Foreword

The Ecosystem Science Council (ESC) welcomes the opportunity to make a submission to the *Inquiry into the impact on the agricultural sector of vegetation and land management policies, regulations and restrictions*. The Ecosystem Science Council was established to advance the goals of "*Foundations for the future: a long-term plan for Australian ecosystem science*"(ESC 2014), working with all individuals, groups and organisations within the ecosystem science and management communities.

The Minister for Agriculture and Water Resources, the Hon. David Littleproud MP, on 5th December, 2018 asked the House of Representatives Committee on Agriculture and Water Resources to inquire into and report on the impact on the agricultural sector of vegetation and land management policies, regulations and restrictions. The terms of reference for the inquiry are:

> The Committee will inquire into the impact on the agricultural sector of vegetation and land management policies, regulations and restrictions.
>
> The inquiry will have particular regard to:
>
> - Past and current practices of land and vegetation management by the agricultural sector and regional industries;
> - The science behind activities such as back burning, clearing and rehabilitation;
> - The economic impact of vegetation and land management policies, regulations and restrictions;
> - The impact of severe fires on the agricultural landscape, agricultural production and industry in regional, rural and remote areas;
> - Factors that contribute to fire risk in regional, rural and remote areas; and
> - The role the agricultural sector has in working with emergency services and forestry management officials in managing fire risk.
>
> Australian Government (2018a).

Due to the short timeframe for preparation of submissions to the Inquiry, the ESC will limit its contributions to the following:

- Past and current practices of land and vegetation management by the agricultural sector and regional industries;
- The science behind activities such as back burning, clearing and rehabilitation;
- The economic impact of vegetation and land management policies, regulations and restrictions; and
- Factors that contribute to fire risk in regional, rural and remote areas;

Summary of submission

1. One of humanity's greatest challenges is to sustainably feed a growing population within an increasingly variable and changing climate. By 2050, nine billion people are expected to populate our planet. To feed this population, the world needs to manage food production *sustainably and ethically* and minimise food waste within a smaller ecological footprint. Meeting this challenge will require global and domestic leadership from government and industry, as evidenced by sound policy settings and business strategy, which more sustainably and intelligently manages our natural resources than in the past.

2. Agricultural producers have stewardship over more than 60% of Australia's land mass. To manage this land, producers are faced with complex decisions that reflect the productivity, profitability and, increasingly, the sustainability gains open to them. Land was typically cleared to support intensive agricultural production systems but agribusinesses also rely on the services - good soils, pollinators, clean water, and provision of waste management - provided by healthy natural ecosystems. Land management policies, regulations and restrictions exist to guide producers in how best to meet these competing demands of production and long-term sustainability. .

3. Approximately 44% of Australian forests and woodlands have been cleared for agriculture since European settlement. Such clearing is ongoing, and continues to put pressure on our plant and animal species. Australia's State of the Environment Report 2011 identified habitat loss through land clearing as the primary contributor to biodiversity decline. Between 1996-2008, only seven countries, including Australia, were responsible for 60% of the global biodiversity decline scores in bird and mammal species, with Australia second only to Indonesia in this list.

4. Land clearing in Queensland fell to a historical low of 78 000 ha in 2009–10 following the introduction of a ban on broadscale clearing that came into effect in 2006. However, by 2015–16, clearing had increased to 395 000 ha, and a cumulative total of 1.2 million ha was cleared over the period 2012-2016. In NSW, the scale of clearing in recent years has been much less than in Queensland, though the trend is also upwards. A trend of accelerating forest clearing runs counter to global initiatives aimed at mitigating climate change, water cycle regulation, and biodiversity protection.

5. Australia spends hundreds of millions of dollars each year trying to redress past environmental damage from land clearing. More than 90% of Australian farmers are actively undertaking natural resource management. Tens of thousands of volunteers, many of them farmers, dedicate their time, money and land to the effort, but their contribution to national environmental goals is undone by the damage from land clearing. For example, one year of increased land clearing in Queensland has already removed many more trees than will be planted during the entire A$50 million Federal Government "20 Million Trees" program.

6. The NSW Native Vegetation Report 2014-16 indicates that 2.8 million ha of land across NSW was restored between 2005-2016, at an average rate of 216 000 ha per annum. Progress in developing restoration techniques, however, remains partial and slow. Funds for restoration are limited and rarely extend to monitoring outcomes to help us learn how to do it better.

7. Sound vegetation and land management policies, regulations and restrictions can help agricultural industries achieve their ambitious growth strategies, which focus on meeting customers' environmental requirements, in increasingly competitive global markets. The

farming industry's strategy for 2030 in part rests on embracing the clean green ethos that the rich modern consumer demands, and which is underpinned by government land management policies that minimize undesirable cross sectoral impacts of agriculture. Protecting natural ecosystems also has direct economic benefits for farmers, such as increased pollination and predation of crop pests. The future balance of the economic impact of such policies is very likely to be positive.

8. About 50 million ha of land are burned across Australia each year, mostly in northern savanna regions. National Parks are a significant source of fires on agricultural lands, but more fires start outside Parks and cross onto Park lands than *vice versa*. Prescribed burning of eucalypt forests and woodlands can actually increase rather than reduce fuel hazard.

9. Enhanced capability in national ecosystem data infrastructure would better equip agricultural and restoration industries, as well as environment agencies, with options to make better use of our natural capital and help manage risks.

1. Past and current practices of land and vegetation management by the agricultural sector and regional industries

1.1. Agriculture and biodiversity

Australian agriculture and forestry production provide food and materials such as cotton, wool and timber, as well as economic benefits, for millions of people in Australia and around the world, but they also profoundly alter environmental conditions. This in turn has led to changes in Australia's biodiversity - most Australian plants and animals have evolved under dry, infertile conditions, and cannot survive the more productive and disturbed conditions of intensive agriculture (CSIRO 2014 Ch. 7). In addition, clearing of forests and woodlands for agriculture is a major driver of biodiversity decline. The process is eloquently described here:

> ***Landclearing – a devastating chain reaction***
>
> *When an area of native bushland is lost, the resident wildlife does not simply move elsewhere. Landclearing starts a devastating ecological chain reaction.*
>
> *Many animals die immediately from injury or trauma associated with the clearing. Others survive for a time before succumbing to starvation, predation, accidents or disease as a result of losing their home and struggling to find a new one.*
>
> *There is rarely "empty" habitat for displaced animals to move into. Those mammals and birds that survive and can migrate, typically experience competition from residents of the same species. The resulting conflict creates stress that, in turn, can lead to disease.*
>
> *"Refugee" populations of native animals are generally isolated, vulnerable and unsustainable. They have to make do with poorer habitat (less food and shelter) and this hampers their breeding success and leaves them susceptible to predation. Fragmented forest habitat is also more prone to invasions by exotic pests like feral cats and weeds and, because it dries out faster, it is more likely to catch fire.*
>
> *Over time, cycles of local impacts and habitat fragmentation generally spell terminal decline for local and regional populations. As a result, species first decline, then become endangered and eventually extinct.*
>
> Taylor and Dickman (2014).

The process of recovery is slow, and the new vegetation does not adequately replace what was lost:

> *Even if the original plant community is restored, it often starts as an unnaturally dense monoculture and takes many decades to develop the same community of mixed-age plants. This is especially true of tree hollows, a critical resource for tree-dwelling animals, which are only found naturally in old trees that have lost limbs.*
>
> Johnson *et al*. (2007).

1.2. Australia's poor record of stewardship

Nearly 100 species of Australian organisms have become extinct since European settlement, of which 26 are mammals, accounting for 30% of the world's mammalian extinctions in the last 100

years (CSIRO 2014 Ch3). About 1600 Australian species of plants and animals are classified as rare or endangered, and these are mainly concentrated along the Eastern seaboard and SW WA.

From an analysis of IUCN Red List data, Waldron *et al*. (2017) determined that only seven countries were responsible for 60% of the global biodiversity decline scores in bird and mammal species between 1996-2008. Of these countries, Australia was second only to Indonesia in the rate of decline of species status.

1.3. Clearing is an important threat to Australia's biodiversity

An important study (Evans *et al*. 2011) indicates that the top three threats to endangered species across Australia are habitat loss (clearing), introduced species, and inappropriate fire regimes (Fig. 1). Of these three, habitat loss is the most important source of pressure on species, and the most widespread.

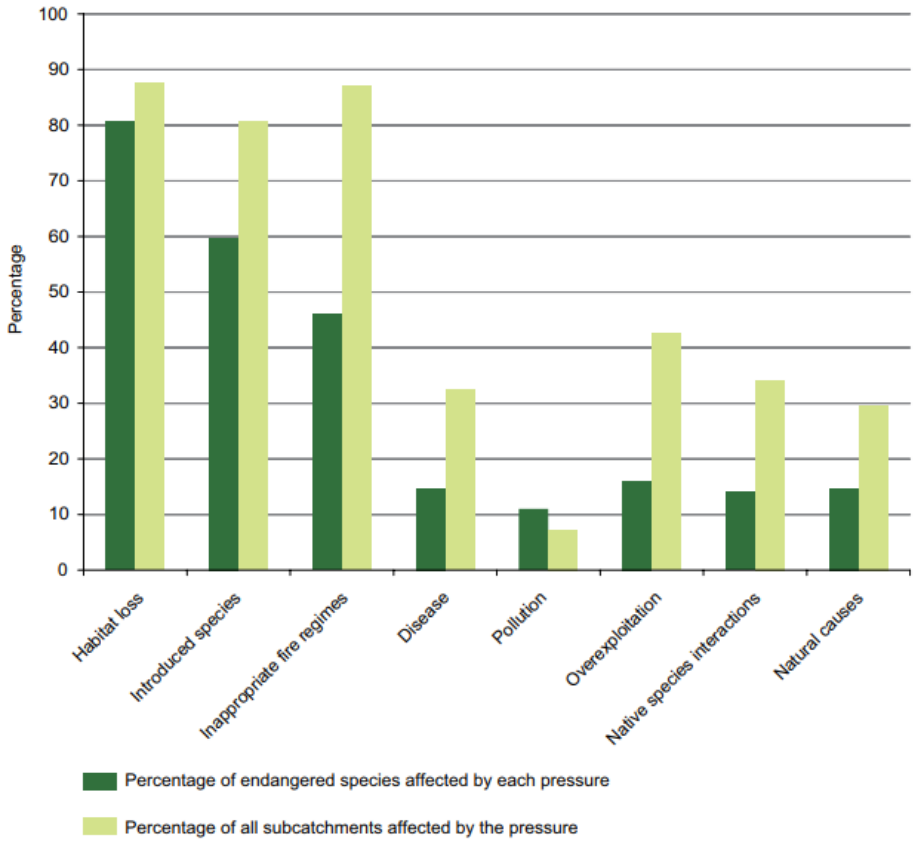

Fig. 1. Habitat loss is the most important factor affecting endangered species across Australia (Evans *et al*. 2011).

The Federal Government's Threatened Species Strategy (Australian Government 2015) contains some excellent initiatives to counter some of these threats, but, surprisingly, lacks any actions to address habitat loss.

1.4. Land clearing comparisons and trends

Global vs Australia

Australia is among the countries, mostly in the Southern hemisphere, that reported a net loss of forest area over the period 1990-2015 (Fig. 2; from FAO 2015, p. 18).

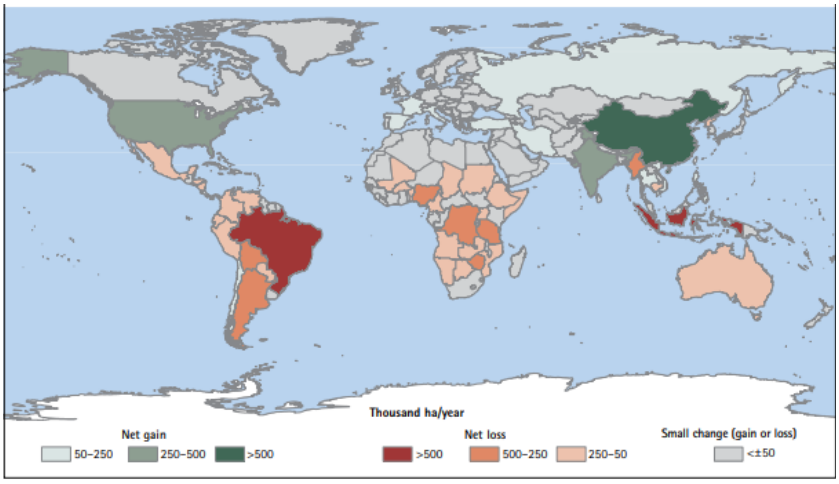

Fig. 2. Annual net forest gain/loss by country, 1990–2015 (FAO 2015 p. 18)

However, the position has somewhat improved since 2010, with Australia now reporting a slight (0.2% or 308 000 ha) net gain in new young forest area between 2010 and 2015. This small net gain, however, hides a continuing large flux in areas of forest cleared and areas regrowing. As described above, clearing is devastating, and regrowth cannot readily compensate for the damage done to our biodiversity.

Australia since European settlement

Australia's 2016 State of the Environment Report (Australian Government 2016) summarizes trends in the clearing of native forests since European settlement, also shown in Fig. 3:

> *Approximately 44 per cent of Australian forests and woodlands have been cleared since European settlement; 39 per cent was cleared before 1972.*
>
> *The three most heavily cleared communities (mallee with a tussock grass understorey, brigalow, and temperate tussock grasslands) together previously covered more than 170,000 square kilometres of Australia, and each has less than 20 per cent of its original extent remaining.*
>
> *Extensive historical clearing continues to exert pressures on the land environment. Clearing rates have decreased over time, largely due to the reduced availability of forested land to clear over time.*
>
> (Australian Government 2016)

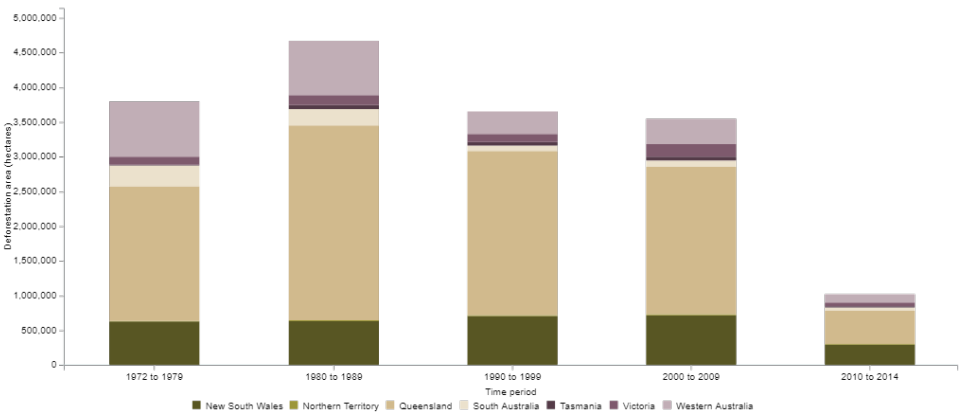

Fig. 3. Rates of deforestation in Australia since 1972, broken down by state and territory (Australian Government 2016).

We appear to be deforesting more slowly since 1980 (Fig. 3), then, but this is largely because there is less forested land left to clear. The loss of native vegetation cover since European settlement has been most intense and widespread in a vast swathe of forested land in the eastern regions and in south-west WA (Fig. 4).

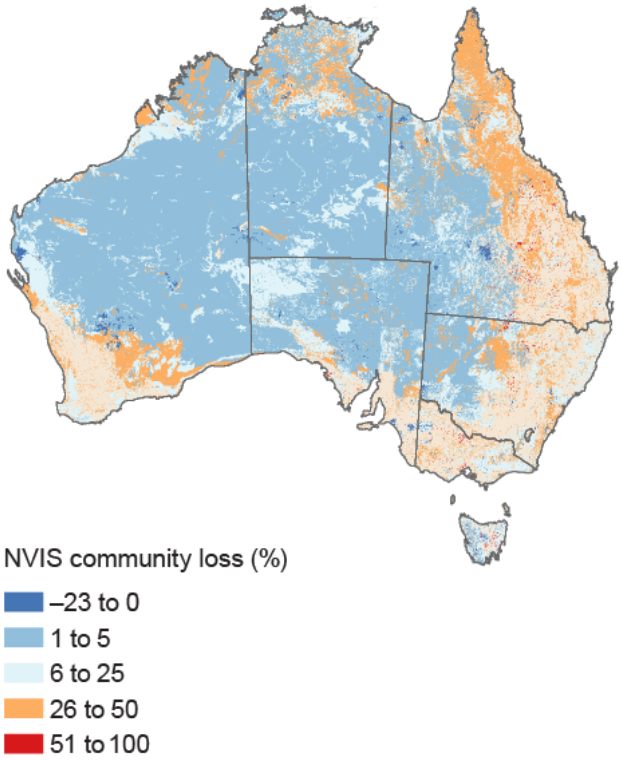

Fig. 4. Proportion of Australian vegetation communities lost since 1750 ("NVIS" refers to *National Vegetation Information System communities*; Australian Government 2016 and Tulloch *et al*. 2015.)

Recent trends - Queensland and NSW

These two states are of particular interest because they have been at the forefront of cross-sectoral conflict between agriculture and the environment over clearing, and were responsible for most of the land-clearing in Australia between 1990-2009 (Fig. 3 & Fig. 5; ANGA 2009).

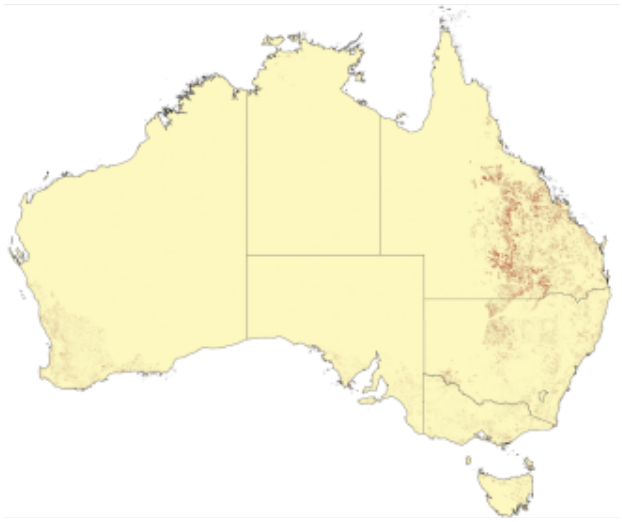

Fig. 5. Location (in red) of land clearing events detected in Australia between 1990 and 2009 (ANGA 2009)

Land clearing in Queensland fell to a historical low of 78 000 ha in 2009–10 following the introduction of a ban on broadscale clearing that came into effect in 2006. However, in 2013, major reforms were introduced to the *Queensland Vegetation Management Act 1999*, and, by

2015–16, clearing had increased to 395 000 ha, and a cumulative total of 1.2 million ha were cleared over the period 2012-2016 (Queensland Government 2019). This compares with the average annual rate of land clearing before the 2006 ban of 448 000 ha per year. Of the total land cleared in 2015-16, 35% or 138 000 ha was categorised as remnant woody vegetation (i.e. it has never been cleared previously).

The clearing not only affects biodiversity on the land – the land cleared in Queensland's Reef catchments increased by 229 %, from 31 000 ha per year in 2008–09 to 102 000 ha per year in 2013–14 (Australian Government 2016). This probably has concomitant impact on sediment run off onto the reef (Reside *et al*. 2017), though the rate of sediment deposition is not currently reported by the Queensland Government. Furthermore, 158 000 ha of trees were cleared in the Reef catchments in 2015-16, a 45% increase on the year before (Queensland Government 2019).

In NSW, the scale of clearing in recent years has been much less than in Queensland, though the trend is upwards. In 2013-14, 900 hectares was cleared in total. In 2014-15 this jumped to 2,730 hectares and by 2015-16 it had increased to 7,390 hectares.

2. The science behind activities such as back-burning, clearing and rehabilitation

2.1. Back-burning and hazard reduction burning

Fire plays a fundamental role in the ecology and evolution of many of Australia's ecosystems. Fire is not an ecological problem, only inappropriate fire regimes (Gill 1975, Penman *et al*. 2011). There is also considerable variation in fire regimes across Australia and knowledge about fire management has to be tailored to the local situation and purpose.

Scientists distinguish between back-burning – a measure of last resort involving fires set hastily from a fire break to reduce fuel load as a bushfire approaches - and hazard reduction or prescribed burning – which is the proactive setting of fires to manage fire behaviour in the long term. Note that prescribed burning encompasses the use of fire to increase as well as to reduce fire frequency - particularly important for maintaining natural fire regimes in fragmented landscapes. Furthermore, prescribed burning of forests can result in increased fuel loads by maintaining a shrubby understorey: a recent study in 81 sites across Eucalyptus forests and woodlands in south-eastern Australia found that fuel hazard was higher in forests and woodlands burned 6–12 years previously than those unburned for at least 96 years (Dixon *et al*. 2018). The probability of high to extreme overall fuel hazard was highest 0.5–12 years post-fire, and lowest where fire had not occurred for at least 96 years.

Hazard reduction burning may be done at large scale across the landscape, or in a manner that focuses more closely on reducing fuel load near to properties and infrastructure. Research indicates that landscape-scale hazard reduction burning would need to be carried out at a vast scale – in fact, to halve the risk of bushfires to people and property, we would need to burn 10% of the landscape of SE Australia per annum (Bradstock *et al.* 2012) Furthermore, projections of 2050 weather conditions under climate change indicate that the proportion of the landscape required to be burnt each year would need to increase still further. In general (our emphasis):

> *There will always be a need for fuel reduction across the broader landscape to achieve other goals, such as conserving ecosystem services and biodiversity. But such measures* ***need to be built on the bedrock of fuel and hazard reduction around properties****. Climate change will only make these actions more pressing*.
>
> Bradstock 2013

Critical to adequate fire management is the management of the fine fuels, that is leaf litter and grasses, because these are the fuels that ignite initially from lightning and intentional and accidental ignition (Cheney 1981). Clearing trees does not remove the fine fuels, but through regrowth, may increase the shrub layer that can also provide fine aerial fuels that carry fire (Cheney 1981). Fine fuel management is best done by prescribed burning along fire breaks, or along management zones where prescribed burns can be controlled.

Fire fuels management is essential for much of Australia's agriculture, particularly pastoralism or intensive grazing. Indeed, much of the pastoral and other agricultural lands were established with the aid of fire (Johnson & Purdie 1981). Vegetation management acts, regulations, codes and policies, such as the Queensland *Vegetation Management Act 1999,* recognize the need to manage land with fire, and to establish firebreaks and to burn vegetation to reduce fuels. Lighting of fires for management and protection of life and property is supported in each State and Territory in different ways, but all allow prescribed burning on agricultural lands, subject to varying rules, codes and permits (e.g. Preece 2007). The long-term implications of altered fire regimes on biodiversity and ecosystem function need to be considered in any legislation that either permits or restricts fires.

2.2. Impact of clearing on environmental progress in Australia

Land clearing affects all Australians. Australia spends hundreds of millions of dollars each year trying to redress past environmental damage from land clearing. 94% Australian farmers are actively undertaking natural resource management, according to the NFF. Tens of thousands of volunteers, many of them farmers, dedicate their time, money and land to the effort, but their contribution to national environmental goals is undone by the damage from land clearing. For example:

a. one year of increased land clearing in Queensland has already removed many more trees than will be planted during the entire A$50 million Federal Government 20 million trees program (Australian Government 2017 http://www.nrm.gov.au/national/20-million-trees)
b. The Australian government's Emissions Reduction Fund (ERF) is paying billions of dollars to reduce carbon emissions from industry. There was a 63% Reduction in greenhouse gas emissions between 1996-2016 by Australian primary industries. But the carbon released from Queensland's land clearing in 2012-2014 alone is estimated at 63 million tonnes, far more than was purchased under the first round of the ERF at a cost to taxpayers of A$660 million. (Australian Government 2018b http://www.environment.gov.au/climate-change/government/emissions-reduction-fund)
c. Under Caring for our Country and Biodiversity Fund grants, tree planting to restore habitat across Australia since 2013 was just over 42 000 ha – while 296 000 ha was

cleared in Queensland alone in 2013-14. Moreover, it is not like for like: cleared habitat is more ecologically valuable than restored habitat (see Section 1).

d. The federal government has committed hundreds of millions of dollars to improve reef water quality, yet land clearing in reef-draining catchments will reverse many of the gains.

A major report from the Queensland Herbarium (Neldner *et al.* 2017) has concluded that:

- Land clearing causes species death and habitat loss, but also exacerbates other threatening processes, particularly in fragmented landscapes.
- Apart from the immediate impacts of clearing, significant time lags occur before the full cumulative impact on biodiversity is realised.
- The impact of the previous century of land clearing has resulted in small, fragmented relictual populations of many native species.
- Any further land clearing will further elevate the extinction pressure arising from loss of habitat and a range of other threatening processes which are exacerbated by fragmentation.
- Land clearing has significant negative impacts offsite e.g. (sediment runoff into streams, rivers, wetlands and the Great Barrier Reef marine lagoon), and is a major contributor to climate change through greenhouse gas outputs, and rainfall and temperature dynamics.
- Land clearing has been directly responsible for two plant species (*Corchorus thozetii* and *Calotis glabrescens*) becoming extinct in the wild and has been identified as a threatening process for many of the 739 threatened flora species and 210 threatened fauna species in Queensland.
- The current State protected area estate and voluntary nature refuge estate combined only retain 11.4% of the pre-clearing potential habitat for terrestrial threatened species, and hence are unlikely to prevent further species from becoming extinct.

A major and well-documented impact of native vegetation clearance is the rise in water tables and increased salinity (Walker *et al*. 1993; DSMWG 1993, pp. 11-23, 24). Causes of secondary salinity were first documented in the 1930s and yet the problem persists. In addition, fragmentation (the breaking up of large areas of intact vegetation) is the main modifier of ecosystem resilience to disturbances such as fire and drought (Saunders *et al*. 1987; Watson *et al.* 2018). Larger patches of vegetation are less susceptible to ecological edge effects such as weed invasion and are more likely to sustain viable populations of native biodiversity (Bennet *et al*. 2000). Lastly, we cannot assume it is possible to restore 'like for like' without huge advances in the science and practice of ecological restoration. We cover this last point in more detail in the next section.

2.3. Rehabilitation

"Rehabilitation" means the repair of the processes, services, and productivity of a damaged ecosystem, but it does not mean to restore the ecosystem to its pre-existing condition. By contrast, "restoration" of an ecosystem is an attempt to return it to its historical trajectory or state.

The NSW Native Vegetation Report 2014-16 (NSW Government 2016) indicates that 2.8 million ha of land across NSW was "restored" between 2005-2016, at an average rate of 216 000 ha per

annum, although it is likely that the process was generally closer to rehabilitation as defined above.

We have seen a transformative process in Australian agriculture over recent decades – the gradual incorporation of conservation practices such as ecological restoration, revegetation and agroforestry as a response to land degradation. Although actions have been impressive in some places, they remain fragmented, are confined to particular districts or properties and run the risk of not being built upon in the future A recent appraisal by Andrew Campbell and colleagues said it well:

> *The past four decades have seen a transformative process in Australian agriculture – the gradual incorporation of conservation practices such as ecological restoration, revegetation and agroforestry as a response to land degradation. Although actions have been impressive, they remain fragmented, are confined to particular districts or properties and run the risk of not being built upon in the future….*
>
> *Landscape-scale restoration and the integration of conservation into farming landscapes have been recognised as a global imperative for decades, for which Australia has generated many innovations – in the technical, social and policy domains…However, we have neither integrated these elements at multiple scales nor sustained them. Unfortunately, although we are excellent at innovating, we have been equally good at forgetting. Progress remains partial, patchy and slow….*
>
> *Australian expertise in revegetation, restoration and regeneration of landscapes remains formidable however, with an enormous amount to offer the world. We are still learning to live and farm more sustainably, but we have made big strides over the last four decades. The challenge will be to maintain the momentum and provide adequate succession so future generations continue the work.*
>
> (Campbell *et al.* 2017.)

Landscape-scale restoration and the integration of conservation into farming landscapes have been recognised as a global imperative for decades (Reid *et al.* 2018), for which Australia has generated many innovations – in the technical, social and policy domains. However, we have neither integrated these elements at multiple scales nor sustained them. In addition, over recent decades Australia has spent billions of dollars planting trees and erecting fences through major government programs including proceeds of sale of Telstra, but has spent virtually nothing on evaluating the success or otherwise of such investment, including for biodiversity outcomes. Long-term studies to monitor the recovery of ecosystem processes (Lindenmayer *et al*. 2012) are scarce, but we do know that the original native landscape is likely to be richer in biodiversity, and healthier in terms of function, than a rehabilitated landscape (e.g. Wade *et al*. 2008; Ngugi *et al.* 2011; Hu *et al*. 2018; Le Brocque & Wagner 2018; Whitworth *et al*. 2018). Restoration and rehabilitation - done properly - are costly, and the carbon market, though gathering strength, is not yet in a position to fund it. Consequently, uncleared vegetation remains a very valuable asset.

3. The economic impact of vegetation and land management policies, regulations and restrictions

3.1. Impact of good stewardship of native vegetation on industry strategies

Sensible vegetation and land management policies, regulations and restrictions can *help* agricultural industries achieve their ambitious growth strategies, given that these rely in part on meeting customers' environmental requirements, in increasingly competitive global markets.

The National Farmers' Federation (NFF 2018) has laid down a vision for the industry: $100 billion in farm gate output by 2030 – growth of almost 70% in the coming 12 years. To achieve this, the NFF proposes an increased focus on high value consumers who:

> *…are increasingly focussed on where their food and fibres come from, and how it's produced. Increasingly, characteristics like taste or price are taking a back seat to animal welfare, sustainability, safety and nutrition. This means farmers are no longer motivated simply by productivity. They must meet their customer's ethical, environmental and nutritional requirements.*
>
> NFF 2018 p. 7

For example, Michele Allan, Chair of Meat and Livestock Australia (MLA) has outlined MLA's ambition to be carbon neutral by 2030. MLA believes achieving the goal would put Australia well above our competitors in the high-value markets where consumers have a growing interest in a food's provenance and environmental footprint:

> *What's more, there's an almost perfect correlation that exists between increased productivity and reduced greenhouse gas emissions.*
>
> M. Allan, MLA, quoted in NFF 2018 p. 15

Note that attaining this goal is likely to be significantly compromised by relaxing restrictions on land-clearing. Instead, the NFF proposes a focus on intensification of land use as a path to sustainability and a clear enabler towards the $100 billion target:

> *Most farm systems are intensifying to some degree. This can deliver improved sustainability and lower footprints.*
>
> *Sustainable intensification will be an important component of the approach in the broadacre industries and particularly in the approach to managing natural resources and responding to climate change in an increasingly variable climate.*
>
> NFF 2018 p. 15

A further vehicle for increasing the environmental and economic sustainability of farms is through biodiversity, with a national market-based approach that rewards farmers for stewardship:

> *Australian farmers are custodians of approximately 48 per cent[1] of Australia's land mass. With this comes a deep connection to the nation's plants and animals and a duty of care in how farm systems interact with them. Some state-based schemes e.g. BioBanking in NSW, have been put in place to support biodiversity management. Uptake of these schemes has been patchy and their national implementation piecemeal. The current depth of the market for conservation services on private land falls short of what is required to properly reward landholders for the significant investments they make in landscape management. While a market-based approach is unlikely to become a comprehensive solution to this issue in the near term, we should nurture new frameworks which provide a consistent mechanism for matching landholders with purchasers of landscape services.*
>
> NFF 2018 p. 16

Again, relaxing the restrictions on clearing would hardly assist in the viability of this initiative!

In summary, the farming industry's strategy rests on embracing the clean green ethos that the rich modern consumer demands, and which is underpinned by government land management policies that minimize undesirable cross sectoral impacts of agriculture. The future balance of the economic impact of such policies is very likely to be positive.

4. Factors that contribute to fire risk in regional, rural and remote areas;

4.1. Fire hazard reduction

Please refer to section "Back-burning and hazard reduction burning" above for the ESC's remarks on fire hazard reduction.

4.2. National Parks and agricultural lands as sources of fire risk

About 50 million ha of land are burned across Australia each year on average and about 80% of fire-affected areas are in northern savanna regions. An analysis of data collated from government agencies across Australia highlighted the following:

> *Moreover, of those fires the NSW NPWS attended, a fire that started off-park and crossed onto park lands (17%) was twice as likely as a fire starting on parks lands but crossing onto neighbouring properties (8% of fires).*
>
> Bryant 2008.

In general, across Australia:

> *Lightning is the cause of almost all naturally occurring bushfires. Human activities account for most of the rest, with accidents associated with burning off, campfires and machinery being the most common sources of ignition. While it is difficult to assess the magnitude of maliciously lit fires, between 25 to 50% of bushfires are thought to be deliberately lit.*
>
> CSIRO 2009

[1] Note that the Australian Academy of Science has this figure at "more than 60%" (Australian Academy of Science 2017 p. 4).

Key challenges for fire management generally, and for national parks in particular, include the following:

a. more people are living in regional Australia near bushfire prone areas, with an ageing population of residents and firefighters
b. the increasing cost of fire suppression;
c. the *significant increase in size and distribution of protected areas, accompanied by a significant reduction in funding and staffing* for parks across Australia; and
d. the changing climate, with an increase in average temperatures, decrease in average rainfall and a consequent increase in severe fires, as well as increasing overlap between fire seasons in the northern and southern hemispheres, such that the sharing of resources has become problematic.

Countering these increasing risks are technological advances such as management information systems and fire and weather behaviour modelling, and improved bushfire detection and suppression.

Despite the success of the Northern Australia Fire Information (NAFI) webtools (https://www.firenorth.org.au/nafi3/) for tracking fires, there is no consistent national approach to the collection and analysis of bushfire data. It is consequently difficult to ascertain whether national parks are a major cause of fire risk for agriculture, or vice versa, at a national scale.

4.3. Changing vegetation as a source of risk

The relationships between anthropogenic disturbance (such as clearing and logging) and fire severity of natural forests have been controversial. A global literature review by Lindenmayer *et al*. (2009) showed that, while strategic logging in dry forests can reduce fire severity, the reverse is true in moist forests, including boreal forests, coniferous forests of north-western North America, and tropical forest worldwide. A later study (Taylor *et al.* 2014) confirmed that logging can contribute to the severity of bushfires in SE Australian wet forests:

> *The risk of "crown" fires, which burn severely and spread rapidly through the forest canopy, is greatest in mountain ash forests that have been regrowing for about 15 years, with young trees that were established following clearfell logging.*
>
> Taylor *et al*. (2014)

Another recent study has shown that the main drivers of fire severity are the species of plant present, rather than surface fuel load (Zylstra *et al*. 2016). There is, however, a grave lack of long-term, ecosystem-specific data to inform policy: we cannot assume data from Victoria are applicable in QLD. As we see a transition to more dry conditions we can expect to see the system burn more frequently, but there is little available science for the ecosystems at risk. We should proceed with caution, and with a solid R&D agenda to inform national policy.

A further source of increased fire risk is the invasion of alien plant species into the understorey - for example, the tall African perennial, Gamba grass (*Andropogon gayanus*) which invades woodlands in Australia's savanna zone, increasing the biomass in the understorey, and curing later in the dry season so that fires burn hotter(e.g. Bowman *et al.* 2014). Such invaders are an issue for conservation areas and pastoralists alike.

5. Need for an evidence-based and multi-sectoral approach to ecosystem management across all land tenures

Enhanced capability in national ecosystem data infrastructure would better equip agricultural and restoration industries, as well as environment agencies, with options to make better use of our natural capital and help manage risks. For example, it would prevent catastrophic loss of productive land from misguided short-term focused management practices, and the expensive rehabilitation efforts that are consequently needed. In the south west of WA alone, salinity damage is estimated to have cost 344 million per annum (WA 2013).

To meet this need, the ESC is proposing the establishment of a national Ecosystem Monitoring and Management Agency (EMMA). Such an agency would:

- establish national ecosystem monitoring and forecasting systems
- measure progress towards environmental goals and objectives
- administer environmental legislation more effectively
- improve the effectiveness of natural resource management and social health initiatives

Details of our proposal are provided in the attached document.

Conclusion

We support the NFF view that the ambitious growth envisaged for the industry will in part come from embracing the clean green ethos that the rich modern consumer demands. This ethos will need to be underpinned by government policies that minimize undesirable cross sectoral impacts of agriculture, and by a strong evidence base from new large-scale data infrastructure for natural resource management.

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