area added in 2011/12

4 Email from ACT Parks and Conservation 3 Feb 2014. No areas were added by purchase.

New South Wales		2008/09 [1]	2009/10 [2]	2010/11 [2]	2011/12 [2]	2012/13 [2]	Totals (2012$ or ha)
Parks	Acquisition ($1000)	$13,984	$7,720	$8,530	$7,060	$7,320	$47,198
	Establishment ($1000)	$23,600	$20,800	$22,000	$18,300	$16,700	$106,890
	Area added (ha)	42,644	30,486	154,725	4,125	5,072	237,052
	Added, no purchase (ha)		8,637	159,641	1,732	752	170,762
	Management ($1000)	$239,770	$237,380	$252,391	$249,167	$255,507	
	Area managed (ha)	6,765,000	6,763,629	7,077,769	7,079,707	7,083,343	
Covenants	Incentives ($1000)		$312	$325	$171	$200	$1,053
	Area added (ha)		74,750	6,550	5,810	3,170	90,280
	Added, no incentives (ha)		12,017 [3]	19,262	10,070	7,852	49,201
	Management ($1000)	$102,362	$73	$127	$108	$63	
	Area managed (ha)	541,104	127,597	134,337	141,852	146,173	
Marine Parks	Management ($1000)	$5,900	$5,666 [4]	$6,247	$6,287	$4,787	
	Area managed (ha)	347,000	347,000 [4]	347,000	347,000	347,000	

NOTES

1 This column from Building Natures Safety Net 2011 report Table 6, unless noted otherwise

2 All statistics these columns from letter from NSW Office of Environment and Heritage dated 27/3/14, unless otherwise noted.

3 This row includes areas protected under Property Vegetation Plans per the register at http://www.environment.nsw.gov.au/vegetation/pvp.htm.

4 These rows per letter from NSW Dept of Primary Industries 31/3/14

Northern Territory		2008/09	[1]	2009/10	[2]	2010/11	[2]	2011/12	[2]	2012/13	[2]	Totals (2012$ or ha)
Parks	Area added, no purchase (ha)							960,846	[3]			960,846
	Management ($1000)	$28,525		$34,376		$41,012		$44,666		$41,003		
	Area managed (ha)	4,634,718	[4]	4,634,718		4,634,718		4,634,718		4,634,718		
Covenants	Establishment ($1000)			$200	[5]	$200		$200		$100		$730
Marine Parks	Area added, no purchase (ha)							880,000				880,000
	Management ($1000)			included in Parks above								

NOTES

1 from Building Nature's Safety Net 2011 report

2 Letter from Parks and Wildlife Commission dated 24/3/14 unless otherwise noted

3 Limmen National Park declaration (http://www.parksandwildlife.nt.gov.au/parks/find/limmen)

4 This row CAPAD 2012 including marine parks. Note that Limmen National Park and Marine Park were proposed proposed prior to declaration in 2012, but still managed by NT Parks

5 From letter note 1, "$600,000 pa for the first three years and a further $100,000 in 2012-13" for Ecolink initiative.

Queensland [1]		2008/09 [2]	2009/10	2010/11	2011/12	2012/13	Totals (2012$ or ha)
Parks	Acquisition ($1000)	$7,900	$16,015	$22,866	$26,404	$105	$77,033
	Area purchased (ha)	574,141	108,083 [3]	29,000	266,889		978,113
	Added, no purchase (ha)		37071 [4]	55,611	236,981		329,663
	Management ($1000)	$95,000	295,435 [5]	$471,302 [6]	[7]	$200,345 [8]	
	Area managed	9,297,000	10,186,876 [9]	10,240,956 [10]	10,610,398 [11]	10,610,398 [11]	
Nature Refuges	Assistance ($1000)	$1,873	$2,049	$2,883	$1,793	$748	$9,877
	Area added (ha)	114,404	625,225	736,470	340,655	4,087	1,820,841
	Management ($1000)		0	$9.9	0	$523.07	
	Area managed (ha)		0	5.7	0	3,314.6	
Marine Parks	Management ($1000)	$27,000					
	Area managed (ha)	7,206,486	included in Parks above				

NOTES

1 All data per letter from Dept of Environment and Heritage Protection May 2014, unless noted otherwise.

2 Building Nature's Safety Net 2011 this column, unless noted otherwise.

3 Figures provided by EHP lumped all areas added purchased or otherwise. In this row we show only areas added as recorded in Commonwealth NRSP grants register. Areas purchased without such grants may be missing and appear in the line below. 2013/13 values could not easily be distinguished from those for previous year and so are included under previous year.

4 In this row, subtracting from aggregate figures provided by EHP those under Areas purchased above.

5 Total expenses for Conservation and Environmental Services in 2009/10 Annual Report of DERM p 105, excluding revaluation decrement. Includes non Parks-related costs.

6 Total expenses for Environment Services in 2010/11 Financial statements of DERM p 10 excluding revaluation decrements. Includes non Parks-related costs.

7 Estimation unreliable due to changes in machinery of government.

8 Total expenses for National Parks in 2012/13 Financial statements of NPRSR p 6,excluding revaluation decrements.

9 Areas from CAPAD 2008 under Qld Parks management, including marine parks.

10 Areas from CAPAD 2010 under Qld Parks management, including marine parks.

11 Areas from CAPAD 2012 under Qld Parks management, including marine parks.

South Australia		2008/09	[1]	2009/10	[2]	2010/11	[2]	2011/12	[2]	2012/13	[2]	Totals (2012$ or ha)
Parks	Acquisition ($1000)	$1,785		$921		$437		$86		$2,050		$5,554
	Area purchased (ha)	1,816	[3]	1,727		822		376		1,900		6,641
	Added, no purchase (ha)	389		86,165		31,547		4,115		6,283		128,499
	Management ($1000)	$51,345		$59,690		$52,750		$49,074		$45,275		
	Area managed (ha)	20,933,088		21,028,599		21,062,786		21,064,822		21,071,106		
Covenants	Area added (ha)	11,547	[4]	1,270		3,727		1,417		4,045		22,006
	Management ($1000)	$571.34		$427.00		$356.00		$407.00		$396.00		
	Area managed (ha)	100,728				117,948	[5]	80,987		122,406		
Marine Parks	Establishment $1000			$3,400.00		$3,400.00		$3,400.00		$3,300.00		$14,010
	Area			2,693,676		-		-		-		2,693,676
	Management	included in terrestrial parks management above										

NOTES

1 This column from Building Nature's Safety Net 2011 unless noted otherwise.

2 all data per Letter from SA Dept of Environment, Water and Natural Resources dated 10/4/2014 unless otherwise noted. Empty cells indicate no data.

3 Revised figures this row per SA DEWNR email dated 28/8/2014.

4 Heritage Agreement covenants. Revised figures this row provided bySA DEWNR in an email dated 28/8/2014.

5 Only for fencing for Heritage Agreement covenants, not including other grants for other purposes.

Tasmania		2008/09	[1]	2009/10	[2]	2010/11	[2]	2011/12	[2]	2012/13	[2]	Totals (2012$ or ha)
Parks	Acquisition ($1000)			0		$367	[3]	0		0		$385
	Area purchased (ha)			0		60		0		0		60
	Added, no purchase (ha)			1,300		15,500		26,200		2,300		45,300
	Management ($1000)	$45,063		$68,921	[3]	$57,788	[4]	$56,484	[5]	$70,953	[6]	
	Area managed (ha)	2,500,000		2,517,007	[7]	2,528,529	[8]	2,578,418	[9]	2,578,418	[9]	
Covenants	Area added (ha)			4,085	[1]	4,200		1,300		3,200		12,785
Marine Parks	Establishment $1000			$300.00	[10]							$324
	Area added (ha)			12,500								12,500
	Management ($1000)			included in parks above								

NOTES

1 This column from Building Natures Safety Net 2011, unless noted otherwise.

2 These columns from Tasmania Parks and Wildlife Service response to survey dated 29/4/2014, unless otherwise noted.

3 Sassafras Ck purchased entirely with Commonwealth Forest Conservation Fund Grant, later transferred to state for management

3 Total expenses actual, Parks and Wildlife Management, Annual Report 2009-10 DPIPWE

4 Total expenses actual, Parks and Wildlife Management, Annual Report 2010-12 DPIPWE

5 Total expenses actual, Parks and Wildlife Management, Annual Report 2009-10 DPIPWE

6 Total expenses actual, Parks and Wildlife Management, Annual Report 2009-10 DPIPWE

7 CAPAD 2008, including marine parks.

8 CAPAD 2010, including marine parks.

9 CAPAD 2012, including marine parks.

10 Bruny Bioregion Marine Conservation Areas. No further marine protected areas since then.

Victoria		2008/09	[1]	2009/10	[2]	2010/11	[2]	2011/12	[2]	2012/13	[2]	Totals (2012$ or ha)
Terrestrial Parks & Reserves	Purchases ($1000)									$1,014.00	[3]	$1,014
	Added by purchase (ha)			685	[4]	2,557		1,281		12		4,535
	Added without purchase (ha)			81,167	[5]	46,558		4		8,645		136,374
	Management ($1000)	$186,067		$204,476	[6]	$230,040		$249,743		$259,327		
	Area managed (ha)	3,969,000		4,040,000	[7]	4,084,000		4,086,000		4,116,000		
Covenants	Incentives: no data provided.											
Marine Parks	No additions.											
		Management spending included in parks management above										

NOTES

1 This column from Building Natures Safety Net 2011, unless otherwise noted.

2 These columns per letter from Department of Environment and Primary Industries, dated 19/3/2014, unless otherwise noted.

3 DEPI Annual Report 2012/13, App.3 Capital Projects, National Reserve Land acquisition line. No areas provided, just expense.

4 this row includes land added under the National Parks Act 1975 and the Crown Land (Reserves) Act 1978.

5 this row includes land added under the National Parks Act 1975 and some areas established under the Crown Land (Reserves) Act 1978.

6 This row from Parks Victoria Annual Report 2012-13 p 37, includes entire expense budget for Parks Victoria.

7 This row from Parks Victoria Annual Report 2012-13 p 36

Western Australia		2008/9 [1]	2009/10 [2]	2010/11 [2]	2011/12 [2]	2012/13 [2]	Totals (2012$ or ha)
Parks	Purchase ($1000)	$3,700	$5,100	$2,040	$3,440	$3,727	$18,956
	Establishment ($1000)		$506	$535	$559	$487	$2,165
	Area purchased (ha)	115,707	8,195	1,166	19,271	51,000	195,339
	Added, no purchase (ha)		-	-	-	4,851	4,851
	Management ($1000)	$74,089	$113,016 [3]	$114,772	$118,406	$125,855	
	Area managed (ha)	27,371,881	17,779,537	17,724,053	17,731,464	17,773,913	
Covenants	Area added (ha)		1,522	1,233	4,488	683	7,926
Marine Parks	Establishment ($1000)		$1,262.00	$1,276.00	$1,272.00	$1,255.00	$5,255
	Area added (ha)		-	-	796,000	148,000	944,000
	Management ($1000)		$5,428	$5,588	$6,264	$7,592	
	Area managed (ha)		1,538,000	1,538,000	2,334,000	2,482,000	

NOTES

1 From Building Natures Safety Net 2011 report

2 All data per letter from NSW Office of Environment and Heritage dated 27 March 2014 unless noted otherwise.

3 This row Nature Conservation and Parks and Visitor Service less Marine Services outputs in Annual Reports.

Appendix 3. Protected area gap analysis

National Reserve System spatial data processing

We extracted National Reserve System components of CAPAD 2002 and 2012.[1] We corrected the NRS for 2002 by removing Limmen National Park, which was recorded as protected in CAPAD in 2002 although not gazetted at that date. Also we removed Henbury Station from CAPAD 2012, as it was recently reversed. We clipped the 2002 layer to the 2012 layer to remove a number of other protected areas that were recorded as protected in 2002 but which turned out not to have been gazetted.

All areas were calculated in ArcGIS 10 based on Albers Equal Area, GDA94 projection. These are not the same as gazetted areas and some differences with CAPAD figures may result.

Overlapping protected areas were removed as follows. All were sorted into Highly (HPA) or Other Protected Areas (OPA) and dissolved to remove overlaps within these two groups. HPA was defined as comprising IUCN categories I-IV for the terrestrial NRS and IUCN categories I-III for the marine NRS.

In cases where a HPA overlapped an OPA, we retained the area as a HPA by erasing the overlap from the OPA layer. Many land protected areas also extend into the sea, or vice versa, in the case of estuaries and mangroves flats. To define the land/sea boundary we modified the Australian 1:100,000 coastline spatial database,[2] by moving mapped estuaries[3] into the marine realm. For the outer limit of the marine jurisdiction and state waters we used the Australian Maritime Boundaries spatial database.[4]

Terrestrial ecosystem protection

From present-day Major Vegetation Subgroups, version 4.1 we substituted all areas shown as cleared or regrowth, with the mapped pre-clearing Major Vegetation Subgroup (MVSE) with a flag to show it had been cleared. We intersected this MVSE modified layer with IBRA v.7 subregions. We removed any naturally unvegetated areas, slivers and any intersection below 100ha in total extent as possible artefacts, as described more fully in the *Changing land use* report.[5]

Each such ecosystem proxy could be assigned uniquely to a particular IBRA bioregion and subregion.

We intersected these ecosystem proxies with the NRS in 2002 and 2012, mapped as described above. We calculated areas of intersection and calculated the area of the ecosystem required to meet the 15% protection standard, and by subtraction the area of the gap that was unprotected in 2002 and 2012 respectively.

Terrestrial bioregion gaps and priorities

We extracted the National Reserve System component of CAPAD 2012 and intersected with IBRA v.7 bioregions. We excluded the external territories. From this we estimated areas and proportions of bioregions that were protected in 2002 and 2012 respectively. We also summed the gaps for all ecosystems (i.e. subregional major vegetation subgroups) within a bioregion, to derive a total ecosystem protection gap area for each bioregion.

We reproduced the bioregional 2002 map in Fig. 2 from the 2006 Safety Net report using IBRA version 5.1 boundaries (provided courtesy of Parks Australia) and the "New Reserve Priority" field in the database for the 2002 Terrestrial Biodiversity Assessment.[6]

To generate an equivalent map for 2012 we calculated ecosystem gaps for bioregions in 2002, and determined using discriminant analysis the gap threshold values appropriate to each of the five prioritisation categories used in the 2002 map in Fig. 2. These were 0-4.35% for category 5 (lowest), 4.35% to 7.59% for category 4, 7.59% to 10.88% for category 3, 10.88% to 12.51% for category 2 and above 12.51% for category 1 (highest).

Extents protected, ecosystem gaps and priorities so derived are shown in Table A3.1.

[1] http://www.environment.gov.au/topics/land/nrs/science-maps-and-data/capad
[2] http://www.ga.gov.au/metadata-gateway/metadata/record/61395/
[3] http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7BFE476606-9BD6-49BA-BF1F-870323BBB7A2%7D
[4] http://www.ga.gov.au/metadata-gateway/metadata/record/63565/
[5] Taylor, M.F.J. et al. 2014. *Changing land use to save Australian wildlife.* WWF Australia, Sydney.
[6] Sattler, P.S. and C. Creighton, 2002. *Terrestrial Biodiversity Assessment 2002.* Land and Water Audit, Australian Government, Canberra.

Table A3.1 Terrestrial bioregions, extents protected, ecosystem protection gaps and priorities (IBRA v 7). Areas are in millions of hectares.

Bioregion	Area (m ha)	NRS 2002	NRS 2012	10% in 2002	10% in 2012	17% in 2012	Ecosys. Gap 2012	Ecosys. Gap 2012(%)	Priority 2002	Priority 2012
Arnhem Coast	3.336	0.000	1.327	0	1	1	0.033	1.0%	2	5
Arnhem Plateau	2.306	0.487	1.729	1	1	1	0.001	0.0%	4	5
Australian Alps	1.233	0.786	0.792	1	1	1	0.001	0.1%	5	5
Avon Wheatbelt	9.517	0.154	0.271	0	0	0	1.172	12.3%	1	2
Ben Lomond	0.658	0.095	0.105	1	1	0	0.025	3.8%	3	5
Brigalow Belt North	13.675	0.292	0.443	0	0	0	1.784	13.0%	1	1
Brigalow Belt South	27.220	0.731	1.448	0	0	0	3.121	11.5%	1	2
Broken Hill Complex	5.635	0.075	0.264	0	0	0	0.707	12.6%	3	3
Burt Plain	7.380	0.019	0.400	0	0	0	0.821	11.1%	1	2
Cape York Peninsula	12.257	1.650	3.518	1	1	1	0.194	1.6%	4	5
Carnarvon	8.430	0.330	0.981	0	1	0	0.468	5.5%	4	4
Central Arnhem	3.462	0.000	0.263	0	0	0	0.260	7.5%	2	4
Central Kimberley	7.676	0.340	0.902	0	1	0	0.448	5.8%	1	4
Central Mackay Coast	1.464	0.176	0.213	1	1	0	0.139	9.5%	3	3
Central Ranges	10.164	4.984	5.808	1	1	1	0.019	0.2%	1	5
Channel Country	30.409	1.924	2.634	0	0	0	2.836	9.3%	2	3
Cobar Peneplain	7.385	0.121	0.207	0	0	0	0.930	12.6%	2	2
Coolgardie	12.912	1.325	1.617	1	1	0	0.585	4.5%	3	4
Daly Basin	2.092	0.052	0.195	0	0	0	0.123	5.9%	1	4
Dampierland	8.361	0.086	0.112	0	0	0	1.133	13.6%	1	1
Darling Riverine Plains	10.700	0.116	0.283	0	0	0	1.358	12.7%	1	1
Darwin Coastal	2.843	0.828	0.895	1	1	1	0.017	0.6%	4	5
Davenport Murchison Ranges	5.805	0.116	0.130	0	0	0	0.743	12.8%	2	2
Desert Uplands	6.941	0.183	0.215	0	0	0	0.861	12.4%	2	2
Einasleigh Uplands	11.626	0.255	0.762	0	0	0	1.140	9.8%	2	3
Esperance Plains	2.921	0.839	0.843	1	1	1	0.017	0.6%	5	5
Eyre Yorke Block	6.120	0.477	0.919	0	1	0	0.628	10.3%	4	4
Finke	7.267	0.002	0.306	0	0	0	0.875	12.0%	1	2
Flinders Lofty Block	6.616	0.313	0.569	0	0	0	0.639	9.7%	2	3
Furneaux	0.538	0.090	0.187	1	1	1	0.017	3.2%		5

Bioregion	Area (m ha)	NRS 2002	NRS 2012	10% in 2002	10% in 2012	17% in 2012	Ecosys. Gap 2012	Ecosys. Gap 2012(%)	Priority 2002	Priority 2012
Gascoyne	18.075	0.349	1.856	0	1	0	0.934	5.2%	3	4
Gawler	12.003	1.468	1.895	1	1	0	1.074	8.9%	4	4
Geraldton Sandplains	3.142	0.478	0.568	1	1	1	0.085	2.7%	4	5
Gibson Desert	15.629	5.413	5.580	1	1	1	0.186	1.2%	4	5
Great Sandy Desert	39.486	1.441	5.894	0	1	0	1.485	3.8%	2	5
Great Victoria Desert	42.247	10.917	12.937	1	1	1	1.176	2.8%	5	5
Gulf Coastal	2.712	0.005	0.570	0	1	1	0.016	0.6%	1	5
Gulf Fall and Uplands	11.848	0.203	1.095	0	0	0	0.716	6.0%	3	4
Gulf Plains	22.042	0.558	1.073	0	0	0	2.389	10.8%	2	3
Hampton	1.088	0.115	0.159	1	1	0	0.089	8.2%	4	4
Jarrah Forest	4.509	0.231	0.642	0	1	0	0.156	3.5%	2	5
Kanmantoo	0.812	0.083	0.169	1	1	1	0.081	9.9%	5	5
King	0.426	0.070	0.083	1	1	1	0.018	4.3%	4	5
Little Sandy Desert	11.090	0.514	0.514	0	0	0	1.340	12.1%	2	2
MacDonnell Ranges	3.929	0.355	0.579	0	1	0	0.257	6.5%	3	4
Mallee	7.398	1.325	1.333	1	1	1	0.288	3.9%	5	5
Mitchell Grass Downs	33.469	0.401	0.562	0	0	0	4.528	13.5%	1	1
Mount Isa Inlier	6.778	0.181	0.186	0	0	0	0.908	13.4%	2	2
Mulga Lands	25.188	0.565	0.972	0	0	0	3.065	12.2%	2	2
Murchison	28.121	0.309	1.877	0	0	0	2.354	8.4%	2	3
Murray Darling Depression	19.958	2.339	3.037	1	1	0	1.565	7.8%	2	3
Nandewar	2.702	0.052	0.091	0	0	0	0.353	13.1%	1	1
Naracoorte Coastal Plain	2.458	0.120	0.236	0	0	0	0.261	10.6%	3	3
New England Tablelands	3.002	0.204	0.311	0	1	0	0.313	10.4%		3
Northern Kimberley	8.420	1.216	1.558	1	1	1	0.122	1.5%	4	5
NSW North Coast	3.997	0.812	1.077	1	1	1	0.180	4.5%	5	5
NSW South Western Slopes	8.681	0.183	0.248	0	0	0	1.017	11.7%	1	2
Nullarbor	19.723	5.644	6.236	1	1	1	0.333	1.7%	5	5
Ord Victoria Plain	12.541	0.889	1.482	0	1	0	1.209	9.6%	3	3
Pilbara	17.823	1.132	1.501	0	0	0	1.315	7.4%	3	4
Pine Creek	2.852	1.214	1.216	1	1	1	0.002	0.1%	5	5
Riverina	9.704	0.166	0.529	0	0	0	1.108	11.4%	1	2

Bioregion	Area (m ha)	NRS 2002	NRS 2012	10% in 2002	10% in 2012	17% in 2012	Ecosys. Gap 2012	Ecosys. Gap 2012(%)	Priority 2002	Priority 2012
Simpson Strzelecki Dunefields	27.984	7.935	8.628	1	1	1	0.770	2.8%	5	5
South East Coastal Plain	1.749	0.081	0.163	0	0	0	0.159	9.1%	2	3
South East Corner	2.532	0.731	0.920	1	1	1	0.019	0.7%	5	5
South Eastern Highlands	8.376	1.317	1.542	1	1	1	0.403	4.8%	5	5
South Eastern Queensland	7.805	0.697	1.163	0	1	0	0.516	6.6%	3	4
Southern Volcanic Plain	2.440	0.026	0.049	0	0	0	0.320	13.1%		1
Stony Plains	13.166	0.852	0.919	0	0	0	1.412	10.7%	3	3
Sturt Plateau	9.858	0.020	0.069	0	0	0	1.411	14.3%	1	1
Swan Coastal Plain	1.526	0.156	0.165	1	1	0	0.107	7.0%	4	4
Sydney Basin	3.630	1.295	1.486	1	1	1	0.156	4.3%	5	5
Tanami	25.997	0.407	11.583	0	1	1	0.815	3.1%	2	5
Tasmanian Central Highlands	0.768	0.428	0.446	1	1	1	0.002	0.3%	4	5
Tasmanian Northern Midlands	0.415	0.012	0.026	0	0	0	0.043	10.3%	1	3
Tasmanian Northern Slopes	0.623	0.076	0.089	1	1	0	0.031	4.9%	3	4
Tasmanian South East	1.132	0.137	0.180	1	1	0	0.025	2.2%	2	5
Tasmanian Southern Ranges	0.757	0.311	0.320	1	1	1	0.007	0.9%	4	5
Tasmanian West	1.565	1.284	1.344	1	1	1	0.000	0.0%	4	5
Tiwi Cobourg	1.011	0.205	0.205	1	1	1	0.110	10.9%	2	2
Victoria Bonaparte	7.301	1.099	1.242	1	1	1	0.480	6.6%	3	4
Victorian Midlands	3.470	0.296	0.380	0	1	0	0.308	8.9%	3	3
Warren	0.845	0.259	0.397	1	1	1	0.001	0.1%	5	5
Wet Tropics	1.989	0.415	1.017	1	1	1	0.051	2.6%	5	5
Yalgoo	5.088	0.507	1.655	0	1	1	0.047	0.9%	4	5
TOTAL	768.83	74.35	118.39	37	52	32	57.21	7.4%		

Connectivity of the terrestrial reserve system

We used ABARES land use layers for 2000 and 2005, reduced down to eight categories as shown in Table A3.2 and as described in the *Changing land use report*.[1]

We updated the 2000 land use layer with CAPAD 2002, corrected as in Appendix 3. Similarly we updated the 2005 land use layer with CAPAD 2012 protected areas, corrected as in Appendix 3. The 2005 land use layer was the most recent available at time of this analysis.

From both corrected layers we extracted the protected areas as polygons, and dissolved without regard to name or jurisdiction. We then replaced their boundaries with 50,000 random points at minimum 5 km spacing. Among these points we generated the Euclidean Minimum Spanning Tree, using a third-party script for ArcGIS 10.[2]

This is the network of the shortest straight line linkages required to connect all protected areas in Australia. It is not however, the solution that minimises cost or other criteria. We extracted from the minimum spanning tree only linkages between polygons that were 2km or more, and which ran over land, not over sea, and derived histograms and median values.

We then extracted the land uses underlying these linkages and added up the total areas in each land use in for each time point. We multiplied the total areas under each land use by the means of species abundances estimated by the GLOBIO project to apply to that land use. We then calculated the overall weighted mean of MSA for linkages among Australian protected areas in 2002 and 2012 (Table A3.2).[3]

[1] Taylor MFJ et al, 2014. *Changing land use to save Australian wildlife*, WWF-Australia, Sydney.
[2] http://arcscripts.esri.com/details.asp?dbid=15121
[3] Bureau of Rural Sciences, 2010. *Land Use of Australia, Version 4, 2005/2006* (September 2010 release) (http://data.daff.gov.au/anrdl/metadata_files/pa_luav4g9abl07811a00.xml);
Alkemade R et al, 2009. GLOBIO3: A Framework to Investigate Options for Reducing Global Terrestrial Biodiversity Loss, *Ecosystems* 12, 374–390.

Table A3.2 Derivation of mean species abundances of broad land use classes along minimum distance linkages between protected areas in 2002 and 2012, adapted from GLOBIO estimates.

Land use	MSA (%)	Area 2000-2002	Area 2005-2012	MSAxAREA 2000-2002	MSAxAREA 2005-2012
Min. use	90	6,934	8,638	6,240.6	7,774.2
Forestry	70	2,513	2,056	1,759.1	1,439.2
Grazing	70	21,260	13,637	1,4882	9,545.9
Cleared pastures	10	6,998	17,684	699.8	1,768.4
Crops/Plantations	10	7,460	9,785	746	978.5
Developed	5	949	1,475	47.5	73.8
TOTALS/ WEIGHTED MEANS		46,114	53,275	52.9%	40.5%

Appendix 4. Marine reserve selection methods

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A Marxan analysis was undertaken in order to determine the additional area of highly protected marine reserves required to meet a minimum standard of protection of marine ecosystems and species in Australian waters, across all jurisdictions.

Primary data files

The following files are required to generate Marxan simulations:

- Planning units file
- Conservation features file
- Conservation features by planning unit file
- Planning unit boundary file

Planning units

The study region was the Australian Exclusive Economic Zone (EEZ) up to the high tide mark. The current Interim Marine and Coastal Regionalisation of Australia (IMCRA v4) map does not include estuaries. We added estuaries to the map using the Australian Government spatial database for estuaries,[2] and divided the combined marine study area into 11 regions within Commonwealth waters, and the seven state or territory coastal waters. Queensland coastal waters within the Great Barrier Reef Marine Park were assigned to the Park, not to Queensland state waters.

A planning unit layer is required to break up the study area into smaller selectable areas and so develop a spatially explicit solution that meets the nominated targets, ensure certain areas are locked in or out of the analysis, as well as allocate appropriate costs of protection to areas of the study region.

A grid of 15km by 15km squares, each 225 km^2 was created to define the spatial planning units, clipped to the study area. Areas locked in and out were substituted into the planning unit grid as below. There were a total of 37,905 planning units.

Areas locked in and out

Highly protected areas were locked into the solution. For highly protected areas we used all IUCN I to III categories of protected area in CAPAD 2012. IUCN IV areas were excluded because they allow widespread commercial fishing. These include for example, Dugong Protection Areas or Fish Habitat Areas under Queensland Fisheries legislation.

Some reserves known to be missing from CAPAD12 and marine parks which were legislated after the publication of CAPAD 2012 were added to an updated custom marine protected area layer maintained by the Centre for Conservation Geography.

To better define the existing division into highly protected areas and other protected areas we first examined management plans, to assess and reallocate IUCN categories based on IUCN definitions. Categories were not always consistent with those nominated in CAPAD 2012 and so were changed to better fit IUCN categories. These changes from CAPAD 2012 are shown in Table A1.1 below.

Where two different IUCN categories overlapped the same area the lower numbered category was assigned. For example, if an area was mapped as both IUCN II and IUCN VI, it was mapped only as highly protected for our purposes. However, in cases where there were temporal differences in application of IUCN categories over the same area (eg, for some coastal parks in SA), the higher numbered categories was assigned to the area. For example, if an area was mapped as IUCN II in one part of a year, and IUCN VI in another, it was mapped only as "other protected area" for our purposes.

Mining lease spatial datasets were collated for all state and commonwealth waters and locked out of the solution as likely to be too expensive to buy-out relative to fisheries. Leased areas listed as active, pending renewal, pending partial surrender, or pending surrender were all included. Exploration permits and leases, or leases listed as retired,

[1] http://conservationgeography.org/

[2] http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7BFE476606-9BD6-49BA-BF1F-870323BBB7A2%7D

expired, pending application, surrendered or withdrawn were all excluded. Leases which overlapped the study area by less than 0.01 ha were ignored.

Costs of protection

The only major extractive or consumptive uses of marine environments are mining, petroleum and fishing. Mining leases that were active were locked out as described above. We used the Gross Value of Production (GVP) of commercial fishing as an indicator of the cost of protection, as provided by the 2000-2002 National Fishing Dataset.[1] This was used as an indicator for the level of assistance likely needed to settle the affected interests of commercial fishers in closing areas to fishing. In the original dataset, grid squares with fewer than five boats had no GVP information. We calculated the average of GVP per boat across the database. Where GVP was not listed due to confidentiality (less than 5 boats), the average GVP for each fishing type was used to impute the missing GVP values using the stated number of boats within the grid squares with missing data.

Conservation features

We based reserve selection on achievement of defined standards for three types of conservation features:

- 177 Species of National Environmental Significance (SNES) as mapped by the Department of Environment. The standard for each species to be protected was 30% by area of the "Known" or "Likely to Occur" polygons with the following variations to the rule for small areas. If 30 per cent of the distribution was less than 1000 hectares, a minimum of 1000 hectares was to be highly protected. If the distribution itself was less than 1000 hectares, 100% was to be highly protected. Finally, if 30 per cent of the distribution was larger than 10 million hectares, at most 10 million ha was to be highly protected. This last rule was implemented to avoid the problem of species with very large ranges skewing the results. Although a subset of species have very large mapped likely-to-occur distributions, it is clear that these are really range maps, not maps of habitat in which the species is genuinely likely to occur, and greatly over-estimate the actual habitat requirements.
- 2,420 ecosystem proxies were developed following Harris et el (2003) and Beaver & Lewellyn (2009)[2]. Benthic ecosystem proxies were represented by the intersection of IMCRA v4.0 mesoscale bioregions with 32 bathomes defined on depth and 55 geomorphological classes.[3] The 5,268 such intersections that were used in the previous Buillding Nature's Safety Net report were rationalised for this analysis to reduce the large number of small intersections that may represent slivers or as described below. For this report we also substituted 103 estuarine ecosystems for benthic ecosystems where they overlapped. Estuaries as mapped in CAMRIS, the national estuaries database, were classified according to IMCRA v4.0 mesoscale bioregion in which they fell, and whether it was one of four types: wave dominated, riverine, tide dominated or other according to CAMRIS.[4] These were used as estuarine ecosystem proxies. From the joint map of benthic and estuarine ecosystem proxies, we removed slivers less than one hectare, and where perimeter was more than 1km per hectare of area. For any intersections types in total less than 100 ha, we substituted the majority ecosystem in a 0.03 degree window around these missing cells. The target to be highly protected for each such marine ecosystem proxy was 15% by area, except that if this was less than 1000 hectares, a minimum of 1000 hectares was to be highly protected. If the total area was less than 1000 hectares, then 100% was to be highly protected.
- 41 IMCRA v 4.0 provincial bioregions. The target was 17% minimum for each province highly protected.

Conservation features by planning units

This file stored the areas of each feature for each planning unit. It was created by intersecting each species or feature dataset with the planning unit layer, calculating the area and exporting the total area for the intersected polygons.

Boundaries of planning units

This file records the length of the boundary that each planning unit shares with every neighbouring planning unit. This enables use of the boundary length modifier feature of Marxan, which can favour more or less connectivity in deriving solutions.

Boundary lengths were calculated using a script created for this purpose and available on the Marxan website.[5]

[1] http://data.daff.gov.au/anrdl/metadata_files/pe_abares99000008_14a.xml

[2] Harris et el, 2003. Geomorphic Features of the Continental Margin of Australia, Geoscience Australia; Beaver D, Lewellyn G, 2009. Designing A Comprehensive, Adequate And Representative (CAR) Network Of Marine Protected Areas For Australia's Commonwealth Waters, WWF-Australia, Sydney.

[3] http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7BA0D9F8EE-4261-438A-8ADE-EFF664EFF55C%7D

[4] http://www.environment.gov.au/metadataexplorer/full_metadata.jsp?docId=%7BFE476606-9BD6-49BA-BF1F-870323BBB7A2%7D

[5] http://www.uq.edu.au/marxan/

Calibration and simulation

Two parameters were calibrated to enable an efficient and optimal solution to be found, the boundary length modifier (BLM) and species penalty factor (SPF).

Cost and boundary length generally trade off. Including only planning units which advance progress to targets, and ignoring boundary length, produces solutions that may meet the targets at least cost, but which are generally very fragmented with many individual isolated and unconnected planning units selected for protection, the "stamp collecting" problem.

Conversely minimizing the fragmentation and therefore the boundary length greatly increases the total cost because many planning units may be added that are sample features well over their targets for the sake of advancing connectivity. Therefore the boundary length parameter is chosen at the inflection point of the trade-off curve for boundary length and cost. The Zonae Cognito BLM calibration tool was used for calibration, and the value of 0.2 selected as representing the best tradeoff value (Fig. A4.1)

The species penalty factor (SPF) is a parameter for each conservation feature, adjusted to ensure that all features are selected so as to achieve their targets. If these parameters are set too low, Marxan will not meet the target of species which are marginally too costly. A calibrated SPF of 30 was selected which ensured targets were met for nearly all features. Due to the exclusion from the solutions of active mining leases, the targets for 48 features could not be met regardless how high SPF was set. However, only five features could not be sampled at over 50% of their target areas. These were all in the mining leases of the northwest coast of Western Australia.

Marxan *Version 243* was used for simulations. We ran 200 simulations of 10 million iterations each.

The gaps of the current marine national park system away from the optimal system identified here are shown for marine provincial bioregions in Table A4.1.

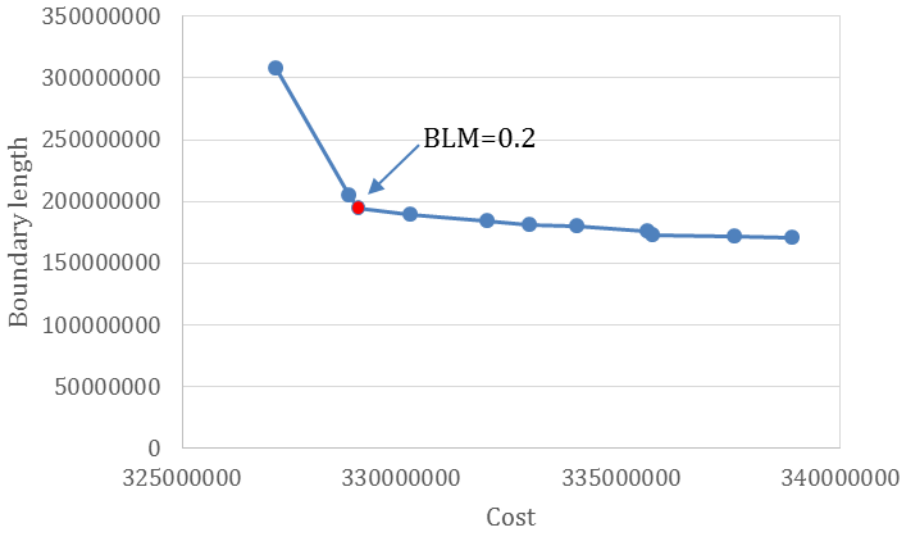

Figure A4.1 Selecting the boundary length modifier (BLM) parameter at the inflection point of the trade-off curve.

Table A4.1 Combined ecosystem and species protection gaps for marine provincial bioregions (IMCRA v4), determined from the lowest cost Marxan solution.

								Marxan best solution		
Bioregion	Area (m ha)	NRS 2002	NRS 2012	10% in 2002	10% in 2012	HPA 2012 (locked in)	OPA-> HPA (gap 1)	Unprot'd ->HPA (gap2)	OPA unchanged	Unprotected unchanged
Bass Strait Shelf Province	6.446	0.009	0.123	0	0	0.015	0.007	2.884	0.095	3.446
Cape Province	10.934	4.330	10.581	1	1	6.549	1.620	0.340	2.413	0.012
Central Eastern Province	26.659	0.000	1.626	0	0	0.000	0.194	3.946	1.433	21.086
Central Eastern Shelf Province	1.822	0.003	0.218	0	1	0.013	0.029	0.375	0.174	1.231
Central Eastern Shelf Transition	4.303	1.208	1.488	1	1	0.230	0.186	0.355	1.071	2.461
Central Eastern Transition	6.715	2.231	4.673	1	1	0.876	0.426	0.237	3.372	1.804
Central Western Province	26.846	0.000	6.071	0	1	0.295	1.229	4.754	4.547	16.021
Central Western Shelf Province	5.052	0.861	2.304	1	1	0.167	0.361	0.560	1.719	2.244
Central Western Shelf Transition	0.970	0.352	0.657	1	1	0.086	0.191	0.032	0.379	0.281
Central Western Transition	16.289	0.036	7.597	0	1	3.269	0.854	1.490	3.474	7.202
Christmas Island Province	32.800	0.000	0.000	0	0	0.000	0.000	9.830	0.000	22.970
Cocos (Keeling) Island Province	46.711	0.002	0.002	0	0	0.000	0.000	7.796	0.000	38.915
Great Australian Bight Shelf Transition	14.655	1.214	4.008	0	1	1.543	0.564	1.847	1.895	8.805
Kenn Province	5.742	0.000	5.742	0	1	2.691	0.059	0.000	2.992	0.000
Kenn Transition	37.713	0.000	29.053	0	1	16.706	0.755	1.029	11.592	7.631
Lord Howe Province	48.535	0.534	9.980	0	1	1.062	1.695	5.167	7.223	33.388
Macquarie Island Province	47.629	16.271	16.263	1	1	5.796	2.456	4.570	8.019	26.787
Norfolk Island Province	43.079	0.000	18.844	0	1	4.166	2.317	1.777	12.362	22.458
Northeast Province	44.287	3.769	44.287	0	1	20.370	4.565	0.000	19.352	0.000
Northeast Shelf Province	18.391	18.348	18.351	1	1	4.680	2.409	0.007	11.261	0.035
Northeast Shelf Transition	9.786	5.545	6.223	1	1	2.300	0.656	0.722	3.265	2.841
Northeast Transition	14.870	1.622	14.867	1	1	7.919	0.366	0.000	6.584	0.000
Northern Shelf Province	55.576	0.280	6.342	0	1	1.306	0.798	7.424	4.208	41.841
Northwest Province	17.865	0.024	2.915	0	1	0.074	0.391	2.909	2.450	12.041
Northwest Shelf Province	23.876	0.054	6.477	0	1	0.363	2.853	3.728	3.159	13.772
Northwest Shelf Transition	30.845	0.011	11.329	0	1	0.483	3.286	3.855	7.550	15.648
Northwest Transition	18.442	0.076	9.688	0	1	3.492	2.852	0.803	3.344	7.951

								Marxan best solution		
Bioregion	Area (m ha)	NRS 2002	NRS 2012	10% in 2002	10% in 2012	HPA 2012 (locked in)	OPA-> HPA (gap 1)	Unprot'd ->HPA (gap2)	OPA unchanged	Unprotected unchanged
Southeast Shelf Transition	5.961	0.077	0.560	0	0	0.060	0.318	1.027	0.177	4.379
Southeast Transition	24.191	0.000	6.420	0	1	5.966	0.029	2.509	0.425	15.262
Southern Province	77.027	0.897	30.613	0	1	15.569	1.371	6.992	13.673	39.422
Southwest Shelf Province	7.377	0.009	2.077	0	1	0.340	0.519	1.677	1.214	3.627
Southwest Shelf Transition	3.281	0.009	1.063	0	1	0.028	0.398	0.438	0.634	1.783
Southwest Transition	10.105	0.000	4.969	0	1	1.222	0.470	0.804	3.276	4.333
Spencer Gulf Shelf Province	13.316	0.013	4.909	0	1	0.338	1.533	2.120	3.036	6.289
Tasman Basin Province	15.642	0.000	7.777	0	1	0.811	1.076	0.821	5.891	7.043
Tasmania Province	29.956	0.039	9.417	0	1	2.296	1.020	2.757	6.102	17.782
Tasmanian Shelf Province	3.237	0.037	0.441	0	1	0.071	0.096	0.787	0.246	2.038
Timor Province	21.709	0.079	5.485	0	1	2.927	1.285	5.357	1.270	10.871
Timor Transition	2.409	0.000	1.187	0	1	0.000	0.296	0.301	0.891	0.916
West Tasmania Transition	28.981	0.000	3.412	0	1	0.199	0.776	4.365	2.437	21.203
Western Bass Strait Shelf Transition	3.727	0.000	0.277	0	0	0.014	0.106	0.533	0.155	2.919
TOTAL	863.757	57.940	318.316	9	35	114.294	40.412	96.925	163.359	448.738

Appendix 5. Comparisons with 2011 report

The *Building Nature's Safety Net 2011* report varied in its criteria and underlying data from the current report.[1] Statistics are therefore, not readily comparable.

Underlying data

The 2011 report was based on CAPAD 2008 which contained about 1.5 million ha of protected areas that do not appear the 2012 CAPAD. This was not due to degazettals but rather stricter rules about what is included in the 2012 CAPAD (Table A5.1). For example, the proposed boundaries of Limmen National Park (see Northern Territory section), were included although the park had not actually been gazetted. The largest contribution was from Western Australia grazing leases that had been flagged for gazettal, but for which gazettal still has not occurred as of 2012.

CAPAD 2012 only included areas gazetted or under contract for gazettal by virtue of being purchased with Australian Government National Reserve System funding, with the exception of Henbury Station, which has been excluded here.

Table A5.1 Areas included in CAPAD 2008, that were not included in CAPAD 2012, by jurisdiction and broad IUCN class.[2]

Jurisdiction	All PAs	HPAs
Ext. territories	327	327
ACT	703	703
NSW	95,256	94,127
NT	321,885	301,307
Qld	125,000	11,085
SA	6,017	1,094
Tas	472	468
Vic	1,967	1,890
WA	691,302	1,961
Marine	270,833	182
Total	1,513,759	413,238

The terrestrial ecosystem data used were also revised version of that used in the 2011 report. The 2011 report used overlaps between Major Vegetation Subgroups v3 and IBRA v6. Also in the 2011 analysis, elaborate rules were used for aggregating and reassigning intersections less than 100 ha, to avoid possible slivers being treated as distinct ecosystems. In terrestrial ecosystems as developed for this report, we defined distinct ecosystems as the intersections between Major Vegetation Subgroups v 4 and IBRA v 7 subregions. Rather than reassign intersections below 100 ha in total area, we simply removed them. We also removed any intersections involving naturally unvegetated areas or unclassified vegetation (see above).

Likewise, the marine proxy ecosystem data were updated since the previous report. We incorporated estuarine ecosystems into the benthic ecosystems layers used for the gap analysis in the last report, and aggregated to ensure no ecosystems were below 100ha.

Criteria

In the 2011 report we took a more restrictive view of requirements for meeting the standards for ecosystem and species protection, only counting progress to meeting the standard with IUCN I-II category strictly protected areas. IUCN III –VI category protected areas may be open to consumptive natural resource uses, principally livestock and fishing.

However, having reviewed the application of guidelines again, we are satisfied that such uses if they occur on land are at such small or localised levels so as not to justify separating out highly protected areas for terrestrial gap analysis.

[1] http://www.wwf.org.au/?2750/Building-Natures-Safety-Net-2011-The-State-of-Protected-Areas-for-Australias-Ecosystems-and-Wildlife
[2] We removed from the mismatched areas any slivers less than one ha in size, or with a perimeter one km per hectare of area or more.

However for marine parks we now consider IUCN I-III to be highly protected. Many nominally IUCN IV zones, such as Dugong Protected Areas in Queensland, are actually broadly open to commercial fishing with some gear restrictions. For more detail see Appendix 4.

In the 2011 report, we based the 15% minimum standard on remnant area not the original area. We now believe that criterion was inappropriately low because it reduces the standard for ecosystems that have suffered high levels of conversion. This is clearly not consistent with the best outcomes for conservation of biodiversity. In this report, we have based the minimum standard on the total area of pre-clearing ecosystems.

We changed the minimum standard for marine ecosystem sampling from 30% in the 2011 report, to a uniform 15% for both terrestrial and marine ecosystems in this report.