



REGIONAL FOREST AGREEMENTS IN NSW

Have they achieved their aims?



ACKNOWLEDGMENTS

This document is an analysis of the Regional Forest Agreements (RFAs) in NSW following their implementation. It is outside the scope of this analysis to discuss conservation outcomes as a result of the RFA process. However it is recognised that a huge effort was made by many individuals in the community, and staff at the National Parks and Wildlife Service, to ensure that conservation outcomes from the RFA process were as extensive as possible. This analysis is in no way designed to detract from those efforts.

This document has benefited from the input of many including Ashley Love, Susie Russell, Dailan Pugh, Warrick Jordan, Harriett Swift, Lorraine Bower, Frances Pike and Keith Muir. All of these people have dedicated a large part of their lives to protecting native forests, and many of NSW's iconic forest National Parks and Wilderness areas would not exist without their commitment. Hopefully this work can complement their efforts by enhancing protection of those public forests not yet in the reserve network.

Publication of this report was generously assisted by Enviroprint Australia. Their mission statement is as follows: Enviroprint Australia print locally using environmentally responsible production techniques. We are dedicated to sourcing papers offering high sustainability credentials, typically from recycled, carbon neutral and FSC mixed sources. We actively work to minimise waste and maximise resource use. We learn from each project and enjoy working with people and organisations that regard the needs of others as important to their self-worth. Our community approach offers opportunities for organisations to work together to make a positive difference to the environmental, cultural and social future of the planet we all share. We support those that support us.



NATIONAL PARKS ASSOCIATION OF NSW
protecting nature through community action

Copies of this report are available from:

The National Parks Association of NSW Inc.
P. (02) 9299 0000 | E. operations@npansw.org.au
W. www.npansw.org.au

The National Parks Association of NSW (NPA) established in 1957, is a community-based organisation with over 20,000 supporters from rural, remote and urban areas across the state. The NPA promotes nature conservation and evidence-based natural resource management.

Citation

Sweeney, O.F. (2016). Regional Forest Agreements in NSW: have they achieved their aims? The National Parks Association of NSW Inc, Sydney.

Copyright: © 2016 National Parks Association of NSW Inc.



Printed on 100% recycled paper
made carbon neutral from
100% post consumer waste.



CONTENTS

Executive Summary.....	6
Recommendations.....	10
Introduction.....	11
A brief history of a lengthy process.....	11
Regional Forest Agreement governance.....	12
Changes to the Regional Forest Agreements.....	12
Analysis of the aims and outcomes of the Regional Forest Agreements.....	13
The aims of the Regional Forest Agreements.....	13
Aim 1. The Comprehensive Adequate and Representative reserve system.....	14
Aim 2. Provide for ecologically sustainable management and use.....	15
Production and conservation: uncomfortable bedfellows.....	15
1. Native forest logging and loss of tree hollows.....	18
2. Bell-miner associated dieback.....	19
3. Fire regimes.....	20
4. Soil impacts.....	20
5. Water impacts.....	20
Aim 3. The long-term sustainability of forests and forest industries.....	22
Economic value.....	22
Jobs in forest industries.....	24
Research and development (R&D).....	25
Ecological stability.....	25
Biomass fuel production from native forests.....	26
Aim 4. Have regard for studies carried out on...27	27
i) Environmental values.....	27
Climate change.....	28
Old-growth.....	29
Wilderness.....	30
Endangered species.....	31
Case study: the koala (<i>Phascolarctos cinereus</i>).....	34

National Estate.....	36
World Heritage.....	36
ii) Indigenous heritage values.....	37
iii) Economic values of forested areas and forest industries.....	38
Economic values of forest industries.....	38
Economic values of forested areas.....	39
iv) Social values (including community needs)....40	40
Tensions remain and are reigniting.....	40
Community use of forests.....	41
Regional employment.....	41
v) Principles of Ecologically Sustainable Forest Management.....	42
The carbon cycle.....	42
Maintaining the biological diversity of forests.....	42
Optimising benefits from uses of forests.....	43
Conclusions	45
References.....	46



Abbreviations used

Abbreviation	Full term
AFCA	Australian Forests and Climate Alliance
BMAD	Bell-miner associated dieback
CAR	Comprehensive, Adequate and Representative
CRA	Comprehensive Regional Assessment
CSO	Community Service Obligation
EPA	New South Wales Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESD	Ecologically Sustainable Development
ESFM	Ecologically Sustainable Forest Management
FC	Forestry Corporation of NSW (includes previous iterations of the company)
FE	Forest Ecosystem
IFOA	Integrated Forestry Operations Approval
LGC	Large-scale renewable energy generation certificates
LNE	Lower North East
MWh	Megawatt-hour
NFPS	National Forest Policy Statement
NPWS	National Parks and Wildlife Service
NSW	New South Wales
NWI	National Wilderness Inventory
RFA	Regional Forest Agreement
UNE	Upper North East

List of Figures

Figure 1: Regional Forest Agreement regions across Australia. Grey shading denotes forests. Map courtesy of the Australian Government Department of Agriculture and Water Resources. **Pg 11**

Figure 2: The number of Forest Ecosystems in the Upper (UNE) and Lower (LNE) North East RFA regions that have met their reservation targets (green bars) and that have not met their reservation targets (blue bars). Source: NSW National Parks and Wildlife Service 2015. **Pg 14**

Figure 3: Total number of flora surveys (a) and fauna surveys (b) conducted over a three year period by Forestry Corporation of NSW and total expenditure on ecological surveys (c) over the same period. Source: Relevant Forestry Corporation Sustainability Supplements. **Pg 16**

Figure 4: Wood supply commitments (blue bars) and actual yields (green bars) of large sawlogs and veneer in the North East RFA region of NSW between 2003 and 2015. Decreases in commitments are a result of periodic timber buy-backs. Source: Research by Dailan Pugh, North-East Forest Alliance, based on NSW Auditor General figures and correspondence with Forestry Corporation. April 2016 **Pg 18**

Figure 5: A Kuczera curve describing the relationship between water yield and rotation age (or time since harvest) in mountain ash forests in the Victorian Central Highlands. Source: Michael McCarthy's Research. **Pg 21**

Figure 6: The change in value of native (green bars) and plantation (blue bars) Australian timber stocks expressed as dollars per capita unit in the decade 2004-2014. Source: Australian Bureau of Statistics 2015. **Pg 23**

Figure 7: The number of people employed in recent years where data was available in Forestry Corporation NSW (blue bars); Forestry Tasmania (orange bars); VicForests (grey bars) and the Forest Products Commission Western Australia (yellow bars). Source: relevant Annual Reports. **Pg 25**

Figure 8: The Comprehensive Regional Assessment reservation targets of number of breeding females (green bars) and the actual outcome (blue bars) for Hastings River Mouse (EPBC endangered); Spotted-tail Quoll (EPBC vulnerable); Barking Owl (NSW vulnerable); Powerful Owl (NSW vulnerable) and Yellow-bellied Glider (NSW vulnerable). Source: Flint, Pugh and Beaver 2004. **Pg 33**

EXECUTIVE SUMMARY

The Regional Forest Agreements (RFAs) were designed to provide for multiple use of native forests including nature conservation, timber extraction and recreation. The RFAs had a number of key aims which are evaluated in this study to determine the degree of success of the RFA model and provide recommendations as to the future management of native forests in light of the findings.

This study analyses the RFA aims and demonstrates that, in all cases, the RFAs have failed to substantially meet their goals either wholly or in part. The process of RFA development was flawed and subsequent governance in regards formal changes to the RFAs and timely reporting has not been to a sufficient standard. The RFA model has therefore failed to deliver effective management of public native forests. Despite evidence that the RFAs have failed, the Australian Government is committed to rolling 20-year extensions without any review as to the current ecological status of forests or reference to new information since the RFAs were signed (Commonwealth of Australia 2015, Lindenmayer et al. 2015). The evidence suggests that extending the RFAs would be detrimental socially, economically and environmentally. Therefore the Commonwealth policy of automatic extension of the RFAs after their expiry should be rejected by NSW. Efforts should begin immediately to ensure a just transition of those employed in logging to other industries and to capitalise on the potential for native forests to provide opportunities for growing coastal populations, provide valuable ecosystem services, underpin efforts to tackle climate change and reverse the declines of iconic wildlife species.



Greater gliders have experienced recent sharp population declines and local extinctions –this should serve as a stark warning as to complacency. Photo: Dave Gallian

Aim 1: a Comprehensive, Adequate and Representative reserve system

The Comprehensive, Adequate and Representative (CAR) reserve system was key to efforts to ensure that the RFA process provided adequate protection for forest ecosystems and threatened species. In the North East RFA region of NSW (the only region for which adequate data could be obtained) a CAR reserve system has not been achieved. This failure is a key reason as to why there is continued social unrest over native forest logging. Current reserves in the region are biased towards steep or infertile land and do not protect those ecosystems most vulnerable to clearing or which are already most compromised. The lack of a strategic methodology to determine reserve placement during the RFAs has resulted in a fragmented reserve system which is unable to meet the habitat needs of many forest species.

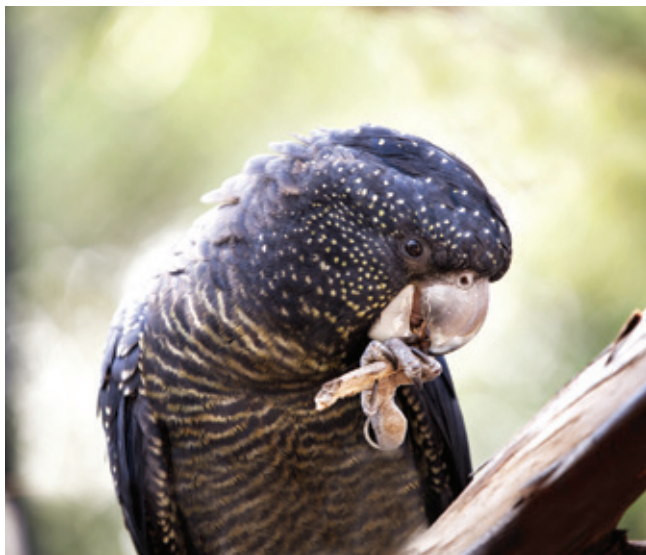


The RFAs have not delivered a Comprehensive, Adequate and Representative reserve system of Forest Ecosystems

Aim 2: provide for the ecologically sustainable management and use of forested areas

There is an inherent contradiction between managing forests under the principles of Ecologically Sustainable Forest Management (ESFM) and maximising wood production and profits, because efforts to protect the environment add costs and reduce timber yields. This has led to multiple documented license breaches. Examples of how logging is not consistent with ESFM are provided including the predicted ecosystem collapse of mountain ash forests in the Central Highlands RFA region in Victoria, loss of tree hollows in logged forests, bell-miner associated dieback, altered fire regimes via logging and soil and water impacts. Provision of water supplies of adequate quantity and quality is one of the key functions of forested

catchments. In light of the impacts of logging on water quantity, water quality and fire regimes and of climate change predictions of increasing temperatures, more frequent droughts and decreased rainfall in south-eastern Australia, ensuring forested catchments are protected should be a priority for government.



Logging removes key habitat features such as large tree hollows which provide nesting sites for many native birds including red-tailed black cockatoos

Aim 3: provide for the long-term stability of forests and forest industries

The accreditation of native forest logging under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) via the RFA process was designed to provide long-term security for forest industries. The value of Australia's native timber stocks have declined by 30% to \$2 billion between 2005 and 2015, and hardwood sawnwood production declined by 44% over a similar period. In contrast plantation stocks increased in value to \$10 billion and softwood sawnwood production has increased by 10%. Forestry Tasmania lost \$64 million and Forestry Corporation \$84 million between 2009 and 2012 in native forest logging operations. Forestry Corporation also receives annual funding from NSW Treasury in the form of a Community Service Obligation—worth \$15.6 million in 2014-15. Direct employment by forestry and logging (including both the native and plantation sectors) in NSW was 2131 according to the 2011 census, and extended employment 5166, or 0.02% of primary industries employment. Across Australia, 7561 people are directly employed in forestry and logging, with indirect employment estimated as 18,328. Employment in the

native forest logging sector in NSW is estimated to be approximately 600, and in Tasmania under 1000. Research and development funding and activity has declined steadily. Innovation, industry restructures and reduced log availability—not conservation—have been the key drivers behind employment declines in the industry. Biomass production from native forests is an emerging market for the logging industry. Biomass has resulted in perverse outcomes in Europe is carbon intensive and is therefore not an appropriate use of native forests. Forestry Corporation has failed to meet its reporting requirements in regards changes in extent and growth stage of forest ecosystems and it is therefore not possible to accurately assess the stability of these elements of the public forest estate.



There are now very few jobs in native forest logging as a result of mechanisation, innovation and industry restructures

Aim 4: have regard to studies and projects carried out in regards to:

- (i) *Environmental values, including old-growth, wilderness, endangered species, National Estate values and World Heritage values*

The RFA model has not facilitated the adoption and implementation of research on environmental values. Two RFA regions are now incorporated in global biodiversity hotspots, 50% of Australia's forest and woodland cover has been lost and 70% of remaining forests have been degraded by logging. Climate change, now the key global issue post-Paris, was not as high a priority at the development of the RFAs. Forty-four percent of carbon stocks have been lost from Australian forests. Logged forests store between 40 and 60% less carbon than undisturbed forests, yet undisturbed temperate eucalypt forests, such as

those logged under RFAs, are the most carbon-dense on earth. Substantial emissions could be avoided were logging to end. The concept of old-growth is not universally accepted within the conservation community, and the protection of old-growth was slow. There have been several documented incidences of logging of old-growth forests in NSW since the RFAs, and in Tasmania logging old-growth is a major reason why Forest Stewardship Certification is not achievable. Although protected wilderness doubled between 1997 and 2007 the prevention of wilderness declaration under the IFOAs has hindered wilderness reservation. The RFAs failed to attain reservation targets for threatened species and weakened protection for threatened species as compared to the rigour of



Koala populations are declining alarmingly throughout NSW

the *EPBC Act*. The impact on species by logging is discussed using the koala as a case study. The concept of the 'extinction debt' means that the full impacts of logging on native species may not be seen until it is too late to prevent extinction, therefore evidence of declines should be acted upon immediately. The direct impact of logging on native fauna is evident via research that used counts of dead animals by logging crews to determine distributions. There are World Heritage values in the North East RFA region and the Southern and Eden RFA regions of NSW that should be considered for nomination.

(ii) Indigenous heritage values

The RFA process failed to facilitate Aboriginal involvement to any more than a marginal degree and only addressed cultural significance, not economic needs or legal rights. The 20-year nature of the RFAs has effectively suspended native title claims over their duration. The 'Tasmanian Wilderness' World Heritage area is the only World Heritage area in an RFA region that considers Indigenous values alongside natural values. Mumbulla mountain, on the south coast of NSW is an example of where well-documented Indigenous values failed to prevent logging operations from being conducted. The Bundian Way, an ancient Aboriginal pathway, may meet world heritage criteria 'Complex persistence of a hunting-and-gathering society on a single continent'.

(iii) Economic values of forested areas and forest industries

As per *Aim 3*, both Forestry Tasmania and Forestry Corporation sustained substantial losses in native forest logging operations between 2009 and 2012 (\$64 million and \$85 million respectively). Projections from the Eden and Southern RFA regions predict a loss of between \$40 and \$70 million between 2014 and 2033. New Zealand, which ceased native forest logging in the late 1980s exported \$3.4 billion worth of wood in 2012 and is an example of how a shift from native forest logging to plantations can be an economically sound decision. Current valuations of forested areas only consider timber and do not include ecosystem services or nature. Control of erosion and water flows by protected areas in Australia were estimated to be worth \$1.5 and \$2.4 billion respectively in 2012. Carbon credits could deliver an estimated \$222 million for the Eden and Southern RFA regions between 2014 and 2022.

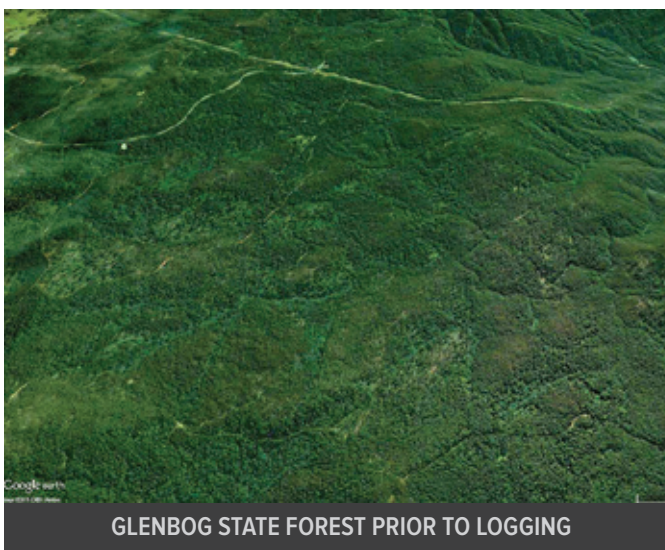
(iv) Social values (including community needs)

The RFA process has failed to resolve social conflict over forests and the community has not accepted the RFA outcomes as being adequate to protect biodiversity values. In NSW, the current drafting of new Integrated Forestry Operations Approvals (IFOAs) is exacerbating tension and is a source of deep mistrust between environment groups and the NSW Environment Protection Authority (EPA). Environment groups believe that the introduction of new rules during current RFAs breaches the RFAs and that the new IFOA is designed to lower the costs of forestry operations rather than safeguard the environment. Although recreation activities are permitted in state forests the infrastructure is often of poor quality as providing for recreation is a secondary function of state forests. Research demonstrating health benefits and significant savings to the state via contact with nature, and a goal of the NSW Premier to reduce childhood obesity, demand that community use of state forests is expanded and facilitated. This is particularly important in light of population growth projections for NSW that show that many coastal regions will experience significant population growth by 2030. Regional jobs provided by logging are now very few. Options to increase employment opportunities exist via appropriate development of the plantation industry and growing regional employment via managing state forests for carbon storage and increasing funding for the NPWS in accordance with the role of natural areas as the key driver of regional tourism.

(v) Principles of Ecologically Sustainable Forest Management

Examples are given in three areas of ESFM: maintaining ecological processes within forests; maintaining the biological diversity of forests and optimising benefits to the community within ecological constraints.

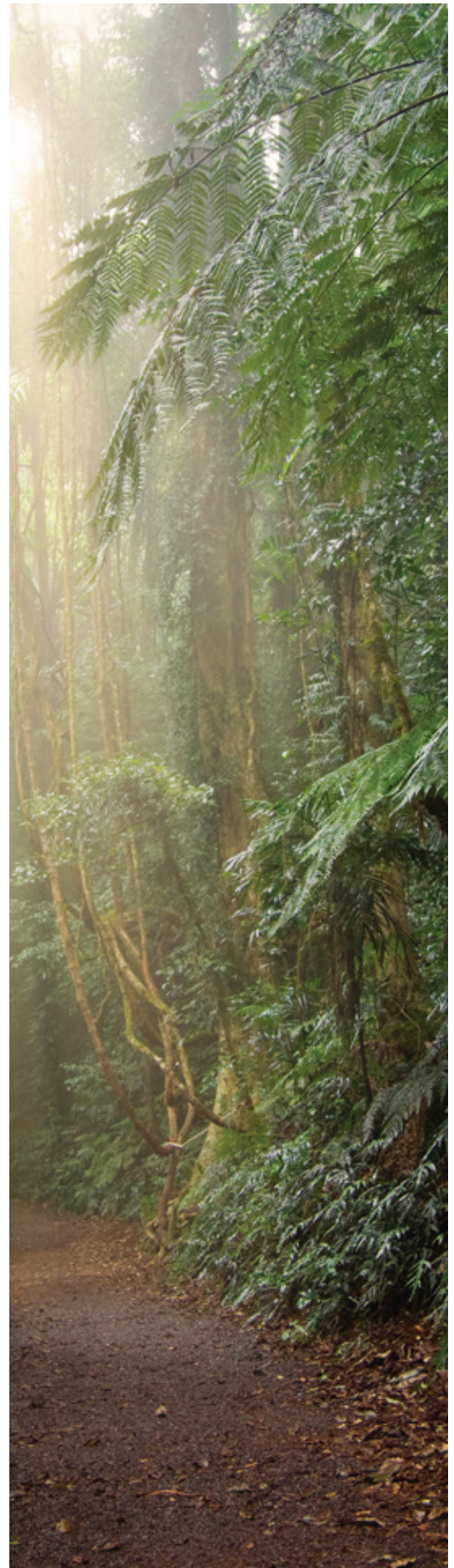
In the case of ecological processes, disruption of the carbon cycle in logged forests is a clear violation of the principles of ESFM. Carbon transfer away from forests is increasing and forest products are typically short-lived meaning carbon is rapidly lost to the atmosphere. Logged forests store 40-60% the quantity of carbon of undisturbed forests. It is difficult to demonstrate a reduction in the biological diversity as a result of logging, potentially because the 'extinction debt' will take a long time to become evident. However, the number of forest-dependent species assessed as threatened is increasing and some species have experienced rapid declines. The precautionary principle is not being adhered to in current management. Desiccation via logging makes logged areas more susceptible to fire while also diminishing the capacity of forests to provide water for human use. Logging is not an optimal use of forests because it jeopardises natural values which are the primary drivers of tourism—the most important industry for regional Australia and a key strategic concern of the NSW government. In contrast, protected areas provide documented economic benefits to regional communities in a variety of areas.



Satellite imagery clearly shows the major impact that native forest logging has on State Forests such as Glenbog in southern NSW. Images: Google Earth

RECOMMENDATIONS

1. That the NSW and Australian Governments make an evidence-based decision to end native forest logging on public land following the expiry of the RFAs.
2. That the NSW Government abandon plans to develop a new Integrated Forestry Operations Approval and reject the Commonwealth policy of an automatic extension of the RFAs.
3. That the NSW and Australian Governments abandon the use of native forest products in the production of energy from biomass burning.
4. That the Auditor General of NSW conducts an audit of the NSW Regional Forest Agreements in respect to:
 - a. The proportion of the Comprehensive, Adequate and Representative reserve network of Forest Ecosystems (FEs) that has been secured and the ecological condition of the outstanding FEs;
 - b. The extent to which the RFAs provided equivalent protection of threatened species to that afforded under the Commonwealth EPBC Act;
 - c. The current conservation status of threatened forest species;
 - d. The committed and actual volumes of timber supplied each year from public native forests during the life of the RFAs.
5. That the outstanding Forest Ecosystems necessary for a CAR reserve network of Forest Ecosystems in NSW are added to the reserve network immediately upon completion of the audit.
6. That the NSW Government take the necessary action, including committing adequate funds, to recover threatened species populations in public native forests.
7. That the NSW Government invest sufficient funds to ensure the natural values of public native forests can be restored and that key threats such as weed incursion, bell-miner associated dieback and the loss of tree hollows are reversed as quickly as possible.
8. That the NSW Government immediately commence widespread consultation with the community, academics and other stakeholders to develop a transition strategy from native forest logging that enhances economic and employment opportunities for regional communities, while protecting the key regional asset—nature.
9. That the NSW Government investigate national and international opportunities to generate revenue from the carbon sequestration potential of native forests to fund forest management.



INTRODUCTION

A brief history of a lengthy process

The National Forest Policy Statement (Commonwealth of Australia 1992, 1995) launched the Comprehensive Regional Assessment (CRA) and Regional Forest Agreement (RFA) process. Unfortunately, a precursor to the National Forest Policy Statement, the survey of Australia’s forest resource conducted by the Resource Assessment Commission (Resource Assessment Commission 1992), failed to assess the impacts of humans on forests. This was a crucial omission and undermined the aim of the RFA process to achieve sustainable forest management (Lunney 2004).

The Comprehensive Regional Assessment (CRA) process was the precursor to the RFAs but did not achieve scientific credibility as it did not adhere to the principles of peer-review, scientific debate, and transparency of methodology. As a result the process could not be checked (Horwitz and Calver 1998). The CRA process was intended to investigate a broad suite of social and economic forest issues, including the value of alternative forest uses such as tourism and water. However, the quality of the data pertaining to

these issues—particularly in regards ecosystem service valuation—was poor (McDonald 1999). Furthermore, the scientific process developed was amended during the RFAs and therefore became a compromise between conservation and development (Kirkpatrick 1998). As a result the RFA process has been flawed from its inception and has failed to deliver a landscape-reserve system that can accommodate diverse requirements (Meek 2004).

The RFAs were designed to accommodate multiple uses in public forests, including wood production, conservation and recreation. RFAs are the mechanism by which the states are permitted to log native forest under accreditation from the Commonwealth Government. There are 10 RFA regions across four states, NSW, Victoria, Tasmania and Western Australia (Figure 1). Under this structure, the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) does not apply to logging operations. However, a review of the EPBC Act (Hawke 2009) stated that if the conditions of the EPBC accreditation of forestry operations under the RFAs were not complied with, or there was insufficient information to verify compliance, then the accreditation should be terminated.

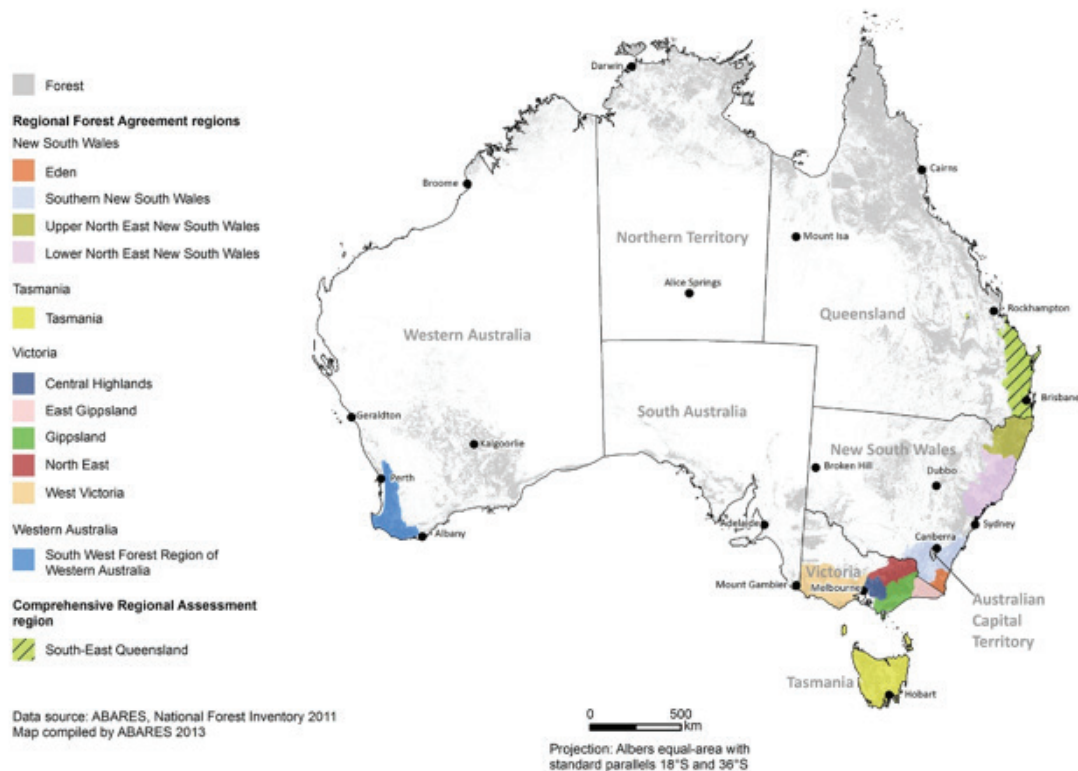


Figure 1: Regional Forest Agreement regions across Australia. Grey shading denotes forests. Map courtesy of the Australian Government Department of Agriculture and Water Resources.

Regional Forest Agreement governance

One of the key mechanisms to verify compliance with the RFAs was via reviews. Annual reviews were required for each of the first five years of operation of RFAs. However, for NSW, annual reviews are only available for years one and two of the RFA implementation. Each RFA also provides for regular, five-yearly reports on their implementation. The first reviews should have therefore been in 2004-2006. In the case of NSW, the one and only review was begun the ninth year of the RFAs (NSW Department of Environment and Climate Change 2009) and completed in the fourteenth. Both reporting and RFA milestone delivery has therefore been slow and inadequate (Spencer 2009).

Changes to the Regional Forest Agreements

The RFAs contain provisions for the adoption and incorporation of changes to the RFAs based on agreement between the individual states and the Federal Government. There has been some compliance with this provision: for example three formal changes were adopted for the Tasmanian RFA prior to the processes of the last five years which have made the RFA effectively redundant. However, NSW has not complied with requirements for formal changes to RFAs to reflect fundamental changes in forest management. For example, in the North East RFA region major changes have occurred to the reserve network and wood supply agreements—including financial compensation—without amendment to the RFA. Currently a new Integrated Forestry Operations Approval is being developed to guide harvesting regimes in the North East, Eden and Southern RFA regions without any discussion of amendments to the RFAs (NSW Environment Protection Authority 2015a).





ANALYSIS OF THE AIMS AND OUTCOMES OF THE REGIONAL FOREST AGREEMENTS

The aims of the Regional Forest Agreements

The key aims of the Regional Forest Agreements are:

1. Identify areas in the region or regions that the parties believe are required for the purposes of a Comprehensive, Adequate and Representative Reserve System, and provide for the conservation of those areas;
2. Provide for the ecologically sustainable management and use of forested areas in the regions;
3. Provide for the long-term stability of forests and forest industries;
4. Have regard to studies and projects carried out in relation to all of the following matters that are relevant to the regions:
 - i. Environmental values, including old-growth, wilderness, endangered species, National Estate values and World Heritage values;
 - ii. Indigenous heritage values;
 - iii. Economic values of forested areas and forest industries;
 - iv. Social values (including community needs);
 - v. Principles of Ecologically Sustainable Forest Management.

This report analyses each of these aims in turn and finds that the RFAs have, either substantially or in part, failed in their aims. The report is primarily NSW focussed but, where possible and relevant, incorporates information from other RFA regions including in Victoria, Tasmania and Western Australia.

Aim 1. The Comprehensive Adequate and Representative reserve system

Globally, protected areas are biased to steep slopes far from roads and human civilization, which means they are protecting areas that were not desirable for agriculture or extractive uses (Joppa and Pfaff 2009). This bias, and the need to put reserves in places where they can prevent species declines and extinctions (Venter et al. 2014), was recently restated in the Promise of Sydney at the World Parks Congress¹. Consistent with this trend, there is a strong documented reserve bias of Forest Ecosystems (FEs) towards steep and infertile areas in NE NSW which has resulted in failure to protect those FEs most vulnerable to clearing and which have already been most compromised (Pressey et al. 1996, Pressey et al. 2002, NSW Environment Protection Authority 2015b). Timber requirements, not the habitat requirements of fauna, was the primary determinant of reserve

size during the RFA process, although fauna were a parameter in determining reserve placement. However, there was no method to determine or implement an ideal spatial configuration of reserves (Flint et al. 2004). Such opportunistic reserve placement is recognised as an inferior strategy for conservation purposes than strategic reserve planning, such as in the creation of a true CAR reserve network (Pressey et al. 1993).

Environmental protection was a core aim of the RFAs, and the implementation of the CAR reserve network of FEs was central to that aim (Hawke 2009). Yet in NSW it is clear that the RFA reservation targets have not been met. In the Upper and Lower North East RFA regions in NSW (the only RFA region for which data could be obtained at the time of writing), most FEs have not yet met their RFA reserve targets (Love and Sweeney 2015) (Figure 2). Many of these FEs require considerable additions to achieve reservation targets agreed under the RFAs.

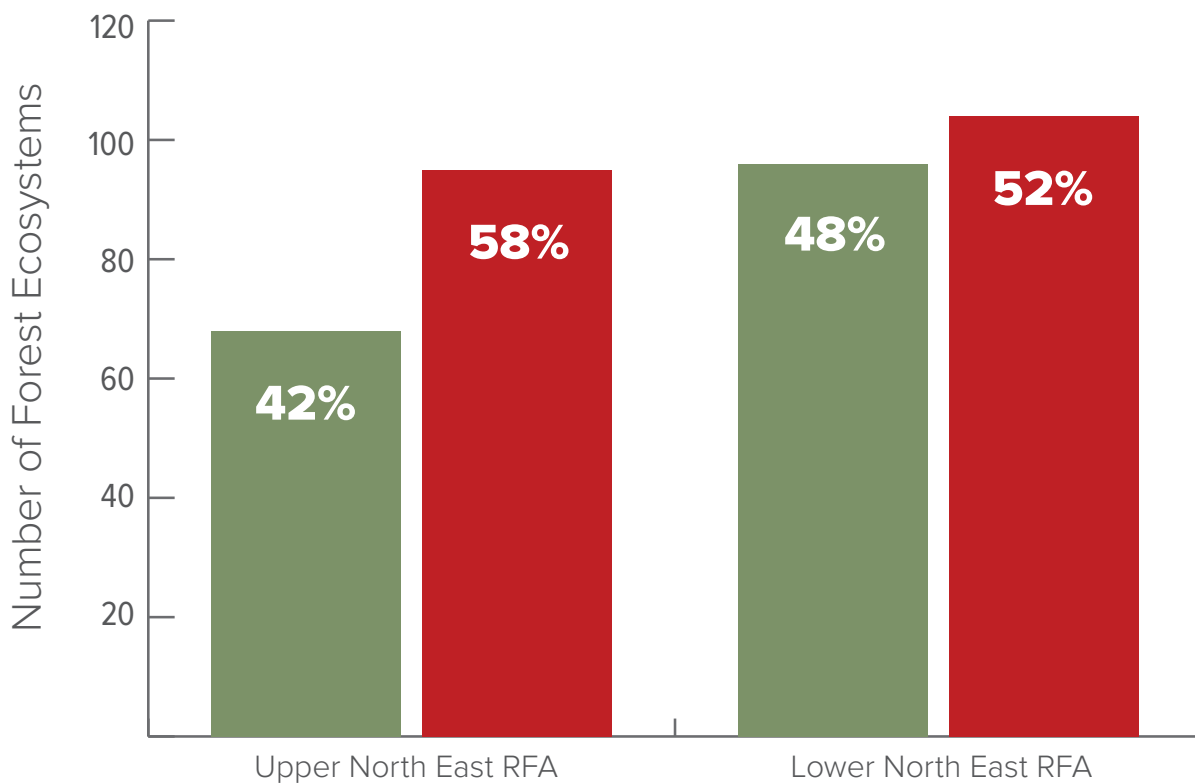


Figure 2: The number of Forest Ecosystems in the Upper (UNE) and Lower (LNE) North East RFA regions that have met their reservation targets (green bars) and that have not met their reservation targets (red bars). Source: NSW National Parks and Wildlife Service 2015.

1. <http://worldparkscongress.org/downloads/approaches/Stream1.pdf>

There is still a considerable way to go to achieve a CAR protected area network in Australia (Dunlop et al. 2012) and NSW (Department of Environment and Climate Change NSW 2008a) and the completion of the CAR reserve system of Forest Ecosystems (FEs) is an important component of this.

The reservation of as many habitats as possible is identified as being of primary importance in conserving maximum biodiversity in the face of climate change (Dunlop and Brown 2008) and conserving maximum biodiversity is in turn a prudent measure to ensure that the risk to ecosystem service provision from climate change is minimised (Cork et al. 2007). The completion of the CAR network of FEs is of paramount importance in the effective conservation of forest flora and fauna because species with greater distribution overlap with strictly protected areas have more populations that are stable or increasing than those with less overlap (Taylor et al. 2011). Informal reserves and areas protected by management prescriptions are not reserved under an International Union for the Conservation of Nature (IUCN) category (Dudley 2008, Worboys et al. 2015) and are not subject to the *National Parks and Wildlife Act 1974*. They can therefore be considered less secure than formal reserves.

Aim 2. Provide for ecologically sustainable management and use

Australia's National Forest Policy Statement (Commonwealth of Australia 1992, 1995) specified three key requirements to sustainable forest use and which were accepted by the Statement as the basis for ecologically sustainable development (ESD). These were:

1. Maintaining the ecological processes within forests (the formation of soil, energy flows and the carbon, nutrient and water cycles);
2. Maintaining the biological diversity of forests and;
3. Optimising the benefits to the community from all uses of forests within ecological constraints.

The NSW Environment Protection Agency defines ecologically sustainable forest management (ESFM) in broadly similar terms (NSW Environment Protection Authority 2015c):

1. Maintain or increase the full suite of forest values for present and future generations across the NSW native forest estate;

2. Ensure public participation, access to information, accountability and transparency in the delivery of ESFM;
3. Ensure legislation, policies, institutional framework, codes, standards and practices related to forest management require and provide incentives for ecologically sustainable management of the native forest estate;
4. Apply precautionary principles for prevention of environmental degradation;
5. Apply best available knowledge and adaptive management processes.



Intensive logging, such as here in Boyne State Forest in 2016, severely disrupts ecological processes. Photo: John Perkins

Production and conservation: uncomfortable bedfellows

There is an inherent contradiction between managing forests according to ESFM principles and maximising wood production and profit. This is because efforts to protect the environment, such as pre and post-harvest ecological surveys, protection of key habitat features, and management of weeds add cost and reduce timber yields (Ajani 2003). An outcome of this contradiction is illustrated in Figure 3: as Forestry Corporation (FC) has strived to reduce losses from its native forest logging operations, the number of ecological surveys and the expenditure on those surveys has fallen markedly in recent years (see also section 3 and Figure 6 for further explanation). It is cost cutting measures such as these and staff reductions (see Figure 7), that are responsible for the smaller economic loss returned by the native forest logging sector of FC in 2014-15 rather than any increase in revenue or profitability (Campbell and McKeon 2015).

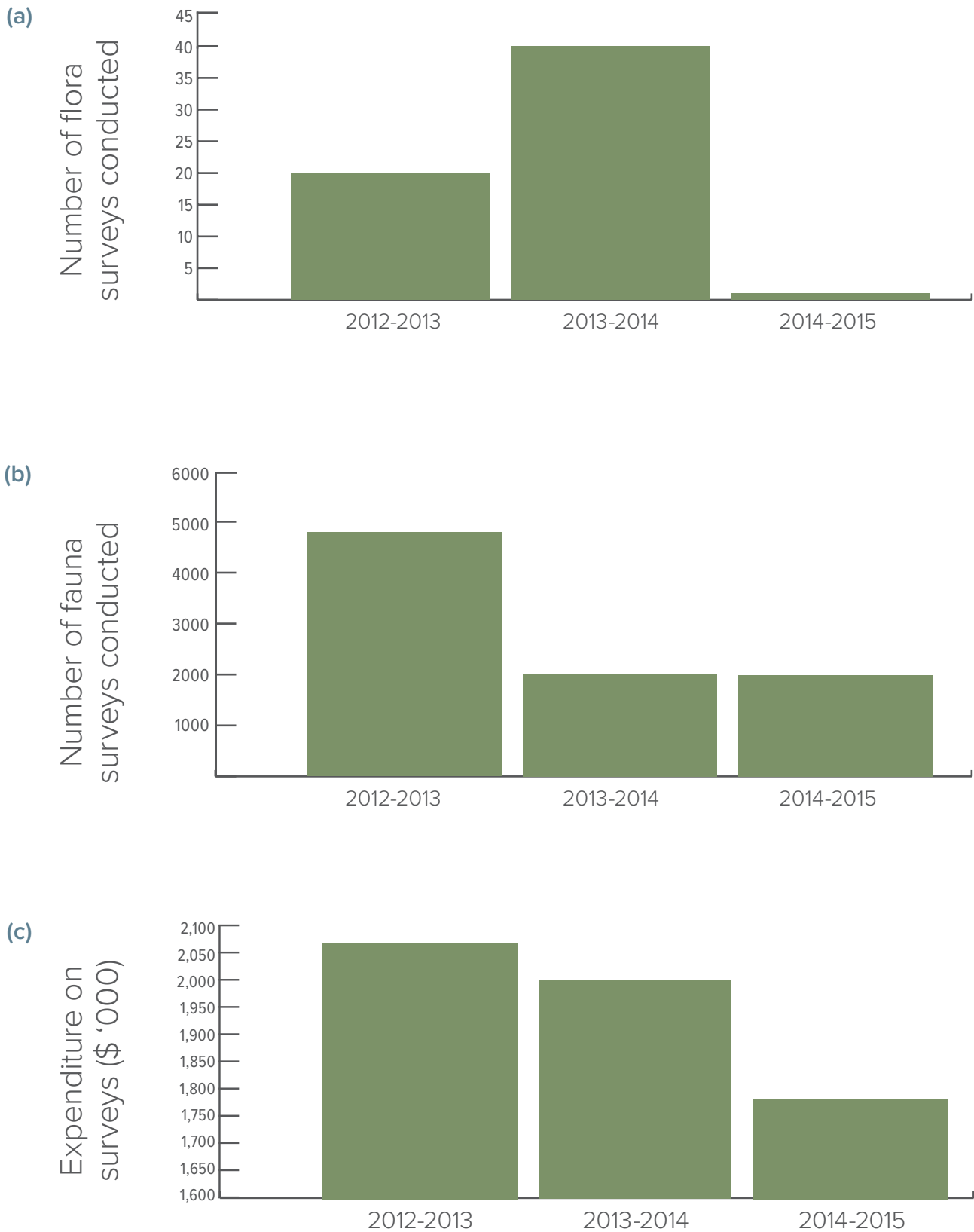


Figure 3: Total number of flora surveys (a) and fauna surveys (b) conducted over a three year period by Forestry Corporation of NSW and total expenditure on ecological surveys (c) over the same period. Source: Relevant Forestry Corporation Sustainability Supplements.

The difficulty in combining adequate protection for forest species and ecological communities is also highlighted by the number and severity of breaches of the IFOAs by Forestry Corporation. Forestry Corporation has multiple responsibilities in regards environmental protection during forestry operations, and has been shown to have breached several. Breaches include: failure to mark-up exclusion zones and habitat features; failure to complete koala surveying; failure to observe outcrop exclusion zones; failure to retain recruitment and habitat trees; logging within stream exclusion zones; piling of debris around habitat trees and breaches of reporting requirements (Hammond-Deakin and Higginson 2011). This report concluded that 'The breaches reported in the breach reports undertaken by NSW conservation organisations are numerous and wide ranging, such that it is not possible to conclude that [then] Forests NSW is operating in a manner that is consistent with ESFM.'

Timber harvesting models were flawed at the inception of the RFAs (Burgman et al. 1994) which locked in

unsustainable practices and undermined the principles of ESFM from the outset. Unsustainable logging practices coupled with extensive fires are the reason that the mountain ash (*Eucalyptus regnans*) forests in the Central Highlands RFA region in Victoria have a >90% chance of ecosystem collapse by 2067 (Burns et al. 2015). Only 1.16% of the mountain ash forest is both unburned and unlogged and stands under 72 years old are dominant (Lindenmayer et al. 2012). Ecosystem collapse is not compatible with the principles of ESFM.

Inaccurate estimates of wood supply volumes and associated unsustainable forest management also occur in NSW. The annual commitments on in the North East RFA region as a result of the RFA was 260,000m³ per year for the life of the RFA. However, in 2009, the NSW Auditor General stated 'to meet wood supply commitments, the native forests managed by Forests NSW (now Forestry Corporation) on the north coast is being cut faster than it is growing back' (Audit Office of New South Wales 2009). Therefore under both current and planned rotation cycles the flora and fauna



The impacts on soils and vegetation of heavy industrial machinery means logging and conservation are incompatible. Photo John Perkins

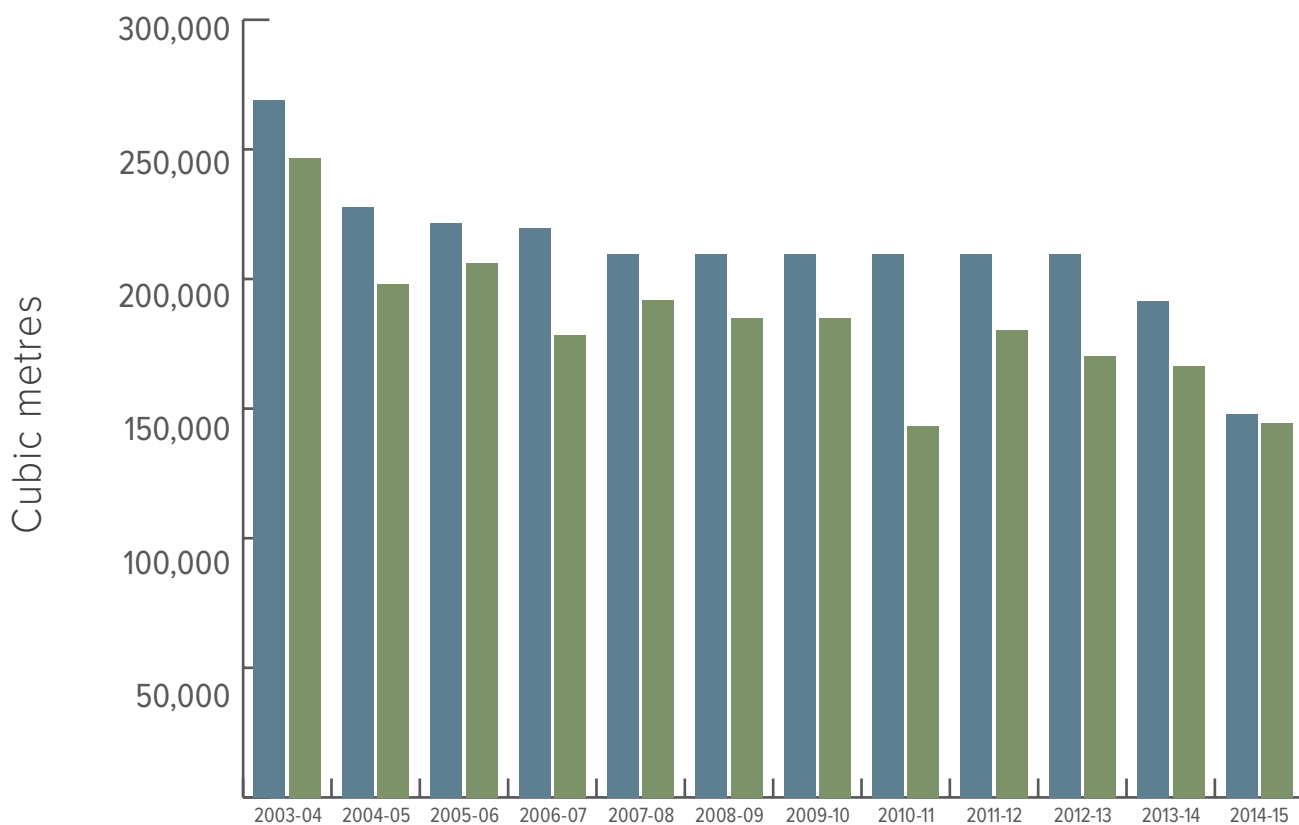


Figure 4: Wood supply commitments (blue bars) and actual yields (green bars) of large sawlogs and veneer in the North East RFA region of NSW between 2003 and 2015. Decreases in commitments are a result of periodic timber buy-backs. Source: Research by Dailan Pugh, North-East Forest Alliance, based on NSW Auditor General figures and correspondence with Forestry Corporation. April 2016

of forest ecosystems cannot persist, and this form of management is therefore not consistent with ESFM. Since 2007, actual yields of large sawlogs and veneer have been lower than wood supply commitments in the North East RFA region and yields have been on a downward trajectory—despite adjustments of supply commitments (Figure 4) (see also section 3).

Forestry practices destroy and modify forest landscapes and forest heterogeneity, prevent or impede ecological processes, kill animals therefore modifying populations and assemblages of species, modify habitat and have implications for the evolutionary potential of forest species (Norton 1996). All of these impacts of native forest logging are inconsistent with the aims of ESFM. Four key examples are illustrated below:

1. Native forest logging and loss of tree hollows

Australia's forest fauna is disproportionately dependent on tree hollows, with between 18 and 28% of all vertebrate fauna utilising hollows depending on region

(Smith and Lindenmayer 1992). Although eucalypt forest covers only 8.3% of Australia, it supports 47% of all hollow-using vertebrates indicating a strong concentration of hollow-using species in forests (Gibbons and Lindenmayer 2002). Hollow-dependant wildlife is most sensitive to logging (Kavanagh et al. 1995, Loyn 2004, Kavanagh and Stanton 2005).

The probability of a hollow forming and the rate of formation varies between species of eucalypt (Gibbons and Lindenmayer 2002). Therefore logging operations will inevitably affect both the density of hollows and the rate of formation as some timber species are preferentially targeted by loggers if available and promoted in regrowth (e.g. blackbutt, *Eucalyptus pilularis*, for timber flooring and silvertop Ash, *E. sieberi*, for woodchipping). The age at which a tree develops a hollow also varies with species, and this age is typically younger than the age at which hollows suitable for vertebrate fauna develop. Generally, suitable hollows are not present in trees below 120-180 years old, and in some species large hollows are rare in trees less

than 240 years old (Gibbons and Lindenmayer 2002). The large timescales required for hollow formation are therefore not compatible with the short rotation lengths typically practiced in native forests.

Native forest logging is identified as a key threat to forest fauna as it drives habitat destruction and the loss of key habitat features such as large old trees and the hollows they possess (Smith and Lindenmayer 1992, Kavanagh and Stanton 2005, Eyre et al. 2010, Lindenmayer et al. 2012, Lindenmayer et al. 2014). Logging is identified as a contributing factor to the key threatening process in NSW 'loss of hollow-bearing trees' (NSW Scientific Committee 2007) because it shifts the age-class distribution of trees from old, hollow-bearing trees to younger trees with fewer hollows (Lunney and Matthews 2004). In NSW, the proposed remake of the Integrated Forestry Operations Approvals (IFOA) (NSW Environment Protection Authority 2015a) has been independently assessed as likely to further accelerate the loss of key habitat features such as hollow-bearing trees (Milledge 2015).

This loss of hollow-bearing trees via logging is identified as a threat to many iconic forest-dependent mammals including the brush-tailed phascogale (*Phascogale tapoatafa tapoatafa*); yellow-bellied glider (*Petaurus australis*); greater glider (*Petauroides volans*); squirrel glider (*Petaurus norfolcensis*) and Leadbeater's possum (*Gymnobelideus leadbeateri*) (Woinarski et al. 2014). The RFAs have therefore not facilitated ESFM as measured by the impact of logging on tree hollow retention and associated impacts on forest mammals.

2. Bell-miner associated dieback

In NSW the Key Threatening Process 'forest eucalypt dieback associated with over-abundant psyllids and Bell Miners' (BMAD) is in part driven by logging (NSW Scientific Committee 2008). Although not specifically identified in the key threatening process 'invasion, establishment and spread of *Lantana camara*', logging is highly likely to play an important role as disturbance is a key factor in facilitating *Lantana* invasion (NSW Scientific Committee 2006). In turn, *Lantana* invasion is thought to play an important role in driving BMAD (Wardell-Johnson et al. 2006).

Bell-miner (*Manorina melanophrys*) associated dieback (BMAD) is a complicated cascade of ecological and abiotic interactions that ultimately serve to promote dieback in canopy eucalypts. It is an excellent example

of how logging disturbs ecological processes which in turn negatively impacts biodiversity values. BMAD is most damaging in moist forests such as in NE NSW where it is identified as a significant threat to that region (Wardell-Johnson et al. 2005). In 2004, 20% of susceptible forests in NE NSW were already affected by BMAD, and 2.5 million hectares of forest are estimated to be at risk in eastern NSW (Wardell-Johnson et al. 2006). BMAD has also been detected on the NSW Central Coast (Stone et al. 2008) and, because it can affect drier forests, close to Melbourne (Wardell-Johnson et al. 2006).

Logging is thought to play a role in BMAD via disturbance to the forest which promotes dense understory growth favoured by bell-miners (Stone 2005, Stone et al. 2008). For a detailed literature review of logging dieback in NE NSW see (Pugh 2014). A simplified explanation of BMAD is:

- i. Logging opens the forest canopy changing insolation levels and facilitating invasion by *Lantana* which can serve to change the nutrient balance of the site;
- ii. The logged area provides habitat favoured by bell-miners (Kavanagh and Stanton 2005) and bell-miner density increases;
- iii. If the nearby trees have high insect loads, the density of bell-miners is maintained and bell-miners aggressively reduce the abundance and diversity of small insectivores;
- iv. The reduction in insectivorous birds results in ongoing high levels of herbivorous insect loads;
- v. This herbivory causes canopy decline, loss of vigour, increased susceptibility to stress and pathogens (Stone 2005) and ultimately tree death.



Bell miners are a native species, but logging influences their behaviour which in turn can drive dieback in eucalypt forests Photo: Wikimedia Commons



Recent logging was shown to have increased the probability of a crown fire in the Black Saturday bushfires. Photo: CSIRO

3. Fire regimes

Logging can increase the susceptibility of moist forests—such as those found in all RFA regions—to fire via several methods (Lindenmayer et al. 2009):

- Changing the microclimate by removing the canopy;
- Changing stand structure and composition;
- Changing fuel characteristics (e.g. via adding fine fuel for ignition);
- Changing ignition points (e.g. via road creation) and;
- Changing the spatial pattern of stands which can influence fire spread.

In addition, moist forest regrowth post-logging may be particularly susceptible to fire when young due to a rapid build-up of fine fuel and changed microclimatic conditions. In forest ecosystems that regenerate from seed rather than epicormic growth, such as the mountain ash (*Eucalyptus regnans*) forests in the Central Highlands RFA region in Victoria, a crown-consuming fire can be catastrophic if it occurs before the regrowth has had time to flower and seed (Taylor et al. 2014a). In the 2009 Black Saturday fires in Victoria, recent logging increased the probability of a crown fire in a range of forest types (Price and Bradstock 2012, Bradstock and Price 2014).

4. Soil impacts

Cable logging operations can increase soil bulk density, decrease organic carbon content and displace topsoil (Laffan et al. 2001) while ground-based logging decreases organic matter and organic carbon, macroporosity and saturated hydraulic conductivity and increases bulk density in forest soils (Rab 1994, 1996). Increased bulk density in turn reduces growth rates of *E. regnans* (Rab 1994) which has implications for forest recovery post-logging. The loss of organic matter from soils breaks down existing soil aggregations and prevents the formation of new aggregates because organic matter acts to cement particles. Because larger aggregates are more resistant to erosion the loss of organic matter, particularly when coupled with increased soil exposure via logging, can increase the potential for erosion (Rab 1996). The negative effects of native forest logging on soil physical properties are still measurable after 10 years (Rab 2004). Compaction by machinery can occur in both sandy and clayey soils (Ampoorter et al. 2012) and recovery from compaction may be slow (<5 years) though infiltration rates may increase and erosion rates decrease faster than this (Croke et al. 2001). Based on evidence from the Central Highlands RFA region, the level of soil disturbance associated with logging does not meet the Montreal Process Criteria (Rab 1999) which are the agreed principles of forest management adopted by the National Forest Policy (Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee 2013).

5. Water impacts

Globally, one third of the world's largest cities rely on forested areas for their water supply—including metropolises such as Mumbai, Tokyo, New York, Rio de Janeiro and Los Angeles. Sydney, Perth and Melbourne also rely on forested catchments to deliver reliable, clean water supplies (Dudley and Stolton 2008), as do many smaller settlements on the eastern seaboard. However, only in the case of Perth is the forested area entirely protected in a national park: mining is permitted in the Sydney catchment and much of the Melbourne catchment is available for logging. Logging has documented impacts on both the quantity and quality of water supplies. This has serious implications for many settlements on the Australian coastal fringe where logging occurs as most Australian streams and rivers have their headwaters in forested catchments which are, in many cases, open to logging (Campbell and Doeg 1989).



Forested catchments are vital to secure water supplies for coastal communities

(5a) Water quantity

Given Melbourne’s reliance on forested catchments for water supplies, approximately half of which are subject to logging, much of the research on water yields from logged catchments has taken place in the *E. regnans* forests of the Victorian Central Highlands. Here, catchments covered in old-growth stands of forests yield approximately twice the volume of water on an annual basis than those catchments covered in regrowth younger than 25 years (Vertessy et al. 2001). The explanation for this is that older forests, because they have fewer stems which are not growing vigorously, transpire less water which is then available as stream flow². In addition, canopy leaf-area index is lower which results in less water interception by the canopy (Vertessy et al. 2001). In the Goulburn Broken catchment of Victoria, modelling has shown that ending logging would deliver an increase of 3807 gigalitres of water over 100 years— six times the annual water use of Melbourne, or 165 times the annual water use of Bendigo. This water was valued at \$1.68 billion, and was worth over twice the estimated timber value over the same period (Australian Conservation Foundation 2009).

The relationship between forest age and water yield in *E. regnans* forests is shown in Figure 5. Immediately following logging, water yields increase because there are few live trees actively growing and water readily enters waterways. As the time since logging increases beyond approximately eight years, there is a sharp decrease in water yield as the actively regrowing forest uses water and decreases water yield. After approximately 40 years, self-thinning begins to occur, stem density decreases and water yield begins to increase. However, recovery of water yields to pre-logging levels takes centuries. It would be theoretically possible to retain high water yields

by shortening rotation lengths to <8 years. However such short rotation lengths would likely yield extremely poor timber, be detrimental to forest fauna and, in the case of *E. regnans* forests that regenerate from seed, compromise the ability of the forest to regrow.

More research is needed to clarify how universally the hydraulic relationships documented for *E. regnans* forests apply to forests that don’t contain *E. regnans*. However, increases in stream flow following logging have been documented in NSW forests (Webb et al. 2012a) and models predicting a similar initial water yield decrease followed by a steady increase in yield post-logging (Webb 2011) have been supported by observations in non-*E. regnans* forests in NSW (Webb et al. 2012b).

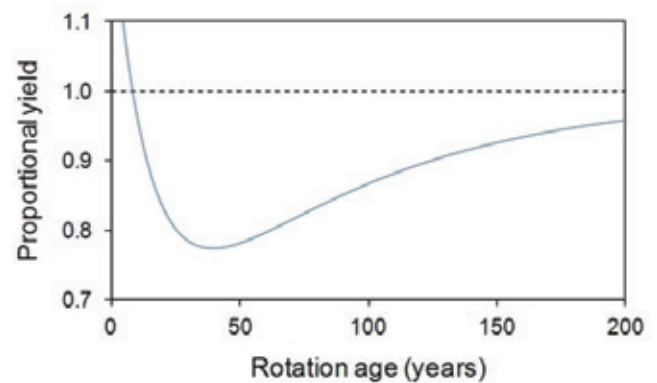


Figure 5: A Kuczera curve describing the relationship between water yield and rotation age (or time since harvest) in mountain ash forests in the Victorian Central Highlands. Source: Michael McCarthy’s Research³

(5b) Water quality

Surface soil compaction decreases water infiltration rates, increases runoff rates and therefore increases erosion (Croke et al. 1999). Because the ‘duplex soils’ (those with contrasting textures in the soil profile) of south-eastern Australia are particularly prone to sealing when vegetation is removed and they are exposed to rain, the risk of erosion is greater in south-east Australia than for other areas (Campbell and Doeg 1989). Logged areas may contribute up to five times more sediment to water bodies than undisturbed catchments (Motha 2003) and runoff from cable logging in Tasmania has been shown to increase fine sediment loads in streams which takes five or more

2. mickresearch.wordpress.com/2012/12/21/effects-of-timber-harvesting-on-water-yield-from-mountain-ash-forests
 3. mickresearch.wordpress.com/2012/12/21/effects-of-timber-harvesting-on-water-yield-from-mountain-ash-forests/

years to recover (Davies and Nelson 1993). Road building associated with logging practices can also increase turbidity in streams in certain circumstances (Cornish 2001).

There is a clear distinction between the area of forest cover and the habitat quality of that forest (Bradshaw 2012). Successful implementation of ESFM of forests would result in the maintenance of the total area of forest cover as well as the habitat quality and ecological processes of the managed forests. The five examples above demonstrate that the RFA model has not met the goal of delivering ESFM. In light of climate change predictions of increasing temperatures, more frequent droughts and decreased rainfall (CSIRO 2015) ensuring sustainability of water supplies by protecting forested catchments should be a priority.



Droughts and extreme weather events will increase as climate change progresses

Aim 3. The long-term sustainability of forests and forest industries

Economic value

The concept of certainty was at the heart of the RFA process (Spencer 2009). Reduced regulation via the accreditation of forestry operations through the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as a result of the RFAs has provided certainty to the logging industry in regards the ability to conduct operations without fear of legal reprisal (Hawke 2009). However these are major question marks over whether the accreditations are still warranted, because forestry operations have not complied with the conditions of the accreditations and RFA reviews have been slow.

Despite not being subject to constant appraisal via Commonwealth environment law (dominant over State law and therefore likely to reject logging of native forests outside of an RFA due to environmental impacts) the native timber industry is in poor condition: Australian Bureau of Statistics environmental accounts show that, since 2005, Australia's native standing timber stocks have fallen in value by 32% to \$2 billion, while the value of plantation timber rose by 30% to \$10 billion (Australian Bureau of Statistics 2014, 2015) (Figure 6). Over a similar period, domestic hardwood sawnwood production declined by 44% (ABARES 2015) at an average of 7.4% per annum (Campbell and McKeon 2015) while softwood sawnwood production increased by 10% (ABARES 2015) at an average of 2.9% per annum (Campbell and McKeon 2015). The primary drivers behind the decline in hardwood production are increasing competition from hardwood and softwood plantations, both domestically and internationally, and higher costs relative to international competitors; weak demand for structural timber; decreasing demand from Japan for pulp due to decreasing paper consumption and efficiencies in the production process; and a reduction in the area of forest available for harvest (Campbell and McKeon 2015). Many of these trends are predicted to continue, which means that demand will continue to fall and profitability from native forest logging will be increasingly difficult to achieve.

The sharp decline in value of the native forest estate may be attributed to unsustainable harvesting practices which have resulted in reduced condition of forests and a decreased availability of timber for harvest (i.e. much has already been cut over and regrowth contains a lower volume of wood) (McDonald 1999). These unsustainable harvest practices are likely a result of historical over-estimates of timber supply volumes (Burgman et al. 1994) (see also Figure 4). The lack of available timber may help to explain why the logging in NSW has increased in intensity over time and why the government is currently developing new Integrated Forestry Operations Approvals (IFOAs) to allow for a shorter rotation time (Milledge 2015, NSW Environment Protection Authority 2015a). In 2014-2015, the volume of native forest sawlogs produced by Forestry Tasmania fell by 63,000 tonnes, while overall wood production grew (Forestry Tasmania 2015). This highlights the decline in the native timber industry compared to the plantation industry.



Figure 6: The change in value of native (green bars) and plantation (blue bars) Australian timber stocks expressed as dollars per capita unit in the decade 2004-2014. Source: Australian Bureau of Statistics 2015 (Australian Bureau of Statistics 2015).

In 2014, in the most recent attempt to closer match wood supply commitments to actual yields (see Figure 4) the citizens of NSW, via the government, ‘bought back’ 50,000m³ of contracted timber from Boral for nine years (450,000 m³) at a cost of \$8.55 million (Hodgkinson 2014). Between 2009 and 2012 Forestry Tasmania lost \$64 million and received \$130 under the Tasmanian Forests Intergovernmental Agreement, while Forestry Corporation NSW lost \$85 million over the same period in native forest logging operations (Macintosh 2013a). Forestry Corporation ran at a loss of \$14.4 million in 2007-8 (Audit Office of New South Wales 2009).

Forestry Corporation (FC) also receives annual funding from the NSW Treasury in the form of a ‘Community Service Obligation’ (CSO). The CSO funding is allocated for forest management activities such as fire-fighting, recreation and tourism and other ‘non-commercial forest management’, as well as road maintenance, community engagement and government relations. Reporting on CSO funding is inconsistent, but in 2012-13 FC received \$14.2 million⁴, rising to \$15.6 million in 2013-14⁵. It is estimated that the CSO has been worth \$136 million to FC over the last ten years (Campbell and McKeon 2015). In 2016, the NSW

Environment Trust allocated a grant of \$2.5 million to subsidise logging contractors upon the creation of the Murrumbidgee Flora Reserves in southern NSW—this grant did not result in a change to wood supply agreements⁶.

Taken in light of the various other public subsidies⁷ that the NSW Forestry Corporation, and other Australian native timber companies, receive (Chipstop.org 2015) a strong case can be made that continued native forest logging operations are not a result of certainty and sound management via the RFAs, but rather of successive and regular government intervention using public funds.

The most recent estimates of the value of the forestry industry (combined plantation and native forest) to the Australian economy is \$20.1 billion in the forest products manufacturing industries. This represents approximately 5% of total sales and services income in the manufacturing sector (ABARES 2015). In 2010-2011, the value of forest product exports in NSW (exclusive of board, paper and pulp) was \$196.4 million, or 17% of the national total of \$1.2 billion (NSW Department of Trade and Investment 2013). The lumping together of data for native and plantation forests makes it difficult to accurately assess the relative contribution of both sectors, but assuming the value of native timber to be

4. www.forestrycorporation.com.au/_data/assets/pdf_file/0016/544120/forestry-corporation-of-nsw-sustainability-supplement-2013-14.pdf

5. www.forestrycorporation.com.au/_data/assets/pdf_file/0003/590340/FCNSW0281-SustainabilitySupp_FY15010216.pdf

6. www.environment.nsw.gov.au/resources/MinMedia/MinMedia160301.pdf

7. The World Trade Organisation definition of a subsidy contains three basic elements: (i) a financial contribution (ii) by a government or any public body within the territory of a Member (iii) which confers a benefit. All three of these elements must be satisfied in order for a subsidy to exist. www.wto.org/english/tratop_e/scm_e/subs_e.htm

approximately 20% that of plantation timber (Figure 6) forest exports of native timber products in NSW would total \$240 million, or 3.4% of the national total. The native timber industry would account for approximately \$5 billion in the forest products manufacturing industries, or 1% of the national income in the manufacturing sector.

Jobs in forest industries

In 2011 the forestry and logging industry directly employed 5398 people across Australia, with a further 2168 employed in forestry support services (Australian Bureau of Statistics 2011). These figures are close to those of the NSW Department of Trade and Investment (DTI), which calculated employment in forestry and logging across Australia as 7561, based on the 2011 census (NSW Department of Trade and Investment 2015a). In NSW in 2011, forestry and logging employed 2131 people (full and part time), which was a fall from the 2522 recorded in the previous census (NSW Department of Industry and Investment 2010).

Using the most recent figures from the 2011 census, forestry and logging employment in NSW is 28% of the Australian total. This results in a total of 7561 employed across Australia, or 0.02% of all primary industries employment (NSW Department of Trade and Investment 2013). DTI applied a multiplier to estimate the extended influence on employment in NSW, which estimated 5166 people employed in forestry and logging, or 0.02% of all people employed in primary industries in NSW. This study did not apply the multiplier to overall Australian employment, but doing so would result in a figure of 18,328 employed directly and indirectly in forestry and logging across Australia.

These data include both the native forest logging and the plantation forest sectors. It is difficult to disentangle the figures as to how many jobs are provided by the native forest logging industry, but the most recent estimates in NSW put the figure at approximately 600 directly employed (Campbell and McKeon 2015), based on native timber accounting for approximately 25% of the harvest volume of Forestry Corporation.

In Tasmania, where the forestry industry has long been regarded as a key employer, total jobs in the forestry industry were estimated to be approximately 2000 in 2013, with native forest logging accounting for 1000 of these. This accounts for 0.5% of total employment

in the state (Macintosh 2013b). Since 2006, both the number of people employed and the number of businesses in the native forest logging sector have declined markedly in Tasmania (The Wilderness Society et al. 2015).

The corporations that manage native forests under the RFA agreements directly employ few staff, and only in Western Australia are employment figures steady (Figure 7). Again, these employment figures are not broken down between the native and plantation sectors so it is difficult to accurately assess employment in native forest logging. However, answers given to questions in the 2015 NSW Budget Estimates hearings indicated that Forestry Corporation employed 220 people in its hardwood division (Budget Estimates secretariat 2015), including both the hardwood native and plantation timber industries.

The decline in jobs over time has frequently been portrayed as a 'jobs versus the environment' conflict. However, evidence does not support this: although wood production increased markedly since the 1970s, employment has declined steadily. But the major drivers of this decline have been technological innovation, structural changes in the timber industry and a lack of available timber as result of historic over-exploitation (McDonald 1999).



Technology and innovation have driven down the number of jobs in native forest logging. Photo John Perkins

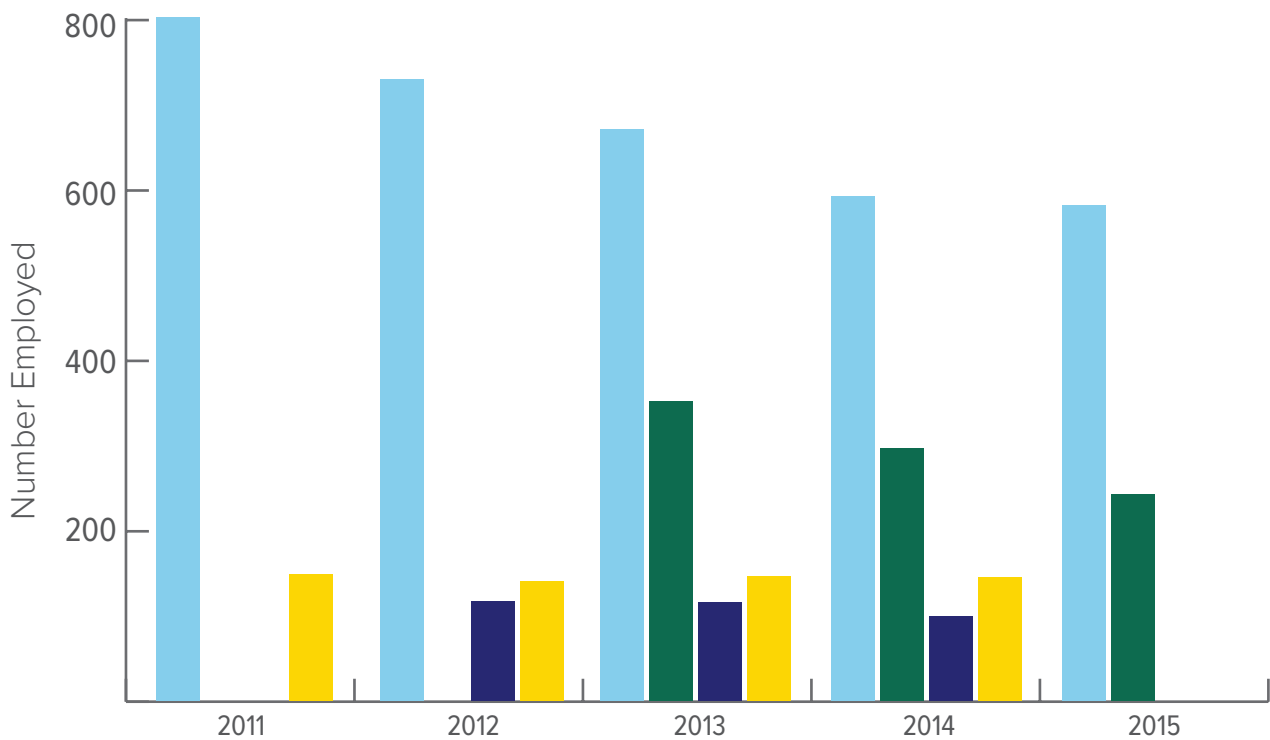


Figure 7: The number of people employed in recent years where data was available in Forestry Corporation NSW (sky blue bars); Forestry Tasmania (green bars); VicForests (navy blue bars) and the Forest Products Commission Western Australia (gold bars). Source: relevant Annual Reports.

Research and development (R&D)

The goal of the National Forest Policy Statement was to ‘increase Australia’s national forest research and development effort and to ensure that it is well coordinated, efficiently undertaken and effectively applied’ (Commonwealth of Australia 1992, 1995). This has not occurred as a result of the Statement, nor the signing of the RFAs. In fact since 1982, adjusted for inflation, there has been a decline in both forestry and forest product R&D expenditure. In 2008 there were 635 researchers and technicians involved in forestry and forest products R&D, whereas in 2011 there were only 396 (Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee 2013).

Ecological stability

Forestry Corporation (FC) has failed to meet its reporting requirements in regards changes in extent and growth stage of Forest Ecosystems. Anecdotal evidence from community groups strongly suggests that these figures would show that the extent of mature forest has dramatically declined over the

duration of the RFA, with most harvestable forest being regrowth under 20 years old. Therefore the RFA model has not been successful in ensuring the long-term stability of forests as logging has dramatically shifted the age-class distribution of forests. Because important ecosystem services, such as water yield, carbon storage and resistance to crown fire, increase with forest age this impact of logging has serious ecological implications.

In addition, forestry operations actively preference some timber species over others—such as blackbutt (*Eucalyptus pilularis*) which is desirable for flooring, and silvertop ash (*E. sieberi*) for woodchipping. Management activities that favour blackbutt regeneration effectively convert native forests to a plantation and, in the southern RFA regions of NSW, logging has left a legacy of near-monoculture regenerating stands of *E. sieberi* with limited regeneration of important species such as woollybutt (*E. longifolia*). These impacts of logging are widespread, considered insidious by the conservation community and leave a legacy that will be challenging to reverse.

Biomass fuel production from native forests

Biomass is an emerging source of income for the logging industry⁸. It is reasonable to assume that this consideration of a future biomass industry was the primary reason behind the inclusion of ‘wood waste’ from forests being included in the Renewable Energy Target (RET) in 2015. Inclusion in the RET makes biomass eligible for large-scale renewable energy generation certificates (LGCs), and LGCs reduce the cost of electricity by subsidising the cost of generation.

A recent estimate of the cost of a megawatt-hour (MWh) from biomass was \$140 before LGC subsidy, with a subsidised price of \$79. This is substantially greater than the 5-year average price of \$42 per MWh across the Australian energy market and means that without a dramatic increase in the unit cost of electricity, a biomass power plant would not be economically viable under current conditions. In addition, because biomass is a mature technology, the price of a MWh is unlikely to fall further, whereas the trajectory of cost of electricity from renewable technologies such as onshore wind and large-scale photovoltaic is downwards (Campbell and McKeon 2015). However, the Australian Forests and Climate Alliance (AFCA) stresses that, although this analysis may be accurate for power stations using only biomass for generation, co-firing—mixing biomass with a fossil fuel—may increase the economic viability of biomass (notwithstanding the other subsidies that native forest logging receives) and is therefore a serious threat to the future of sustainable management of native forests (L. Bower, AFCA Convenor, *pers. comm.* March 2016).

Although it may sound attractive to utilise the left-over waste from forest activities, environment groups are concerned that an industry reliance on biomass will become a driver of forest destruction in its own right. These concerns appear well-founded, as the NSW government approved the burning of whole trees for power generation in 2014⁹. This has provided an alternative market for harvested trees besides the declining woodchip industry. In Europe, the biomass industry is more developed and the Drax power station in England is the biggest user of biomass in the world, consuming over three million tonnes of wood pellets per annum¹⁰. Although Drax states that its wood pellets

primarily come from ‘residues’ and ‘thinnings’¹¹ it has now become a driver for deforestation in the USA according to environment groups there¹².

In NSW, the *Protection of the Environment Operations (General) Amendment (Native Forest Bio-material) Regulation 2013* legislates that there should be no increase in the intensity of logging as a result of biomass production. Therefore Forestry Corporation is limited in its capacity to profit from biomass to increasing the value of existing products from native forest logging, such as pulplogs, thinnings and tree crowns. (Campbell and McKeon 2013).

One of the drivers behind biomass generation is the assertion that biomass is a carbon neutral fuel. This is not the case and biomass may in fact produce more greenhouse gas emissions than fossil fuels¹³. The reasons for this are because although trees may regrow if allowed, it may take hundreds of years to sequester an equivalent amount of carbon as emitted via the losing of a mature tree. In addition, transportation, logging emissions and the loss of soil carbon during logging operations must be accounted for as well as the burning of the wood. There are also loopholes in the international greenhouse gas accounting mechanisms that result in biomass emissions frequently going uncounted (Putt and Graham 2015).



Biomass power generation in Britain has become a driver of deforestation in North America: the potential for such perverse outcomes has led environment groups to strongly oppose biomass from forests

8. www.abc.net.au/radionational/programs/backgroundbriefing/hazelwood-considers-clean-energy-biomass-burning-option/6641880

9. www.smh.com.au/environment/devastating-changes-allow-forests-to-be-burned-for-power-20140307-34bd5.html

10. www.abc.net.au/radionational/programs/backgroundbriefing/hazelwood-considers-clean-energy-biomass-burning-option/6641880

11. www.drax.com/media/56583/biomass-supply-report-2014.pdf

12. www.dailymail.co.uk/news/article-2581887/The-bonfire-insanity-Woodland-shipped-3-800-miles-burned-Drax-power-station-It-belches-CO2-coal-huge-cost-YOU-pay-cleaner-greener-Britain.html

13. www.pfpi.net/wp-content/uploads/2015/05/EPA-Bioenergy-Clean-Power-Plan-05-08-15.pdf

Aim 4. Have regard for studies carried out on:

(i) Environmental values

Habitat loss and degradation have been identified as one of the major conservation policy issues for Oceania (Kingsford et al. 2009). Australia's native forests cover approximately 147 million hectares—19% of its landmass (Bradshaw 2012). However closed forest cover is substantially less and Australia has one of the lowest total areas of closed forest cover on earth at just 4% (Singh et al. 2001). In Australia, approximately 50% of woodland and forest ecosystems have been destroyed, and 70% of remaining forests are degraded by logging. Resource extraction via logging is recognised as a driver of environmental change (Hobday and McDonald 2014). As a result, some of Australia's most high profile scientists have called for policy shifts that stop logging via education, incentives and compensation (Kingsford et al. 2009).

In 2011, the Forests of East Australia were listed as the world's 35th Biodiversity Hotspot (Williams et al. 2011), recognising them as globally significant to the world's biodiversity. Biodiversity hotspots are characterised as having exceptional concentrations of endemic species coupled with high loss of habitat (Myers et al. 2000). In the Forests of East Australia 77% of forest cover has been lost completely or degraded and protected areas cover only 18% of the hotspot (Barrett and Vernes 2011). The hotspot incorporates two RFA regions of NSW entirely (Upper North East and Lower North East) and a portion of the Southern RFA region. The Southwest Forest RFA Region of Western Australia is also entirely contained within a Biodiversity Hotspot, Southwest Australia.

The World Wildlife Fund (WWF) global ecoregion 'Eastern Australia Temperate Forests' (critically endangered) (WWF 2015a) incorporates the Upper North East, Lower North East, Southern and Eden RFA regions in NSW; the East Gippsland, Gippsland, North East, Central Highlands and West Victoria RFA regions in Victoria and part of the Tasmania RFA region. The South West Forest RFA region in Western Australia is contained in the WWF ecoregion 'Southwestern Australia Forests and Scrub (critically endangered)' (WWF 2015b). In 2015, WWF identified eastern Australia as a global deforestation front, the only one

in a developed country, and identified logging as a major driver of that deforestation in NSW (WWF 2015c).

The 2015 NSW State of the Environment Report (NSW Environment Protection Authority 2015b) identified native forest logging as the largest driver of canopy loss in NSW—accounting for twice the rate of canopy loss via agriculture and infrastructure. The figures also illustrated that the annual rate of canopy loss in 2012-13 (the data that informed the 2015 report) was over 20,000ha, and is on an upward trajectory. This is over double the rate of loss from 1998 (the earliest time period displayed). The documented increase confirms concerns amongst environment groups that logging is increasing in intensity—especially when the area available for logging has decreased over time as state forests have been transferred to national parks. The report highlights that logging is not considered clearing as it is not a change of land-use, but given the impacts of logging highlighted in (2), the increase in extent of canopy loss and intensity is a major cause for concern.

The combination of the comparative rarity of forests in Australia in regards land cover, coupled with their global biodiversity significance, makes a compelling argument that Australia's forests are too important to further degrade by logging.



Native forest logging is now by far the largest driver of canopy loss in NSW

Climate change

There is no explicit aim in the RFAs to consider studies on climate change. However, since the signing of the RFAs, climate change has become the number one global environmental threat and, arguably, has progressed more in research terms than any other environmental issue. It is identified as one of six key threatening processes for Australia (Kingsford et al. 2009). Considerations of climate change must therefore be included in any reasonable analysis of the successes and failures of the RFA model.

Climate change could reasonably be considered under 4(iii) 'economic values of forested areas and forest industries', given there is scope to earn carbon credits from using forests for carbon sequestration (Perkins and Macintosh 2013, ABC 2015) and 4(iv) 'social values, including community needs, given the ecosystem services provided by forests which will be vital in mitigating the worst effect of climate change.

Globally, deforestation and land-use change accounted for approximately 10% of anthropogenic emissions in 2010 (IPCC 2014) and climate change has serious implications in terms of rainfall, temperature and extreme weather events across Australia (CSIRO 2015). Temperate eucalypt forests are the most carbon-dense in the world (Mackey et al. 2008, Keith et al. 2009, Keith et al. 2010) and using these forests for conservation rather than wood production could result in significant emissions reductions over the next century (Roxburgh et al. 2006, Keith et al. 2014, Keith et al. 2015, Macintosh et al. 2015). Australia requires emissions reductions of 236 million tonnes of CO₂ to meet the 2020 target of -5% on 2000 levels (Christoff 2015). In the Southern Forestry Region of NSW, managing forests for conservation rather than timber production could result in 79-85 million tonnes of avoided emissions over the next century (Macintosh et al. 2015).

In south-eastern Australia, forests subject to logging have carbon stores of between 40 and 60% of undisturbed forests (Roxburgh et al. 2006, Mackey et al. 2008). Nation-wide, approximately 44% of carbon stocks have been lost from Australia's temperate forests due to deforestation (Wardell-Johnson et al. 2011). Despite this knowledge, carbon transfer from native forests into wood products is increasing (Montreal Process Implementation Group for Australia

and National Forest Inventory Steering Committee 2013, ABARES 2015) and more than half of these products are derived from pulp and are short-lived. In addition, logging generates a high proportion of waste material that is also short-lived (Keith et al. 2015, Macintosh et al. 2015). This results in embodied carbon being rapidly lost to the atmosphere and contributing to climate change.

Climate change can be an exacerbating factor in the declines of native species in logged forests. In the case of koalas in SE NSW, research has shown that decreasing rainfall and increasing temperatures have compounded habitat loss from clearing and logging to dramatically reduce koala populations in this region (Lunney et al. 2014). Climate change also has significant implications for Australia's reserve network and the biodiversity it is designed to protect. A Comprehensive, Adequate and Representative (CAR) reserve network which incorporates the greatest habitat diversity possible is identified as conferring the greatest resilience in the face of climate change to conserve as many species as possible (Dunlop and Brown 2008, Dunlop et al. 2012). In turn, conserving as many species as possible is a prudent strategy to manage the risk associated with climate change on ecosystem services, and for retaining management options in an uncertain future (Cork et al. 2007).



Most of the products from native forests are short-lived and the embodied carbon rapidly enters the atmosphere, helping to drive climate change

Old-growth

The concept of ‘old-growth’ forest is not universally accepted by the conservation community because there are difficulties in accurately defining old-growth and eucalypt forests will be multi-aged as a result of natural disturbance. In some areas that have now been subject to intense logging for decades, such as the Southern and Eden RFA regions, it is now very difficult to identify any forest that has not been disturbed, but the conservation community does not accept that this renders them worthless. Nonetheless, old-growth was included in the RFAs and it is therefore addressed here.

From the first broad national recognition of the need to protect remaining old-growth forest as a requirement for sustainable forestry (Stewart 1991), through the incorporation of protection provisions into the National Forest Policy (Commonwealth of Australia 1992, 1995), the adoption of conservation criteria (Australian and New Zealand Environment and Conservation Council 1997) and the signing of the RFAs, the actual protection of old-growth has been problematic and today remains so. It was not until 2004, sixteen years after the need to protect remaining old-growth was nationally recognised, that full protection of what was mapped as old-growth in NSW state forests was achieved.

Initial difficulties in providing for the conservation of old-growth related to differing interpretation of issues such as ‘naturalness’ and the habitat requirements for the conservation of old-growth dependent fauna. Stakeholders were often poles apart on key issues (NSW National Parks and Wildlife Service 1996) and despite some attempts at interim protection much old-growth was logged before protection measures were implemented. Subsequently, many areas of mature and older forest providing high quality habitat for old-growth dependent fauna were excluded from protection because of minor disturbance from either past selective logging or natural events such as wildfire.

The patch size for mapping old-growth in NSW ranged from 5 to 25 hectares (Flint et al. 2004), but the rigour of mapping varied widely between land tenures. Because of the exclusion of patches <5ha, many small or linear old-growth patches were excluded from protection. Since the RFAs there have been well-documented incidents of patches of old-

growth forest under 10ha in size being logged at Koorah State Forest^{14,15} (Pugh 2013) and at Girard State Forest (Pugh 2010).

Recent government figures state that 73% of the five million hectares of forests classed as ‘old-growth’ during the RFA process are in formal or informal conservation reserves (ABARES 2015). Considering the lengthy delays in providing protection for old-growth, difficulties in defining and mapping old-growth and ongoing unauthorised logging it is likely that less than 50% of the old-growth present in 1988 remains today and is located in permanently protected reserves (A. Love *pers. comm.* February 2016). The success of the RFA process in protecting old-growth forest can therefore be considered partial.

Furthermore, it not possible to have certainty as to the long-term security of old growth forest that is not in a formal reserve—as is currently the case for much old-growth. One of the more pervasive influences of logging is that it prevents the succession of forests into older states. This is because logging shifts the age-class distribution of trees from older to younger (Lunney and Matthews 2004). In Tasmania, continued clear-felling of old-growth forests was identified by the Forest Stewardship Council in a 2015 audit as one of the key reasons products derived from native forest logging were not certifiable¹⁶.



Large old trees are now rare in public forests as a result of logging, but are vital for wildlife and carbon storage

14. www.abc.net.au/news/2013-06-28/what-remains-of-a-1000-year-old-brushbox.jpg/4786832

15. www.echo.net.au/2013/06/mps-shocked-at-forest-devastation/

16. www.abc.net.au/news/2015-12-04/forestry-tasmania-needs-to-change-more-practices-to-gain-accred/7000986?section=tas

Wilderness

The National Forest Policy Statement (NFPS) (Commonwealth of Australia 1992, 1995) identified the importance of Australia having reserves for the protection of wilderness. The NFPS acknowledged the significance of these areas to the Australian community because of their very high aesthetic, cultural and nature conservation values and their freedom from disturbance.

Because biodiversity is not static in time or space (Pressey et al. 2007) the protection of wilderness is crucial in the protection of biodiversity by allowing plants and animals to respond to environmental change and accommodating landscape-scale processes (Soulé et al. 2004). This whole-of-landscape approach is particularly important in the present day to allow native species to adapt to climate change (Drielsma et al. 2015). Since 2000, when approximately 14% of wilderness in Australia was protected, reserve establishment has been biased against wilderness. Incorporating a measure of future threats instead of only considering past threats is one way to overcome this bias (Watson et al. 2009).

The NFPS led the development of a nationally agreed approach to conserve and manage old-growth forests and wilderness. The agreed approach had five stages: (1) *agreed criteria*, (2) *assessment*, (3) *interim protection to areas of likely wilderness values*, (4) *reserves for protecting wilderness* and (5) *management plans to protect at least 90% of identified wilderness values*.

In NSW wilderness protection had been active for at least ten years prior to the application of the NFPS, primarily as a result of the *Wilderness Act (1987)*. The Act was, and still remains, progressive legislation providing a statutory framework for the nomination, assessment, identification, declaration and management of wilderness.

The NFPS required the application of the National Wilderness Inventory (NWI) for wilderness assessment and for measuring wilderness protection. Compared with the NSW *Wilderness Act (1987)* the NWI relied on a limited data set, simplistic criteria and was without a statutory basis.

The three NSW RFAs reported a high level of interim protection for wilderness against the NWI-based assessment criteria. Legislation supporting the NSW RFAs was subsequently implemented which overrode

the *Wilderness Act (1987)* to exclude application of its provisions to most forested areas of eastern NSW, including to 97,000ha of potentially suitable forested wilderness. The one five-year report completed so far on the NSW RFAs (Anon 2014) did not mention wilderness protection.

Many existing wilderness areas in forested regions in NSW are incomplete and require either voluntary acquisition or further resolution of forestry (beyond the RFA processes) and mineral resource issues to fully protect wilderness areas identified in accordance with the *Wilderness Act (1987)* (Muir 2016). These include the undeclared Carrai, Mann River, Timbarra, Binghi, Catatract, Deua, Pilliga and Bebo wilderness areas. These eight areas have not progressed to stage three (interim protection) of the five-stage NFPS process.

Incomplete wilderness areas, such as the Macleay Gorges, require resolution of forestry, mineral resources issues and considerable voluntary land acquisition to finalise. These areas have also not completely progressed to stage three of the NFPS process.

The Moors in Myall Lakes National Park and the Sandon and Wooli catchments in Yuraygir National Park are remain in stage two (assessment) of the NFPS process. Having been assessed as wilderness under NFPS process, despite a formal nomination by community groups under the provision of the NSW *Wilderness Act (1987)* no state assessment has been conducted and formal protection of the wilderness values of these important and rare coastal wilderness areas has not occurred.

Nevertheless, in NSW, wilderness areas protected by the reserve system almost doubled to 2 million hectares between 1997 and 2007 (Department of Environment and Climate Change NSW 2008a). The rate of wilderness protection achieved for the first ten years of the application of the NFPS was approximately equal to that achieved in the preceding ten years.

In NSW, although designated wilderness has increased overall, the extent to which the NFPS processes contributed to the increase can be questioned in light of its displacement of strong State statutory processes (the *Wilderness Act*) which has led to the exclusion of potential wilderness areas and the stalling of the processes for protection for others. Wilderness establishment that has occurred was also assisted by the Dunphy Wilderness Fund—a fund for

the acquisition of wilderness lands with no links to the NFPS process. The protection of other important forest wilderness, such as the Coolangubra and Tantawangalo in the south east forests, Mt Ballow on the Border Ranges and Murrui in the Blue Mountains have not progressed.

In NSW, areas subject to an Integrated Forestry Operations Approval (IFOA) are not eligible for wilderness declaration (Department of Environment and Climate Change NSW 2008b). However the IFOA continues to capture areas of land that could be proposed as wilderness despite not being productive timber forest and which could be excluded from the IFOA (Department of Environment Climate Change and Water NSW). Some progress on this issue has been made recently (Keith Muir, *pers. comm.* 8th March 2016).

The RFA process in NSW can therefore be considered partially successful in increasing designated wilderness, but the target of 90% was not met; the overriding of the *Wilderness Act (1987)* by the NFPS process excluded large areas of wilderness and the IFOA has since hindered wilderness declarations. More broadly, besides one area in Victoria, the RFAs did not result in the any permanent wilderness protection anywhere but NSW.



Important forested wildernesses such as the Coolangubra have not been progressed. Photo: Henry Gold

Endangered species

The RFA model has weakened protection for threatened species compared to that afforded under the federal *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* (Feehely et al. 2013). This is primarily because:

1. The states have lower regulatory requirements than those imposed by the *EPBC Act*. For example, in NSW and Tasmania the RFAs have exempted forestry operations from state laws pertaining to threatened species;
2. The states have failed to take into account new information on threatened species and biodiversity, therefore locking in poor environmental outcomes;
3. RFA reviews have not been sufficiently timely or thorough, with the result that it has not been possible to ensure compliance with RFAs and therefore to justify the accreditation of logging via the RFAs under the *EPBC Act*;
4. Monitoring, compliance and enforcement has not been sufficient, and;
5. There are limited third party participation rights. This has also resulted in the maintenance of conflict in all RFA states.

There are a total of 1413 forest-dwelling species of flora and fauna on the federal EPBC list. Between 2006 and 2011, 89 species were added to the list of threatened species while 21 were removed (Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee 2013). It is becoming clear that to effectively conserve species, particularly in the face of climate change, a whole-of-landscape approach to fauna management is required (Lunney and Matthews 2004, Drielsma et al. 2015). Logging native forests compromises the ability to implement this approach as it impacts directly on species and individuals, and affects a range of ecological processes and habitat features (Norton 1996).

Since European settlement, all native mammals in the Bega valley have declined in numbers, at least six have become locally extinct and four more are threatened with extinction (Lunney and Leary 1988). This is largely due to the combined effect of clearing native vegetation for agriculture and introduced predators, but the authors point out that most of the mammals

inhabit state forests around the Bega valley and their conservation must be weighed against using forests for pulpwood production.

It is often stated that no forest-dwelling species is known to have become extinct due to logging. This was repeated in Australia's State of the Forests Report 2013 (Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee 2013), but is misleading for several reasons:

1. Knowledge of terrestrial biodiversity—particularly of invertebrates, fungi, lichens, algae and microorganisms—is incomplete (Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee 2013). In the absence of accurate knowledge of presence, accurate accounting of loss is not possible;
2. The process for nominating a species or ecosystem as threatened is both time and resource consuming. Therefore the listing process will inevitably lag ecological impacts;
3. Although none of the more high-profile forest animals (birds and mammals) may yet be extinct, there have been substantial population declines in many common and rare species (such as greater gliders, koalas, Leadbeater's possum and the swift parrot), including local extinctions (Lunney and Leary 1988, Lindenmayer et al. 2011, Woinarski et al. 2014, The Wilderness Society et al. 2015, The Wilderness Society and The Environmental Defenders Office 2015) which places remaining populations at greater risk of stochastic events such as large fires;
4. In 2004, 40 of 81 extant forest mammals in NSW were listed as threatened, and of the 41 not listed, 34 had declined (Lunney and Matthews 2004);
5. The NSW State of the Environment Report 2015 was unable to accurately assess trends in threatened species populations or distributions as monitoring had not occurred (NSW Environment Protection Authority 2015b). In the absence of monitoring, it is not possible to accurately assess impacts;
6. It is rarely possible to identify a single cause of a species decline or extinction as there are usually a suite of compounding factors e.g. (McAlpine et al. 2015). Logging is identified as a contributing factor in the declines of many forest species (Woinarski et al. 2014);

7. The phenomenon of the extinction debt (Tilman et al. 1994) dictates that current activities that destroy, degrade and fragment habitat may not result in immediate extinctions, but extinctions postponed over long timescales—particularly in species with a longer generation time (Vellend et al. 2006, Kuussaari et al. 2009). Ecological impacts of logging may therefore not yet be fully realised.

The direct negative impact of logging on forest fauna is clearly illustrated by a series of studies in the Eden area of NSW that used counts of 'displaced' arboreal mammals by logging crews to answer various questions as to species distributions (Braithwaite 1983, Braithwaite et al. 1983, Braithwaite et al. 1984). The studies identified 930 dead mammals of seven species (greater glider, yellow-bellied glider, feathertail glider (*Acrobates pygmaeus*), sugar glider (*Petaurus berviceps*), brush-tail possum (*Trichosurus vulpecula*), ring-tail possum (*Pseudocheirus peregrinus*) and pygmy possum (*Cercartetus nanus*)) over 5000 hectares.



Logging kills arboreal mammals such as sugar gliders, as well as removing key habitat features such as tree hollows

In light of documented declines in forest fauna and increasing numbers of species being listed as threatened, the precautionary principle should prevail, as per Ecologically Sustainable Forest Management. i.e. instead of arguing that logging should continue as species have not yet been driven to extinction, ceasing logging to ensure that species have the best chance of recovery before they become extinct is a more logical approach to management.

An analysis of adequacy of the Upper and Lower North-East RFA regions in NSW (Flint et al. 2004) has demonstrated that forest reserve targets identified via the Comprehensive Regional Assessments are inadequate for fauna species. The authors found that:

- 45% of fauna populations had sufficient habitat reserved to achieve $\geq 50\%$ target fulfilment;

- 20% of fauna populations had $< 10\%$ of required habitat reserved to meet targets;
- 79% of the most vulnerable species had not achieved targets for any populations;
- 0% of the most vulnerable species had attained targets for all populations;
- 21% of the most vulnerable species had attained targets for one or more populations.

Figure 8 demonstrates the failure in attaining reservation targets for five threatened species in North-East NSW.

The most current information available (Woinarski et al. 2014) indicates that the total population of Hastings river mouse (*Pseudomys oralis*) is now under 10,000 and is declining.

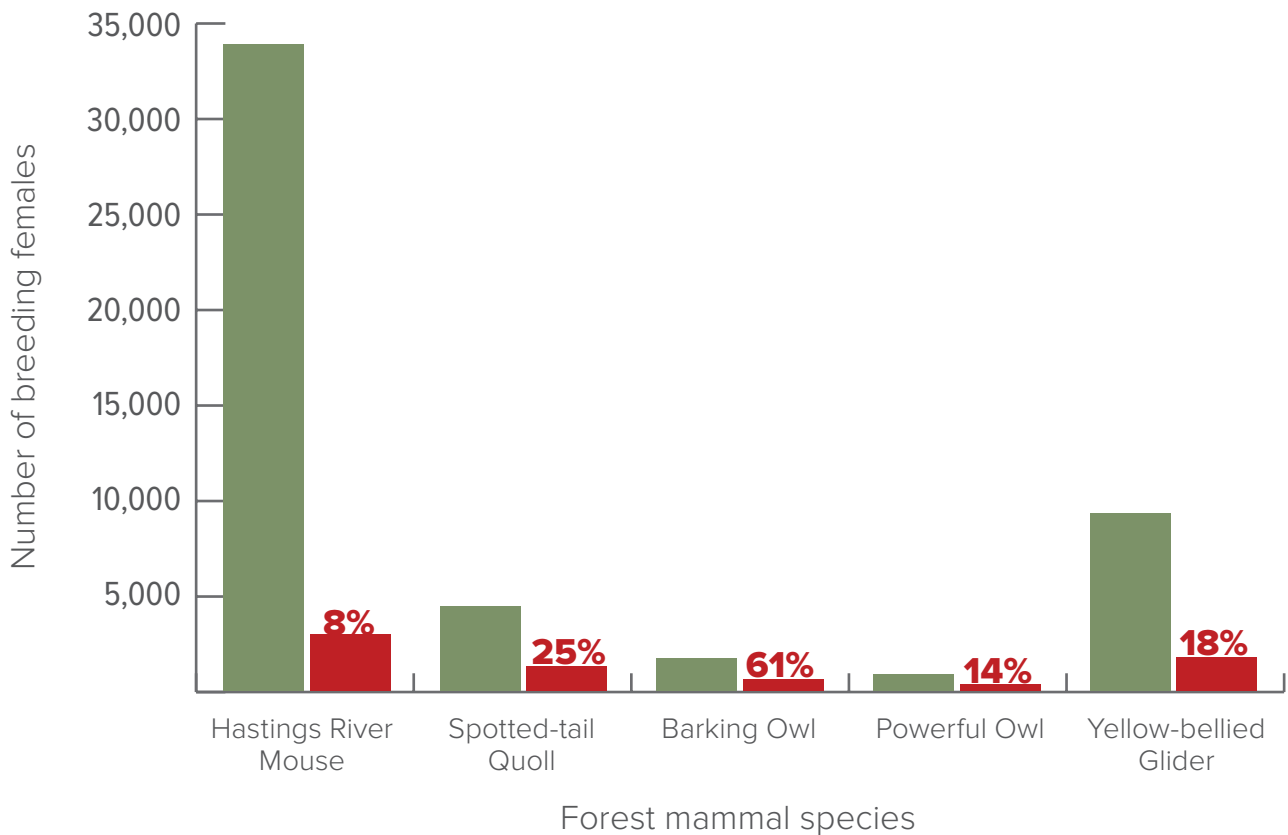


Figure 8: The Comprehensive Regional Assessment reservation targets of number of breeding females (green bars) and the actual outcome (red bars) for Hastings River Mouse (EPBC endangered); Spotted-tail Quoll (EPBC vulnerable); Barking Owl (NSW vulnerable); Powerful Owl (NSW vulnerable) and Yellow-bellied Glider (NSW vulnerable). Percentage (%) refers to % of target number achieved. Source: Flint, Pugh and Beaver 2004 (Flint et al. 2004)

Case study: the koala (*Phascolarctos cinereus*)

The koala is an ideal case study for logging in NSW as it was not listed under the federal *EPBC Act* during the signing of the RFAs. Koala populations in NSW, Queensland and ACT were listed under the EPBC Act in 2012 after having been assessed as having undergone a population decline of 33% between 1990 and 2010 (Woinarski et al. 2014). Despite knowing that many koala populations have been declining for decades (Phillips 2000), and awareness of policy issues preventing effective action (Clark et al. 2000), recent evidence shows continued alarming declines in most koala populations in NSW (McAlpine et al. 2015).

Extinction of koalas in NSW is a real possibility if threats to the species are not addressed, and conservation actions must be 'unequivocal and long-term'. Conservation of remaining habitat is central to conservation efforts in the face of climate change because it is both difficult and expensive to restore (McAlpine et al. 2015). Logging is one of a suite of threats to koalas which must be addressed, alongside other threats, to effectively recover the species (Rhodes et al. 2011, McAlpine et al. 2015). Incredibly, despite it being the most high profile forest-dependent species in Australia, experts have pointed out that there has been no rigorous study done as to the impact of logging on koalas¹⁷. However, current logging practices where a high proportion of basal area is removed, leaving only small-diameter stems, are not compatible with koala conservation (Smith 2004).

Because habitat patch size and connectivity are important predictors of koala occurrence (McAlpine et al. 2006), state forests that contain koala habitat and which are adjacent to existing protected areas should be considered particularly important habitat components for koalas. Because of the bias in reserve establishment (see (aim 1)), much of the remaining high quality koala habitat is in state forests and on private land on the more fertile coastal soils. There are several state forests in northern NSW that are subject to logging operations and are known to be high quality koala habitat with a high concentration of koala records.

Climate change is a serious long-term threat to koalas (Lunney et al. 2014, McAlpine et al. 2015) as they are vulnerable to extremes of temperature and droughts (Seabrook et al. 2011, Lunney et al. 2012).



Koalas are one of the world's favourite animals yet are seriously threatened by logging and development on the coastal fringe, and climate change west of the Great Divide

The distribution of koala feed trees, and the range of the species itself, is predicted to contract eastwards under climate change projections (Adams-Hosking et al. 2011, Adams-Hosking et al. 2012, Adams-Hosking et al. 2014) which means that protecting koala habitat east of the Great Dividing Range is key to the species persistence in the face of climate change. In order to maximise the probability of occurrence of koalas in NSW in 50 years, allocating sufficient funds for restoration and protection of koala habitat in the eastern part of the species range has been identified as the best approach (Santika et al. 2015).

Contrary to the requirement to protect habitat to reverse the decline in koala numbers, a NSW Senate Inquiry into the performance of the NSW EPA revealed serious breaches of Forestry Corporation's threatened species license in Royal Camp state forest in the Upper North East RFA region. Pre-logging koala searches were found to be insufficiently thorough and logging was occurring in koala high use areas (New South Wales Parliament 2015).

17. www.smh.com.au/nsw/fears-for-koalas-under-state-governments-native-forest-logging-overhaul-20151223-glu3l3.html

In late 2015, community groups on the north coast of NSW acquired documents under Government Information (Public Access) (GIPA)¹⁷ which detailed expert analysis of proposed new koala protections under the NSW government's proposed new Integrated Forestry Operations Approvals (IFOA) (NSW Environment Protection Authority 2015a). The new IFOA proposes to replace on-ground surveys for koalas with models that use several variables such as plant community type, forest type and presence of feed trees to predict koala occurrence. The experts found that the models did not work because they did not consider koala socio-biology or disturbance history (including logging). This approach therefore did not constitute a substitute for actively looking for koalas. The consideration by the EPA and Forestry Corporation to move to a model-based approach to protecting koalas from logging operations is contrary to scientific evidence that urgent measures are needed to protect koala habitat.

In March 2016 the NSW Government gazetted four new flora reserves (the Murrah Flora Reserves) in the far south of NSW to protect the remaining koala

populations¹⁸. This action implicitly recognised the inability to reconcile logging with effective koala conservation. Although it was broadly welcomed by conservation organisations, concerns were raised by comments from the local member (The Hon. Andrew Constance) stressing that the creation of flora reserves was to ensure the option of logging was available again in future¹⁹. In addition, the reserves did not result in any overall decrease of timber quotas, raising fears of increased impacts elsewhere, and a \$2.5 million grant from the NSW Environment Trust was allocated to subsidise logging contractors.

The failure to consider the research documenting koala population declines and failure to implement evidence-based conservation measures for koalas is in contravention of the RFA goal to incorporate new knowledge into forest management. Another key example of this, not addressed in detail here is the case of the swift parrot (*Lathamus discolor*): the Tasmanian government repeatedly approved logging operations despite expert advice that the operations would have a detrimental effect on the species and undermine recovery efforts (Pullinger 2015).



Public protests and the huge decline in koala populations led to the creation of the Murrah Flora Reserves near Bega in 2016. Photo: Samantha Davis

17. www.smh.com.au/nsw/fears-for-koalas-under-state-governments-native-forest-logging-overhaul-20151223-glu3l3.html
18. www.environment.nsw.gov.au/news/nsw-government-protects-south-coast-koalas-and-local-timber-industry
19. www.begadistrictnews.com.au/story/3762127/far-south-coasts-state-forests-become-flora-reserves/

National Estate

Issues relevant to the national estate are addressed in Aim 1 and Aim 4(i) and examples given in Aim 2 are relevant as to their impact on the national estate. Both World Heritage and Indigenous Heritage values are also relevant to this section.

World Heritage

As part of the National Forest Policy process the Federal Government commissioned a national expert panel to identify significant themes relating to natural and cultural values of outstanding universal value relevant to forest biomes in Australia²⁰. The panel was then required to identify, with reference to the World Heritage criteria, those places essential to each theme of outstanding universal value. All themes and places identified by the panel were subsequently incorporated into relevant RFA's with a commitment by State and Federal Governments to further assess those areas for possible World Heritage nomination.

However the World Heritage assessments committed to have not occurred—with the exception of Tasmania which was largely driven by processes outside the RFA.

In New South Wales, under the theme of “*Eucalyptus dominated vegetation in Australia as an outstanding example of on a continental scale of forest and woodland vegetation dominated by a single genera*” the following places were identified as warranting further investigation²¹:

1. Sections of the North East forests including Moonee—Bindery area and Guy Fawkes Wilderness;
2. Specified national parks in the sandstone area centred on the Blue Mountains (*sensu lato*), and;
3. Natural forest areas extending from the sea to the Australian Alps and inland slopes.

The only investigation that has been driven by government in regards this theme was for the Blue Mountains. However this occurred in a narrow rather than the intended broader sense, before the relevant RFA was signed, and was driven by processes other than the RFA. An investigation relevant to north-east NSW was carried out by the National Parks Association of NSW in 2012 (Cerese 2012), and an investigation relevant

to the southern forests and the Australian Alps occurred in 1992 by the Earth Foundation – Australia (Mosley and Costin 1992). These investigations were both carried out by non-governmental organisations independent of government funding or support and are not therefore an outcome of the RFAs. Furthermore, despite this work having been done by community organisations, there has been no progress in implementing the findings to develop World Heritage nominations.

Assessments recommended in NSW as part of the RFA process relative to the theme of “*Artistic expression—Rock art of the Sydney Basin and Central coast*” and sub-theme “*passive continental margins—as ancient records of landforms*” have not occurred.

A commitment in separate NSW Forest Agreements to nominate additional areas of rainforest in North East NSW for World Heritage listing has progressed to the “Tentative listing” stage.

The failure to deliver on the World Heritage commitments identified in the Regional Forest Agreements means the RFA model has not been successful in ensuring the listing of new World Heritage areas. In contrast, much of the work relative to World Heritage has occurred by non-government organisations and not as a result of the RFAs.



The Blue Mountains World Heritage investigation was not a result of the RFA process and committed-to assessments in NSW have not yet occurred

20. www.agriculture.gov.au/forestry/policies/rfa/publications/whcp-meeting/summary

21. www.agriculture.gov.au/forestry/policies/rfa/publications/whcp-meeting/nsw

(ii) Indigenous heritage values

The RFA process as a rule neglected access and ownership rights of Aboriginal groups, and cultural significance was the only Aboriginal claim to forests recognised in the RFAs—not economic needs or legal rights. None of the RFAs, with the exception of Eden, facilitated a significant role for Aboriginal groups in forest management, and the 20-year nature of the RFAs have effectively suspended native title claims for their duration (Rangan and Lane 2001).

The ‘Tasmanian Wilderness’ World Heritage area is the only World Heritage area in an RFA region that considers Indigenous values alongside natural values. There may also be examples of the World Heritage theme ‘Complex persistence of a hunting-and-gathering society on a single continent’ in NSW: for example, the Bundian Way is an Aboriginal pathway that follows an ancient route between the high country and the coast (Blay and Eden Local Aboriginal Land Council 2011).

Logging in NSW has had documented impacts on sites of Aboriginal significance. In 2010, compartments 2133 and 2135 of Mumbulla state forest near Bega were approved for logging, which proceeded against strong community protests uniting the local indigenous and wider communities. The mountain is an important heritage site for the Yuin people and the Yuin have battled to protect Mumbulla mountain since the 1970s. The cultural value of the mountain lies in its form and its significance as a cultural place, and its remaining an ‘unaltered landscape’ is vital to its significance (English 2004).

Local Koori elders led walks into the prohibited zone, and marches and public rallies were held in Bega in support of stopping the logging and protecting the forest on the mountain. This resulted in Forests NSW issuing an apology to the Chairman of the Biamanga Board of Management. Although the contractor received \$18,000 compensation over this incident²², the local Aboriginal community received nothing²³.



Logging has driven social conflict for generations in NSW. Protest outside the Eden Chip Mill 1989. Photo: David Gallan

22. www.parliament.nsw.gov.au/prod/lc/qalc.nsf/search/883FAA08548FF3B4CA2577CA002934D4

23. www.parliament.nsw.gov.au/prod/lc/qalc.nsf/search/8E07A165A6482E81CA25789B0025519B

(iii) Economic values of forested areas and forest industries

Economic values of forest industries

The economic value of both native forested areas and native forest industries is in steep decline (see also (Aim 3) for further relevant information). Australian Bureau of Statistics (ABS) environmental accounts show that, since 2005, Australia's native standing timber stocks have fallen in value by 32% to \$2 billion (Australian Bureau of Statistics 2015). It is therefore clear that the RFAs have not resulted in a sustainable economic yield, and that forestry activities appear to have steadily eroded the value of native timber stocks.

In contrast, the value of plantation timber has increased by 30% over the same time period to \$10 billion (Australian Bureau of Statistics 2015) and plantations now account for over 80% of the wood supply in NSW (Ajani 2013). The most recent statistics from the federal government show that, over the last decade, there has been a 60% decline in the logs harvested from native forests, but a 280% increase in plantation logs. Softwood plantations now account for 56% of Australia's total wood supply (ABARES 2015).

This is despite the native forest logging industry being, in effect, a government subsidised competitor to the

commercial plantation sector. However, in recent years and following years of expansion, investment in the plantation industry has stagnated. In addition, 14,600 hectares of plantations were removed or not replanted, possibly because they were considered economically unviable (ABARES 2015, Gavran 2015). Although not explicitly stated, it is possible that the stagnation in the plantation sector and the removal of unviable plantations is in part driven by competition from the government-subsidised native timber industry.

New Zealand successfully transitioned out of native forest logging in the 1980s, and exports of plantation timber were worth \$3.4 billion in 2013 while timber imports were negligible (Statistics New Zealand 2014). In other words, New Zealand's timber exports in a single year are worth close to double the entire native timber stocks in Australia. Given the suitability of many regions of Australia for growing plantation trees, there is no reason why the success of the New Zealand plantation industry could not be replicated in Australia.

The starkest example of the economic failure of the native timber industry is the bankruptcy of Gunns Limited, which was the largest hardwood producer in Australia, but there are other examples of economic failure: In NSW, the native forest logging operations of Forestry Corporation lost \$85 million between 2009



The value of native timber stocks in Australia has declined sharply in the last decade. Photo John Perkins

and 2012, while Forestry Tasmania lost \$64 million over the same period (Macintosh 2013a). Projections in the Southern Forestry Region of NSW estimate that the future losses of Forestry Corporation's native forest logging operations between 2014 and 2033 will be between \$40-70 million (Perkins and Macintosh 2013) in the absence of a major rebound in the woodchip price.

Economic values of forested areas

Timber is currently the only forest product currently accorded any value by policy makers, because information on non-timber uses was very poor during the Comprehensive Regional Assessments (McDonald 1999). Economic valuations of native timber industries do not place a dollar figure on natural values, including biodiversity and ecosystem services (Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee 2013, Australian Bureau of Statistics 2014). There are a suite of non-market values associated with native forests that are not accounted for when evaluating the economic value of forests (Slee 2001), as well as a suite of non-market products and ecosystem services.

Globally, ecosystem service valuations are enormous but declining (de Groot et al. 2012, Costanza et al. 2014). In Australia, terrestrial protected areas

(not state forests) were estimated in 2012 to have provided between \$38 and \$104 billion worth of ecosystem services, with control of erosion and water flows by forests two of the highest value services (\$1.5 and \$2.34 billion respectively) (Taylor et al. 2014b). Carbon sequestration is another important ecosystem service. In the Southern RFA region of NSW it is estimated that, over a 20-year period between 2014 and 2033, the government could earn \$222 million (net) from carbon credits via cessation of logging (Perkins and Macintosh 2013). In a Background Briefing report in July 2015 (ABC 2015), Professor David Lindenmayer of the Australian National University indicated that stopping logging would result in billions of dollars' worth of carbon mitigation based on the Australian Government's Emissions Reduction Fund valuations.

When water and carbon sequestration values are incorporated into models on tree harvest decisions in Victorian forests, it is optimal to either increase rotation times to intervals of hundreds of years or, in a wide range of cases, cease harvesting (Dargavel et al. 1995, Creedy and Wurzbacher 2001, Spring et al. 2005). Any valuation of the native forest logging industry should therefore be seen in light of the potential to reduce the value of ecosystem services from forests and the associated costs to society.



The value of ecosystem services from forests dwarfs their value for timber, yet timber is the only forest product afforded any value

(iv) Social values (including community needs)

Tensions remain and are reigniting

The community expectation from the RFA process was an end to social conflict and a CAR reserve network of Forest Ecosystems. The CAR reserve network is discussed in (Aim 1).

Logging in public forests has been the driver behind some of Australia's most entrenched conflicts over natural resources, and one of the goals of the RFAs was to reduce conflict over forests (Dargavel 1998). However, the RFAs have failed to resolve social conflict over forests (Lane 1999, Musselwhite and Herath 2005) and the conservation community has not accepted the RFA outcomes as being adequate to protect biodiversity values (Kirkpatrick 1998). In Tasmania the signing of the RFA failed to end concerns over the lack of reservation of key biodiversity elements and the failure to assure that native forests, including both reserved and unreserved forests, were not converted to other land-uses (Kirkpatrick 1998). In Victoria, the RFA outcomes have not matched the aims, in that in some cases the RFAs have polarised stakeholders and exacerbated conflict (Slee 2001).

In NSW, the current remake of the Integrated Forestry Operations Approval (IFOA) (NSW Environment Protection Authority 2015a), the mechanism by which NSW regulates native forest logging under the RFA model, has been independently assessed as to its potential environmental impacts (Milledge 2015). This report showed that the new IFOA would result in 'the implementation of virtual plantation forestry.' The new IFOA is therefore not in the spirit of the RFAs—purported to have ecological sustainability at their core—and is unlikely to receive a social license in NSW. Furthermore, because of the independent assessment of the new IFOA, the conservation community does not accept the assertion made by the NSW Environment Protection Agency (EPA) that 'the new IFOA will continue to meet commitments made under the [RFAs] (NSW Environment Protection Authority 2015a).' The new IFOA is seriously exacerbating the antipathy towards native forest logging in NSW. Although conservation groups pulled out of the IFOA process because it was seen as a mechanism to safeguard wood supplies and lower costs for the logging industry, the IFOA drafting process has been secretive and the conservation community has had to resort to freedom of information requests to determine what the impacts of the new IFOA is likely to be on koalas²⁴ (see case study).



The development of new logging rules in NSW is a source of increasing social discontent Photo Samantha Davis

24. www.smh.com.au/nsw/fears-for-koalas-under-state-governments-native-forest-logging-overhaul-20151223-glu3l3.html

Community use of forests

As outlined in Aim 4(v), logging forests compromises other uses of forests including ecosystem service delivery and recreation. Although many state forests can currently be used for recreation activities, facilities are typically poor and not well maintained. This is likely due to the fact that provision of community services is a secondary function of state forests and Forestry Corporation. Logging takes precedence over recreation so at any point a mountain bike trail or walking route could be logged.

In NSW, many coastal areas within RFA regions will experience substantial population growth over the next 20 years (NSW Department of Planning and Environment 2015). A more equitable and sustainable use of public forests could provide significant opportunities for recreation and health benefits to this growing population. It is becoming clear that there are substantial positive health benefits from spending time outdoors and in nature²⁵, including to mental and physical health; self-esteem; job satisfaction and reduced stress levels (Maller et al. 2006, Beyond Blue Limited 2010) and that significant savings could accrue via improved health outcomes (Vardakoulias 2013). Tackling childhood obesity is one of 12 'Premier's Priorities' in NSW (New South Wales Government 2015) and one which could be progressed by greater access to public forests via, for example, the creation of outdoor activity centres which could utilise greater access to forests to educate youth.

Regional employment

The maintenance of jobs in regional areas is likely to be the largest driver in government support for the native forest logging industry. As covered in section (Aim 3), the number of jobs that are now supported by the logging industry is small, and the decline has been driven by factors other than conservation. However, it is recognised that in regional areas even a small number of jobs is important and that government has a responsibility to ensure regional employment opportunities.

Given the documented profitability of the plantation sector, and the continual cross-subsidies provided by the plantation sector to the native forest logging sector within Forestry Corporation for example, a case can be made that current policy does not maximise

employment opportunities in regions. By focussing on the profitable plantation sector, and encouraging the ecologically sensitive expansion of this sector to provide timber, more jobs could be created in the forestry industry while transitioning away from native forest logging.

There are other opportunities to provide employment in regional areas via weed, fire and pest management in state forests following ending logging, particularly under a scenario where maximising carbon storage is a key aim. The largest driver of regional tourism is nature (Destination NSW 2014), yet the National Parks and Wildlife Service (NPWS) is experiencing recurring budget cuts. Reversing that trend to expand regional employment opportunities in the NPWS would be another way of maintaining regional employment—and safeguarding the natural values that are so important to regional tourism.

The long-term drivers of declining employment in the native forest logging industry are technological innovation, a lack of available timber due to over-exploitation and industry restructures (McDonald 1999, Campbell and McKeon 2015). Because these factors are likely to recur repeatedly in the industry, a failure to address the systemic declines in employment and to implement more innovative employment initiatives will be detrimental to regional communities and future generations—particularly in light of the fact that logging reduces the value of ecosystem services of native forests to communities and compromises other uses of forests.



There are documented benefits to health and wellbeing via contact with nature: public forests could enhance these benefits if managed better for recreation and adventure tourism

25. <http://ngm.nationalgeographic.com/2016/01/call-to-wild-text>

(v) Principles of Ecologically Sustainable Forest Management

There are several examples in previous sections (see particularly Aim 2) that demonstrate that native forest logging under the RFAs has failed to deliver Ecologically Sustainable Forest Management (ESFM). The principles of ESFM accepted by Australia's National Forest Policy Statement (Commonwealth of Australia 1992, 1995) are:

1. Maintaining the ecological processes within forests (the formation of soil, energy flows and the carbon, nutrient and water cycles);
2. Maintaining the biological diversity of forests and;
3. Optimising the environmental, economic and social benefits to the community within ecological constraints.

Examples of how new information has come to light since the signing of the RFAs, and how this information illustrates violation of the principles is shown below:

The carbon cycle

Forests play a globally significant role in the carbon cycle, which is why forests were afforded their own article in the Paris Agreement (United Nations Framework Convention on Climate Change 2015). In Australia, the disruption of the carbon cycle is perhaps the starkest effect of native forest logging on ecological processes: carbon transfer is increasingly away from forests rather than towards forests (Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee 2013, ABARES 2015) which illustrates that logged forests are acting as a source of carbon rather than a sink—as they would were they undisturbed. Research has demonstrated that ecologically mature forests are more carbon-dense than regrowth forests due to being multi-aged and multi-layered (Keith et al. 2009), that 44% of carbon has been lost from Australia's forests (Wardell-Johnson et al. 2011), that logged forests have lost between 40 and 60% of their carbon stocks (Roxburgh et al. 2006, Mackey et al. 2008) and that there are significant carbon emissions reductions to be made from ending logging (Keith et al. 2014, Keith et al. 2015, Macintosh et al. 2015). Taken together this is compelling evidence to suggest that the carbon cycle in logged forests is significantly different to that

of undisturbed forest and therefore that this principle of ESFM has not been adhered to.

Maintaining the biological diversity of forests

This section has largely been covered in Aims 4 (i) and (v). The key points to consider are that although it is often said that no forest species has yet become extinct due to logging:

1. The number of forest-dependent species being listed as threatened is increasing;
2. Some formerly common species, such as greater gliders, have experienced sharp recent declines indicating that we cannot be complacent about the status of any forest species;
3. The concept of the extinction debt means that impacts on forest species, particularly those with long generation times, are unlikely to yet be completely apparent;
4. The evidence of the impact of logging on forest species and ecological processes is sufficient to warrant the application of the precautionary principle prior to declines becoming extinctions.



Ecologically mature forests maximise stored carbon. About 50% of this carbon is lost upon logging

Optimising benefits from uses of forests

Aim (4iii) illustrates the huge monetary value of ecosystem services that forests deliver on an ongoing basis. The field of ecosystem service valuation is still relatively young and was therefore inadequately addressed during the development of the RFAs. Despite not being explicitly focussed on native forests subject to logging, new information on the value of water flows and erosion control by Australian forests (Taylor et al. 2014b) suggests that logging forests incurs a cost that is not yet factored into decision making on the optimal use of forests. In the Goulburn Broken catchment of Victoria, increased water yields from ending logging were estimated as worth \$1.68 billion, or over twice the estimated timber value over the same period. Other research has demonstrated that were carbon and water services costed into logging decision-making, rotations would be extended in many cases to infinity (Creedy and Wurzbacher 2001).

Coupled with taxpayer-funded interventions to underwrite losses (see Aims 3 and 4iii), compromising ecosystem service values by logging native forests is unlikely to be the optimal use of forests. Aim (4i) demonstrates how current uses of native forests are not within ecological constraints.



Industrial logging does not fit the image portrayed by the National Landscapes program, such as here in Australia's Coastal Wilderness Photo: R. Green

Recent research has taken place as to the socio-economic values of protected areas (i.e. the National Park network) in NSW to regional and rural communities (Heagney et al. 2015). The study, which analysed 110 rural communities across 600,000km², found that the establishment of new protected areas resulted in more new dwelling approvals and developer contributions that in the longer term led to an increase in rates revenue; an increase in the number of local businesses and an increase in local government revenue via grants and council user-pays services utilised by the protected area. This cycling of economic benefits from protected areas provides strong evidence that the current use of logged public native forests is not optimal in terms of benefits to regional communities.

Native forest logging also undermines the value of forested areas for other activities, such as tourism and recreation. For example, four 'National Landscapes' (the Green Cauldron and the Coastal Wilderness in NSW; Tasmania and the Great South West Edge in WA) are subject to RFA agreements (Australian Government and Tourism Australia 2011). There is a tension between trying to increase tourism visitation to these regions and their being subject to industrialised logging. Tourism is a hugely important industry for Australia, and has grown dramatically since the signing of the RFAs. In 2014, 85 million visitors spent over \$100 billion, 543,600 people were directly employed in the tourism industry and a further 385,400 indirectly. For every tourist dollar spent, 87 cents are generated in other parts of the economy (Tourism Research Australia 2014).

Perhaps most importantly, 44 cents in every dollar are spent regionally (Tourism Research Australia 2014). In NSW, nature is the number one driver of international tourism (Destination NSW 2014) and regional economic development is a strategic concern of the NSW Government (NSW Department of Trade and Investment 2015b). As of September 2-14, \$110 million of the Restart NSW program had been invested into the Regional Tourism Infrastructure Fund. The 'Visitor Economy' is one of eight key industries and \$26.7 million has been spent on regional events and tourism. Using native forests to underpin regional tourism development has the potential to deliver on several identified goals to promote economic development in NSW including:

Goal 1: Promote key regional sectors and regional competitiveness

Goal 2: Drive regional employment and regional business growth

Goal 3: Invest in economic infrastructure and connectivity

The Tourism 2020 strategy, prepared jointly by the Australian Government and Tourism Australia, identifies ‘nature-based tourism offerings’ and ‘unique landscapes’ as part of Australia’s competitive advantage. The report also identifies strategic areas, including the promotion of the aforementioned National Landscapes. Nature is the primary reason that overseas visitors choose to come to Australia (Australian Government and Tourism Australia 2011). In 2009, 67% of international visitors chose to visit state or national parks (Tourism Research Australia 2009), while in 2014 in NSW 80% of international visitors came to see nature (Destination NSW 2014). Wild nature

visitors are high value, as they tend to stay longer and spend more than other types of visitor (Taylor et al. 2014b). On average, nature-based visitors to NSW in 2014 spent \$2,483 per visitor and \$94 per night (Destination NSW 2014).

Initially, these statistics suggest a flourishing industry despite logging occurring throughout native forests. However, it is likely that there are significant gains to be made by fully realising the potential of native forests to better contribute to regional tourism, and by ending logging before further damage is done to wildlife and forests which would undermine tourism. One under-exploited area is adventure tourism—an area in which New Zealand excels (Tourism New Zealand 2013), but Australia currently lags. With a benign climate and excellent terrain, Australia has the potential to be a world leader in nature-based adventure tourism, and the 7.5 million hectares of public forest available for wood production under the RFAs (ABARES 2015) could be a key contributor to developing that industry.



Australia’s forested landscapes and the nature they contain are key drivers of the \$100-billion per year tourism industry

CONCLUSIONS

The evidence that the RFAs have failed to meet their goals in NSW and more broadly is extensive and, in most cases, unequivocal. The RFAs achieved their greatest successes in increasing the area of wilderness protected and protecting old-growth. However there have been several documented incidences of logging old-growth since the signing of the RFAs. Although the RFAs did result in a significant increase of the area of forest in the reserve network the agreed CAR reserve network of Forest Ecosystems has not been delivered in its entirety.

The RFAs have been a major economic burden on the citizens of NSW and Tasmania via assorted taxpayer bailouts and, in NSW, ongoing treasury payments of several million dollars (\$14.2 million in 2013-14 and \$15 million in 2014-15) per annum have occurred via the Community Service Obligation. The value of Australia's native forest estate has declined markedly in the last decade, and jobs in native forest logging are now very few. Currently the only forest product afforded any value under the RFAs is timber. However, extensive research since the signing of the RFAs has shown the value of ecosystem services such as water provision and soil stabilisation. In addition, native forests are habitat for many unique plants and animals, which are the subject of taxpayer-funded conservation efforts, and this nature is the primary driver of regional tourism. Logging should therefore be evaluated as to its potential to compromise these alternative values.

The RFAs did not achieve intended targets to protect threatened species, and the RFAs have reduced protections for threatened species as compared to protections under the *EPBC Act 1999*. This is demonstrated by the increasing number of forest-dependent species listed as threatened and documented population declines and local extinctions in many species of forest fauna. The direct impacts of logging on forest species is clearly illustrated by studies in the Eden area in the 1980s which used counts of dead animals as a response variable.

Ecologically sustainable forest management has not been achieved as a result of the RFAs and this is evident in the measurable damage to soils and water as a result of logging, in the reduction of tree hollows

and associated declines in hollow-dependent species as a result of logging and in the major reduction of stored carbon in logged forests. The RFAs have largely failed to incorporate new knowledge on forest ecology, ecologically sustainable forest management or ecosystem service valuation (Lindenmayer et al. 2015), and the field of climate change research is the clearest, but not the sole, example of this.

The RFAs have failed to end social conflict over forests and logging of Aboriginal places has occurred despite community protests and warnings. In fact, social unrest and opposition to native forest logging is increasing in NSW as a result of the failure of the regulatory regime and plans to intensify logging in the new Integrated Forestry Operations Approval (IFOA). The loss of public confidence in the NSW EPA is also a consequence of failed regulation of logging and the new IFOA.

Logging is not the optimal use of public native forests either environmentally or socially. A strategic exit from native forest logging coupled with a commitment to stimulate regional industries, including the profitable plantation industry, adventure tourism and recreation and forest management for biodiversity, water and carbon outcomes could result in an increase in regional jobs and revenue to local government. Employment in native forest logging has been in decline for a long time and is driven primarily by innovation (e.g. mechanical harvesting techniques) and a lack of timber as a result of historic over-exploitation. On current employment trends, a failure to manage the exit from native forest logging will risk ongoing erosion of employment in regional areas. This may accelerate as consumers become ever more discerning about the source of their wood products and environmental impacts from logging become ever more apparent.

Current Commonwealth Government policy is to extend the RFAs upon their expiry. On the basis of the evidence presented here, that would constitute an irrational decision on environmental, economic and social grounds. The NSW state government should commit to ending native forest logging immediately so that the transition from logging can be managed prior to the expiry of the current RFAs between 2019 and 2021.

REFERENCES

- ABARES. 2015. Australia's forests at a glance 2015: with data from 2013-14. ABARES, Canberra.
- ABC. *A Burning Question*, <<http://www.abc.net.au/radionational/programs/backgroundbriefing/a-burning-question/6616386>> (2015).
- Adams-Hosking, C., H. S. Grantham, J. R. Rhodes, C. McAlpine, and P. T. Moss. 2011. Modelling climate-change-induced shifts in the distribution of the koala. *Wildlife Research* **38**:122-130.
- Adams-Hosking, C., C. McAlpine, J. R. Rhodes, H. S. Grantham, and P. T. Moss. 2012. Modelling changes in the distribution of the critical food resources of a specialist folivore in response to climate change. *Diversity and Distributions* **18**:847-860.
- Adams-Hosking, C., C. A. McAlpine, J. R. Rhodes, P. T. Moss, and H. S. Grantham. 2014. Prioritizing regions to conserve a specialist folivore: considering probability of occurrence, food resources, and climate change. *Conservation Letters* **8**:162-170.
- Ajani, J. 2003. A new forest and wood industry policy framework for Australia. Pages 189-203 in D. B. Lindenmayer and J. F. Franklin, editors. *Towards Forest Sustainability*. Island Press, Washington DC.
- Ajani, J. *Key information for NSW forest policy today*, <<http://www.serca.org.au/research/2013/Ajani.pdf>> (2013).
- Ampoorter, E., A. de Schrijver, L. van Nevel, M. Hermy, and K. Verheyen. 2012. Impact of mechanized harvesting on compaction of sandy and clayey forest soils: results of a meta-analysis. *Annals of Forest Science* **69**:533-542.
- Anon. *Joint Australian and New South Wales Government Response to the Final Report on Progress with Implementation of NSW Regional Forest Agreements: Report of Independent Assessor*, <<http://www.agriculture.gov.au/SiteCollectionDocuments/rfa/publications/annual-reports/nsw/jointresponse-nswrfa.pdf>> (2014).
- Audit Office of New South Wales. *Sustaining native forest operations: Forests NSW*, <http://www.audit.nsw.gov.au/ArticleDocuments/141/185_Sustaining_Native_Forest.pdf.aspx?Embed=Y> (2009).
- Australian and New Zealand Environment and Conservation Council. 1997. Nationally agreed criteria for the establishment of a comprehensive, adequate and representative reserve system for forests in Australia / a report by the Joint ANZECC/MCFFA National Forest Policy Statement Implementation Sub-Committee. Canberra.
- Australian Bureau of Statistics. *2011 census of population and housing*, <<http://www.abs.gov.au/websitedbs/censushome.nsf/home/data?opendocument&navpos=200>> (2011).
- Australian Bureau of Statistics. 2014. *Australian System of National Accounts: Concepts, Sources and Methods*. Australian Bureau of Statistics, Belconnen.
- Australian Bureau of Statistics. *Australian Environmental-Economic Accounts*, <<http://www.abs.gov.au/ausstats/abs@.nsf/mf/4655.0>> (2015).
- Australian Conservation Foundation. *Woodchipping our Water: A case for reassessing the use of Victoria's Goulburn Catchment's wet montane forests*, <https://www.acfonline.org.au/sites/default/files/resources/woodchipping_our_water-Goulburn_Catchment_Report.pdf> (2009).
- Australian Government, and Tourism Australia. *Australia's National Landscapes: a partnership between conservation and tourism*, <http://www.tourism.australia.com/documents/corporate/NL_Program_Summary_2011.pdf> (2011).
- Barrett, T., and K. Vernes. *Forests of eastern Australia are the world's newest biodiversity hotspot*, <<https://theconversation.com/forests-of-eastern-australia-are-the-worlds-newest-biodiversity-hotspot-3935>> (2011).
- Beyond Blue Limited. 2010. *Beyond Blue to Green: the benefits of contact with nature for mental health and well-being*. Beyond Blue Limited, Melbourne.
- Blay, J., and Eden Local Aboriginal Land Council. *Report of a survey of the Bundian Way 2010-2011*, <http://www.bundianway.com.au/Bundian_Survey_Public.pdf> (2011).
- Bradshaw, C. J. 2012. Little left to lose: deforestation and forest degradation in Australia since European colonization. *Journal of plant ecology* **5**:109-120.
- Bradstock, R. A., and O. F. Price. 2014. Logging and Fire in Australian Forests: errors by Attiwill et al. (2014). *Conservation Letters* **7**:419-420.
- Braithwaite, L., J. Turner, and J. Kelly. 1984. Studies on the Arboreal Marsupial Fauna of Eucalypt Forests Being Harvested for Wood Pulp at Eden, N.S.W. iii. Relationships Between Faunal Densities, Eucalypt Occurrence and Foliage Nutrients, and Soil Parent Materials. *Wildlife Research* **11**:41-48.
- Braithwaite, L. W. 1983. Studies on the arboreal marsupial fauna of eucalypt forests being harvested for woodpulp at Eden, N.S.W. I. The species and distribution of animals. *Wildlife Research* **10**:219-229.
- Braithwaite, L. W., M. L. Dudzinski, and J. Turner. 1983. Studies on the arboreal marsupial fauna of eucalypt forests being harvested for woodpulp at Eden, N.S.W. II. Relationship between the fauna density, richness and diversity, and measured variables of the habitat. *Wildlife Research* **10**:231-247.
- Budget Estimates secretariat. *Budget Estimates 2015-2016, supplementary questions. General Purpose Standing Committee No. 5. Primary Industries, Land and Water*, <[http://www.parliament.nsw.gov.au/prod/parliament/committee.nsf/0/6ec3bc4568a0299aca257ed000277ecd/\\$FILE/73211780.PDF/Blair%20BE%20Supp%20Questions%20FINAL.PDF](http://www.parliament.nsw.gov.au/prod/parliament/committee.nsf/0/6ec3bc4568a0299aca257ed000277ecd/$FILE/73211780.PDF/Blair%20BE%20Supp%20Questions%20FINAL.PDF)> (2015).
- Burgman, M., R. Church, I. Ferguson, R. Gijbers, A. Lau, D. Lindenmayer, R. Loyn, M. McCarthy, and W. Vandenberg. 1994. Wildlife planning using FORPLAN: a review and examples from Victorian forests. *Australian Forestry* **57**:131-140.
- Burns, E. L., D. B. Lindenmayer, J. Stein, W. Blanchard, L. McBurney, D. Blair, and S. C. Banks. 2015. Ecosystem assessment of mountain ash forest in the Central Highlands of Victoria, south-eastern Australia. *Austral Ecology* **40**:386-399.
- Campbell, I., and T. Doeg. 1989. Impact of timber harvesting and production on streams: A review. *Marine and Freshwater Research* **40**:519-539.
- Campbell, R., and R. McKeon. 2015. Money doesn't grow on trees: the financial and economic losses of native forestry in NSW. The Australia Institute, Canberra.
- Cerese, B. 2012. *The Eucalypt Forests of Northeast New South Wales: A Preliminary Assessment and Documentation of their World Heritage Values*. National Parks Association of New South Wales, Sydney.
- Chipstop.org. *Woodchipping subsidies*, <<http://www.chipstop.savetheforests.org.au/subsidies.htm>> (2015).
- Christoff, P. *Australia's climate targets still out of reach after second emissions auction*, <<https://theconversation.com/australias-climate-targets-still-out-of-reach-after-second-emissions-auction-50519>> (2015).
- Clark, T. W., N. Mazur, S. J. Cork, S. Dovers, and R. Harding. 2000. Koala Conservation Policy Process: Appraisal and Recommendations. *Conservation Biology* **14**:681-690.
- Commonwealth of Australia. *National Forest Policy Statement. A new focus for Australia's forests*, <http://www.agriculture.gov.au/SiteCollectionDocuments/forestry/australias-forest-policies/nat_nfps.pdf> (1992, 1995).
- Commonwealth of Australia. *Regional Forest Agreements - an overview and history*, <<http://www.agriculture.gov.au/SiteCollectionDocuments/forestry/australias-forest-policies/rfa/rfa-overview-history.pdf>> (2015).
- Cork, S., G. Stoneham, and K. Lowe. *Ecosystem services and Australian natural resource management (NRM) futures: paper to the Natural*

- Resource Policies and Programs Committee (NRPPC) and the Natural Resource Management Standing Committee (NRMSC), <<http://www.environment.gov.au/system/files/resources/11543d24-9f2c-44ee-a52c-83dfa6adb7d9/files/ecosystem-services.pdf>> (2007).
- Cornish, P. M. 2001. The effects of roading, harvesting and forest regeneration on streamwater turbidity levels in a moist eucalypt forest. *Forest Ecology and Management* **152**:293-312.
- Costanza, R., R. de Groot, P. Sutton, S. van der Ploeg, S. J. Anderson, I. Kubiszewski, S. Farber, and R. K. Turner. 2014. Changes in the global value of ecosystem services. *Global Environmental Change* **26**:152-158.
- Creedy, J., and A. D. Wurzbacher. 2001. The economic value of a forested catchment with timber, water and carbon sequestration benefits. *Ecological Economics* **38**:71-83.
- Croke, J., P. Hairsine, and P. Fogarty. 1999. Runoff generation and redistribution in logged eucalyptus forests, south-eastern Australia. *Journal of Hydrology* **216**:56-77.
- Croke, J., P. Hairsine, and P. Fogarty. 2001. Soil recovery from track construction and harvesting changes in surface infiltration, erosion and delivery rates with time. *Forest Ecology and Management* **143**:3-12.
- CSIRO. *Climate Change in Australia*, <<http://www.climatechangeinaustralia.gov.au/en/>> (2015).
- Dargavel, J. 1998. Politics, Policy and Process in the Forests. *Australian Journal of Environmental Management* **5**:25-30.
- Dargavel, J., C. Hamilton, and P. O'Shaughnessy. 1995. Logging and water: a study of the effects of logging regimes on water catchment hydrology and soil stability on the eastern seaboard of Australia The Australia Institute.
- Davies, P. E., and M. Nelson. 1993. The effect of steep slope logging on fine sediment infiltration into the beds of ephemeral and perennial streams of the Dazzler Range, Tasmania, Australia. *Journal of Hydrology* **150**:481-504.
- de Groot, R., L. Brander, S. van der Ploeg, R. Costanza, F. Bernard, L. Braat, M. Christie, N. Crossman, A. Ghermandi, L. Hein, S. Hussain, P. Kumar, A. McVittie, R. Portela, L. C. Rodriguez, P. ten Brink, and P. van Beukering. 2012. Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem Services* **1**:50-61.
- Department of Environment and Climate Change NSW. 2008a. New South Wales National Parks Establishment Plan 2008: directions for building a diverse and resilient system of parks and reserves under the National Parks and Wildlife Act. Sydney.
- Department of Environment and Climate Change NSW. 2008b. Wilderness Assessment Guidelines. Department of Environment and Climate Change NSW, Sydney.
- Department of Environment Climate Change and Water NSW. Review of NSW Forest Agreements and Integrated Forestry Operations Approvals: Upper North East, Lower North East, Eden and Southern regions. Sydney.
- Destination NSW. *Nature Based Tourism to NSW: Year ended September 2014*, <<http://www.destinationnsw.com.au/wp-content/uploads/2013/05/Nature-based-tourism-YE-Sep-14.pdf>> (2014).
- Drielsma, M., G. Manion, J. Love, K. J. Williams, T. Harwood, and H. Saremi. 2015. 3C modelling for biodiversity management under future climate. Office of Environment and Heritage, Sydney.
- Dudley, N., and S. Stolton. 2008. Drinking water and protected areas. *in* L. Janishevski, K. Noonan-Mooney, S. B. Gidda, and J. K. Mulongoy, editors. Protected areas in today's world: their values and benefits for the welfare of the planet. Secretariat of the Convention on Biological Diversity, Montreal.
- Dudley, N. e. 2008. Guidelines for applying protected area management categories. IUCN, Gland, Switzerland.
- Dunlop, M., and P. R. Brown. *Implications of climate change for Australia's National Reserve System: a preliminary assessment. Report to the Department of Climate Change*, <<http://www.environment.gov.au/system/files/resources/917bb661-b626-44bb-bd52-325645ae7c49/files/nrs-report.pdf>> (2008).
- Dunlop, M., D. W. Hilbert, S. Ferrier, A. House, A. Liedloff, S. M. Prober, A. Smyth, T. G. Martin, T. Harwood, K. J. Williams, C. Fletcher, and H. Murphy. *The implications of climate change for biodiversity and the National Reserve System: Final Synthesis*, <<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.435.3281&rep=rep1&type=pdf>> (2012).
- English, A. W. 2004. Echidnas and archaeology: understanding the Aboriginal values of forests in NSW. *in* D. Lunney, editor. Conservation of Australia's Forest Fauna. Royal Zoological Society of NSW, Mosman.
- Eyre, T. J., D. W. Butler, A. L. Kelly, and J. Wang. 2010. Effects of forest management on structural features important for biodiversity in mixed-age hardwood forests in Australia's subtropics. *Forest Ecology and Management* **259**:534-546.
- Feehely, J., N. Hammond-Deakin, and F. Millner. 2013. One Stop Chop: How Regional Forest Agreements streamline environmental destruction. Lawyers for Forests, Melbourne.
- Flint, C., D. Pugh, and D. Beaver. 2004. The good, the bad and the ugly: science, process and politics in forestry reform and the implications for conservation of forest fauna in north-east New South Wales. Pages 222-255 *in* D. Lunney, editor. Conservation of Australia's Forest Fauna. Royal Zoological Society of New South Wales, Mosman.
- Forestry Tasmania. *Annual Report 2014/15*, <http://www.forestrytas.com.au/uploads/File/pdf/pdf2015/annual_report_2014_15.pdf> (2015).
- Gavran, M. *Australian plantation statistics 2015 update*, <http://data.daff.gov.au/data/warehouse/aplnsd9ablf002/aplnsd9ablf201505/AustPlantationStats_2015_v1.0.0.pdf> (2015).
- Gibbons, P., and D. B. Lindenmayer. 2002. Tree hollows and wildlife conservation in Australia. CSIRO, Collingwood.
- Hammond-Deakin, N., and S. Higginson. *If a tree falls: Compliance failures in the public forests of New South Wales*, <http://d3n8a8pro7vhm.cloudfront.net/edonsw/pages/284/attachments/original/1380667654/110728when_a_tree_falls.pdf?1380667654> (2011).
- Hawke, A. *The Australian Environment Act - Report of the independent review of the Environment Protection and Biodiversity Conservation Act 1999*, <<http://www.environment.gov.au/system/files/resources/5f3fdad6-30ba-48f7-ab17-c99e8bcc8d78/files/final-report.pdf>> (2009).
- Heagney, E. C., M. Kovac, J. Fountain, and N. Conner. 2015. Socio-economic benefits from protected areas in southeastern Australia. *Conservation Biology* **29**:1647-1657.
- Hobday, A. J., and J. McDonald. 2014. Environmental Issues in Australia. *Annual Review of Environment and Resources* **39**:1-28.
- Hodgkinson, K. *Buyback to ensure sustainable supply of timber from north coast forests*, <http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0015/520224/media_release_140624_timber_buyback_sustainable_supply_north_coast.pdf> (2014).
- Horwitz, P., and M. Calver. 1998. Credible science? Evaluating the Regional Forest Agreement Process in Western Australia. *Australian Journal of Environmental Management* **5**:213-225.
- IPCC. 2014. Climate Change 2014: synthesis report. Contribution of working groups I II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva.
- Joppa, L. N., and A. Pfaff. 2009. High and Far: Biases in the Location of Protected Areas. *PLoS ONE* **4**:e8273.
- Kavanagh, R., S. Debus, T. Tweedie, and R. Webster. 1995. Distribution of Nocturnal Forest Birds and Mammals in North-Eastern New South Wales: Relationships With Environmental Variables and Management History. *Wildlife Research* **22**:359-377.

- Kavanagh, R. P., and M. A. Stanton. 2005. Vertebrate species assemblages and species sensitivity to logging in the forests of north-eastern New South Wales. *Forest Ecology and Management* **209**:309-341.
- Keith, H., D. Lindenmayer, A. Macintosh, and B. Mackey. 2015. Under what circumstances do wood products from native forests benefit climate change mitigation? *PLoS ONE* **10**:e0139640.
- Keith, H., D. Lindenmayer, B. Mackey, D. Blair, L. Carter, L. McBurney, S. Okada, and T. Konishi-Nagano. 2014. Managing temperate forests for carbon storage: impacts of logging versus forest protection on carbon stocks. *Ecosphere* **5**:art75.
- Keith, H., B. Mackey, S. Berry, D. Lindenmayer, and P. Gibbons. 2010. Estimating carbon carrying capacity in natural forest ecosystems across heterogeneous landscapes: addressing sources of error. *Global Change Biology* **16**:2971-2989.
- Keith, H., B. G. Mackey, and D. B. Lindenmayer. 2009. Re-evaluation of forest biomass carbon stocks and lessons from the world's most carbon-dense forests. *Proceedings of the National Academy of Sciences* **106**:11635-11640.
- Kingsford, R. T., J. E. M. Watson, C. J. Lundquist, O. Venter, L. Hughes, E. L. Johnston, J. Atherton, M. Gawel, D. A. Keith, B. G. Mackey, C. Morley, H. P. Possingham, B. Raynor, H. F. Recher, and K. A. Wilson. 2009. Major Conservation Policy Issues for Biodiversity in Oceania. *Conservation Biology* **23**:834-840.
- Kirkpatrick, J. B. 1998. Nature Conservation and the Regional Forest Agreement Process. *Australian Journal of Environmental Management* **5**:31-37.
- Kuussaari, M., R. Bommarco, R. K. Heikkinen, A. Helm, J. Krauss, R. Lindborg, E. Öckinger, M. Pärtel, J. Pino, F. Rodà, C. Stefanescu, T. Teder, M. Zobel, and I. Steffan-Dewenter. 2009. Extinction debt: a challenge for biodiversity conservation. *Trends in Ecology & Evolution* **24**:564-571.
- Laffan, M., G. Jordan, and N. Duhig. 2001. Impacts on soils from cable-logging steep slopes in northeastern Tasmania, Australia. *Forest Ecology and Management* **144**:91-99.
- Lane, M. B. 1999. Regional Forest Agreements: Resolving Resource Conflicts or Managing Resource Politics? *Australian Geographical Studies* **37**:142-153.
- Lindenmayer, D. B., D. Blair, L. McBurney, and S. C. Banks. 2015. The need for a comprehensive reassessment of the Regional Forest Agreements in Australia. *Pacific Conservation Biology* **21**:266-270.
- Lindenmayer, D. B., W. Blanchard, L. McBurney, D. Blair, S. Banks, G. E. Likens, J. F. Franklin, W. F. Laurance, J. A. R. Stein, and P. Gibbons. 2012. Interacting Factors Driving a Major Loss of Large Trees with Cavities in a Forest Ecosystem. *PLoS ONE* **7**:e41864.
- Lindenmayer, D. B., M. L. Hunter, P. J. Burton, and P. Gibbons. 2009. Effects of logging on fire regimes in moist forests. *Conservation Letters* **2**:271-277.
- Lindenmayer, D. B., W. F. Laurance, J. F. Franklin, G. E. Likens, S. C. Banks, W. Blanchard, P. Gibbons, K. Ikin, D. Blair, L. McBurney, A. D. Manning, and J. A. R. Stein. 2014. New Policies for Old Trees: Averting a Global Crisis in a Keystone Ecological Structure. *Conservation Letters* **7**:61-69.
- Lindenmayer, D. B., J. T. Wood, L. McBurney, C. MacGregor, K. Youngentob, and S. C. Banks. 2011. How to make a common species rare: A case against conservation complacency. *Biological Conservation* **144**:1663-1672.
- Love, A., and O. F. Sweeney. 2015. A blueprint for a comprehensive reserve system for koalas (*Phascolarctos cinereus*) on the North Coast of New South Wales National Parks Association, Sydney.
- Loyn, R., H. 2004. Research for Ecologically Sustainable Forest Management in Victorian eucalypt forests. Pages 783-806 *in* D. Lunney, editor. Conservation of Australia's Forest Fauna. Royal Zoological Society of New South Wales, Mosman.
- Lunney, D. 2004. A test of our civilisation. *in* D. Lunney, editor. Conservation of Australia's Forest Fauna. Royal Zoological Society of New South Wales, Mosman.
- Lunney, D., M. S. Crowther, I. R. Wallis, W. Foley, J. M. Lemon, R. Wheeler, G. Madani, C. Orscheg, J. E. Griffith, M. Krockenberger, R. Retamales, and E. Stalenberg. 2012. Koalas and climate change: a case study on the Liverpool Plains, north-west New South Wales. *in* D. Lunney and P. Hutchings, editors. Wildlife and climate change. Towards robust conservation strategies for Australian fauna. Royal Zoological Society of New South Wales, Mosman, NSW.
- Lunney, D., and T. Leary. 1988. The impact on native mammals of land-use changes and exotic species in the Bega district, New South Wales, since settlement. *Australian Journal of Ecology* **13**:67-92.
- Lunney, D., and A. Matthews. 2004. Conserving the forest mammals of New South Wales. Pages 988-1021 *in* D. Lunney, editor. Conservation of Australia's Forest Fauna. Royal Zoological Society of New South Wales, Mosman, NSW.
- Lunney, D., E. Stalenberg, T. Santika, and J. R. Rhodes. 2014. Extinction in Eden: identifying the role of climate change in the decline of the koala in south-eastern NSW. *Wildlife Research* **41**:22-34.
- Macintosh, A. *The Australian native forest sector: causes of the decline and prospects for the future. Technical Brief No. 21.*, <<http://www.tai.org.au/node/1971>> (2013a).
- Macintosh, A. *Chipping away at Tasmania's future: alternatives to subsidising the forestry industry*, <http://www.tai.org.au/sites/default/files/IP%202015%20Chipping%20away%20at%20Tasmanias%20future_0.pdf> (2013b).
- Macintosh, A., H. Keith, and D. Lindenmayer. 2015. Rethinking forest carbon assessments to account for policy institutions. *Nature Climate Change* **5**:946-949.
- Mackey, B. G., H. Keith, S. L. Berry, and D. B. Lindenmayer. 2008. Green carbon: the role of natural forests in carbon storage. Part 1, a green carbon account of Australia's south-eastern Eucalypt forest, and policy implications. ANU E press, Canberra.
- Maller, C., M. Townsend, A. Pryor, P. Brown, and L. St Leger. 2006. Healthy nature healthy people: 'contact with nature' as an upstream health promotion intervention for populations. *Health Promotion International* **21**:45-54.
- McAlpine, C., D. Lunney, A. Melzer, P. Menkhorst, S. Phillips, D. Phalen, W. Ellis, W. Foley, G. Baxter, D. de Villiers, R. Kavanagh, C. Adams-Hosking, C. Todd, D. Whisson, R. Molsher, M. Walter, I. Lawler, and R. Close. 2015. Conserving koalas: A review of the contrasting regional trends, outlooks and policy challenges. *Biological Conservation* **192**:226-236.
- McAlpine, C. A., J. R. Rhodes, J. G. Callaghan, M. E. Bowen, D. Lunney, D. L. Mitchell, D. V. Pullar, and H. P. Possingham. 2006. The importance of forest area and configuration relative to local habitat factors for conserving forest mammals: A case study of koalas in Queensland, Australia. *Biological Conservation* **132**:153-165.
- McDonald, J. 1999. Regional Forest (Dis) Agreements: the RFA Process and Sustainable Forest Management. *Bond Law Review* **11**:295-342.
- Meek, P. 2004. Compromising science for regulatory compliance: a case study for confounding conservation policy. Pages 256-269 *in* D. Lunney, editor. Conservation of Australia's Forest Fauna. Royal Zoological Society of New South Wales, Mosman.
- Milledge, D. 2015. Brief report on a field inspection to demonstrate proposed changes to IFOA prescriptions designed to protect threatened species and their habitats during forestry operations, compartment 10, Queens Lake State Forest, 30 June 2015.
- Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee. 2013. Australia's State of the Forests Report 2013. ABARES, Canberra.

- Mosley, G., and A. B. Costin. 1992. World Heritage Values and their protection in Far South East New South Wales. Report to the Earth Foundation Australia.
- Motha, J. A. 2003. Determining the source of suspended sediment in a forested catchment in southeastern Australia. *Water Resources Research* 39:1056.
- Muir, K. 2016. Future Wilderness Protection in NSW. Nature NSW.
- Musselwhite, G., and G. Herath. 2005. Australia's regional forest agreement process: analysis of the potential and problems. *Forest Policy and Economics* 7:579-588.
- Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. da Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403:853-858.
- New South Wales Government. *State Priorities*, <<https://www.nsw.gov.au/making-it-happen>> (2015).
- New South Wales Parliament, L. C., General Purpose Standing Committee No. 5., *Inquiry into the performance of the NSW Environment Protection Agency*, <[http://www.parliament.nsw.gov.au/Prod/Parliament/committee.nsf/0/7548a6b1d605d845ca257deb00116295/\\$FILE/150213%20GPSC5%20Report%2040.pdf](http://www.parliament.nsw.gov.au/Prod/Parliament/committee.nsf/0/7548a6b1d605d845ca257deb00116295/$FILE/150213%20GPSC5%20Report%2040.pdf)> (2015).
- Norton, T. W. 1996. Conserving biological diversity in Australia's temperate eucalypt forests. *Forest Ecology and Management* 85:21-33.
- NSW Department of Environment and Climate Change. 2009. A draft report on progress with implementation of the New South Wales Regional Forest Agreements. NSW Department of Environment and Climate Change, Sydney.
- NSW Department of Industry and Investment. *The contribution of primary industries to the NSW economy. Key data 2010.*, <http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0006/330945/Contribution-of-primary-industries-to-the-NSW-economy-2010.pdf> (2010).
- NSW Department of Planning and Environment. *Population Projections*, <<http://www.planning.nsw.gov.au/projections>> (2015).
- NSW Department of Trade and Investment. *The contribution of primary industries to the NSW economy. Key Data 2013*, <http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0011/463763/Contribution-of-PI-to-the-NSW-economy-2013.pdf> (2013).
- NSW Department of Trade and Investment. *The contribution of primary industries to the NSW economy. Key data 2015.*, <http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0006/550347/contribution-of-primary-industries-to-the-nsw-economy-2015.pdf> (2015a).
- NSW Department of Trade and Investment. *Economic Development Strategy for Regional NSW*, <http://www.industry.nsw.gov.au/_data/assets/pdf_file/0010/67699/Economic-Development-Strategy-for-Regional-NSW_with-APPENDIX_Feb2015.pdf> (2015b).
- NSW Environment Protection Authority. *Coastal IFOA remake*, <<http://www.epa.nsw.gov.au/forestagreements/coastlIFOAs.htm>> (2015a).
- NSW Environment Protection Authority. *New South Wales State of the Environment 2015*, <<http://www.epa.nsw.gov.au/soe/20150817soe-2015.htm>> (2015b).
- NSW Environment Protection Authority. *Questions and answers*, <<http://www.epa.nsw.gov.au/forestagreements/questions.htm#what-esfm>> (2015c).
- NSW National Parks and Wildlife Service. 1996. Broad Old Growth Mapping Project. Final Report.
- NSW Scientific Committee. *Lantana camara - key threatening process listing*, <<http://www.environment.nsw.gov.au/determinations/LantanaKtp.htm>> (2006).
- NSW Scientific Committee. *Loss of hollow-bearing trees - key threatening process determination*, <<http://www.environment.nsw.gov.au/determinations/lossofhollowtreesktp.htm>> (2007).
- NSW Scientific Committee. *Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners*, <<http://www.environment.nsw.gov.au/determinations/bellminerfd.htm>> (2008).
- Perkins, F., and A. Macintosh. 2013. Logging or carbon credits: comparing the returns from forest-based activities in NSW's Southern Forestry Region. Technical Brief No. 23.
- Phillips, S. S. 2000. Population Trends and the Koala Conservation Debate. *Conservation Biology* 14:650-659.
- Pressey, R. L., M. Cabeza, M. E. Watts, R. M. Cowling, and K. A. Wilson. 2007. Conservation planning in a changing world. *Trends in Ecology & Evolution* 22:583-592.
- Pressey, R. L., S. Ferrier, T. C. Hager, C. A. Woods, S. L. Tully, and K. M. Weinman. 1996. How well protected are the forests of north-eastern New South Wales? — Analyses of forest environments in relation to formal protection measures, land tenure, and vulnerability to clearing. *Forest Ecology and Management* 85:311-333.
- Pressey, R. L., C. J. Humphries, C. R. Margules, R. I. Vane-Wright, and P. H. Williams. 1993. Beyond opportunism: Key principles for systematic reserve selection. *Trends in Ecology & Evolution* 8:124-128.
- Pressey, R. L., G. L. Whish, T. W. Barrett, and M. E. Watts. 2002. Effectiveness of protected areas in north-eastern New South Wales: recent trends in six measures. *Biological Conservation* 106:57-69.
- Price, O. F., and R. A. Bradstock. 2012. The efficacy of fuel treatment in mitigating property loss during wildfires: Insights from analysis of the severity of the catastrophic fires in 2009 in Victoria, Australia. *Journal of Environmental Management* 113:146-157.
- Pugh, D. 2010. Preliminary audit of Girard State Forest compartments 44, 45, 46, 54, 55, and 56. North East Forest Alliance.
- Pugh, D. 2013. Koreelah State Forest audit. North East Forest Alliance.
- Pugh, D. *The causes of logging dieback: NEFA background paper*, <https://d3n8a8pro7vnmx.cloudfront.net/ncecp/pages/39/attachments/original/1422674489/NEFA_BP_The_Causes_of_Logging_Dieback.pdf?1422674489> (2014).
- Pullinger, P. *Pulling a swiftie: systemic Tasmanian Government approval of logging known to damage Swift Parrot habitat*, <https://www.wilderness.org.au/sites/default/files/PDFS/Pulling_a_Swiftie_Report_WEB.pdf> (2015).
- Rab, M. A. 1994. Changes in physical properties of a soil associated with logging of Eucalyptus regnan forest in southeastern Australia. *Forest Ecology and Management* 70:215-229.
- Rab, M. A. 1996. Soil physical and hydrological properties following logging and slash burning in the Eucalyptus regnans forest of southeastern Australia. *Forest Ecology and Management* 84:159-176.
- Rab, M. A. 1999. Measures and operating standards for assessing Montreal process soil sustainability indicators with reference to Victorian Central Highlands forest, southeastern Australia. *Forest Ecology and Management* 117:53-73.
- Rab, M. A. 2004. Recovery of soil physical properties from compaction and soil profile disturbance caused by logging of native forest in Victorian Central Highlands, Australia. *Forest Ecology and Management* 191:329-340.
- Rangan, H., and M. B. Lane. 2001. Indigenous Peoples and Forest Management: Comparative Analysis of Institutional Approaches in Australia and India. *Society & Natural Resources* 14:145-160.
- Resource Assessment Commission. 1992. A survey of Australia's forest resource. Canberra.
- Rhodes, J. R., C. F. Ng, D. L. de Villiers, H. J. Preece, C. A. McAlpine, and H. P. Possingham. 2011. Using integrated population modelling to quantify the implications of multiple threatening processes for a rapidly declining population. *Biological Conservation* 144:1081-1088.
- Roxburgh, S. H., S. W. Wood, B. G. Mackey, G. Woldendorp, and P. Gibbons. 2006. Assessing the carbon sequestration potential of managed forests: a case study from temperate Australia. *Journal of Applied Ecology* 43:1149-1159.

- Santika, T., C. A. McAlpine, D. Lunney, K. A. Wilson, and J. R. Rhodes. 2015. Assessing spatio-temporal priorities for species' recovery in broad-scale dynamic landscapes. *Journal of Applied Ecology* **52**:832-840.
- Seabrook, L., C. McAlpine, G. Baxter, J. Rhodes, A. Bradley, and D. Lunney. 2011. Drought-driven change in wildlife distribution and numbers: a case study of koalas in south west Queensland. *Wildlife Research* **38**:509-524.
- Singh, A., H. Shi, T. Foresman, and E. A. Fosnight. 2001. Status of the World's Remaining Closed Forests: An Assessment Using Satellite Data and Policy Options. *AMBIO: A Journal of the Human Environment* **30**:67-69.
- Slee, B. 2001. Resolving production-environment conflicts: the case of the Regional Forest Agreement Process in Australia. *Forest Policy and Economics* **3**:17-30.
- Smith, A. 2004. Koala conservation and habitat requirements in a timber production forest in north-east New South Wales. Pages 591-611 in D. Lunney, editor. *The Conservation of Australia's Forest Fauna*. Royal Zoological Society of NSW, Mosman.
- Smith, A. P., and D. B. Lindenmayer. 1992. Forest succession and habitat management for Leadbeater's possum in the State of Victoria, Australia. *Forest Ecology and Management* **49**:311-332.
- Soulé, M. E., B. G. Mackey, H. F. Recher, J. E. Williams, J. C. Z. Woinarski, D. Driscoll, W. C. Dennison, and M. E. Jones. 2004. The role of connectivity in Australian conservation. *Pacific Conservation Biology* **10**:266-279.
- Spencer, S. 2009. Final Report on Progress with Implementation of NSW Regional Forest Agreements: Report of Independent Assessor.
- Spring, D. A., J. O. S. Kennedy, and R. Mac Nally. 2005. Optimal management of a forested catchment providing timber and carbon sequestration benefits: Climate change effects. *Global Environmental Change* **15**:281-292.
- Statistics New Zealand. *New Zealand in Profile: 2014. Imports and exports.*, <http://www.stats.govt.nz/browse_for_stats/snapshots-of-nz/nz-in-profile-2014/imports-exports.aspx> (2014).
- Stewart, D. G. 1991. Forest and timber inquiry: draft report. Resource Assessment Commission, Canberra.
- Stone, C. 2005. Bell-miner-associated dieback at the tree crown scale: a multi-trophic process. *Australian Forestry* **68**:237-241.
- Stone, C., A. Kathuria, C. Carney, and J. Hunter. 2008. Forest canopy health and stand structure associated with bell miners (*Manorina melanophrys*) on the central coast of New South Wales. *Australian Forestry* **71**:294-302.
- Taylor, C., M. A. McCarthy, and D. B. Lindenmayer. 2014a. Nonlinear Effects of Stand Age on Fire Severity. *Conservation Letters* **7**:355-370.
- Taylor, M. F. J., J. A. Fitzsimons, and P. Sattler. 2014b. Building Nature's Safety Net 2014: a decade of protected area achievements in Australia. WWF-Australia, Sydney.
- Taylor, M. J., P. Sattler, M. Evans, R. Fuller, J. M. Watson, and H. Possingham. 2011. What works for threatened species recovery? An empirical evaluation for Australia. *Biodiversity and Conservation* **20**:767-777.
- The Wilderness Society, Environment Tasmania, and Australian Conservation Foundation. *An opportunity for genuine reform: Replacing the Regional Forest Agreements. A submission to the 2007-2012 RFA Review*, <https://www.wilderness.org.au/sites/default/files/PDFS/TWS_RFA_Reform_Report_FA_Web_HR_SinglePages.pdf> (2015).
- The Wilderness Society, and The Environmental Defenders Office. *State forests, national interests: A review of the Tasmanian RFA*, <https://www.wilderness.org.au/sites/default/files/TAS/TWS_Tasmanian_RFA_Report_FA_Web.pdf> (2015).
- Tilman, D., R. M. May, C. L. Lehman, and M. A. Nowak. 1994. Habitat destruction and the extinction debt. *Nature* **371**:65-66.
- Tourism New Zealand. 2013. Adventure Tourism.
- Tourism Research Australia. *Snapshots 2009: Nature Tourism in Australia*, <http://www.tra.gov.au/documents/Snapshots_2009_Nature_FINAL.pdf> (2009).
- Tourism Research Australia. *State of the Industry 2014*, <http://www.tra.gov.au/documents/State-of-the-industry/TRA_State_of_the_Industry_2014_FINAL.pdf> (2014).
- United Nations Framework Convention on Climate Change. *Adoption of the Paris Agreement*, <<https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf>> (2015).
- Vardakoulias, O. 2013. The Economic Benefits of Ecominds: a case-study approach. New Economics Foundation, London.
- Vellend, M., K. Verheyen, H. Jacquemyn, A. Kolb, H. Van Calster, G. Peterken, and M. Hermy. 2006. Extinction debt of forest plants persists for more than a century following habitat fragmentation. *Ecology* **87**:542-548.
- Venter, O., R. A. Fuller, D. B. Segan, J. Carwardine, T. Brooks, S. H. M. Butchart, M. Di Marco, T. Iwamura, L. Joseph, D. O'Grady, H. P. Possingham, C. Rondinini, R. J. Smith, M. Venter, and J. E. M. Watson. 2014. Targeting Global Protected Area Expansion for Imperiled Biodiversity. *PLoS Biol* **12**:e1001891.
- Vertessy, R. A., F. G. R. Watson, and S. K. O'Sullivan. 2001. Factors determining relations between stand age and catchment water balance in mountain ash forests. *Forest Ecology and Management* **143**:13-26.
- Wardell-Johnson, G., C. Stone, H. Recher, and A. J. J. Lynch. 2005. A review of eucalypt dieback associated with bell miner habitat in south-eastern Australia. *Australian Forestry* **68**:231-236.
- Wardell-Johnson, G., C. Stone, H. F. Recher, and J. J. Lynch. *Bell Miner Associated Dieback (BMAD) Independent Scientific Literature Review: A review of eucalypt dieback associated with Bell miner habitat in north-eastern New South Wales, Australia. DEC NSW Occasional Paper DEC 2006/116*, <<http://www.bmad.com.au/publications/LiteratureReview.pdf>> (2006).
- Wardell-Johnson, G. W., G. Keppel, and J. Sander. 2011. Climate change impacts on the terrestrial biodiversity and carbon stocks of Oceania. *Pacific Conservation Biology* **17**:220-240.
- Watson, J. E. M., R. A. Fuller, A. W. T. Watson, B. G. Mackey, K. A. Wilson, H. S. Grantham, M. Turner, C. J. Klein, J. Carwardine, L. N. Joseph, and H. P. Possingham. 2009. Wilderness and future conservation priorities in Australia. *Diversity and Distributions* **15**:1028-1036.
- Webb, A. A. 2011. Can timber and water resources be sustainably co-developed in south-eastern New South Wales, Australia? *Environment, Development and Sustainability* **14**:233-252.
- Webb, A. A., D. Dragovich, and R. Jamshidi. 2012a. Temporary increases in suspended sediment yields following selective eucalypt forest harvesting. *Forest Ecology and Management* **283**:96-105.
- Webb, A. A., A. Kathuria, and L. Turner. 2012b. Longer-term changes in streamflow following logging and mixed species eucalypt forest regeneration: The Karuah experiment. *Journal of Hydrology* **464-465**:412-422.
- Williams, K., A. Ford, D. Rosauer, N. De Silva, R. Mittermeier, C. Bruce, F. Larsen, and C. Margules. 2011. Forests of East Australia: The 35th Biodiversity Hotspot. Pages 295-310 in F. E. Zachos and J. C. Habel, editors. *Biodiversity Hotspots*. Springer Berlin Heidelberg.
- Woinarski, J. C. Z., A. A. Burbidge, and P. L. Harrison. 2014. The action plan for Australian Mammals 2012. CSIRO, Collingwood, VIC.
- Worboys, G. L., M. Lockwood, A. Kothari, S. Feary, and I. Pulsford. 2015. Protected area governance and management. ANU Press, Canberra.
- WWF. *Eastern Australia Temperate Forests*, <http://wwf.panda.org/about_our_earth/ecoregions/easternaustralia_temperate_forests.cfm> (2015a).
- WWF. *Southwestern Australia Forests and Scrub*, <http://wwf.panda.org/about_our_earth/ecoregions/swaustralia_forests_scrub.cfm> (2015b).
- WWF. *WWF Living Forests Report: Chapter 5. Saving Forests at Risk*, <http://www.wwf.org.au/news_resources/resource_library/?13360/Living-Forests-Report-Chapter-5-Saving-forests-at-risk> (2015c).

