Barriers to effective climate change adaption: Invasive species and biodiversity conservation

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invasive species council

ISC campaigns for better laws and policies to protect the Australian environment from weeds, feral animals, exotic invertebrates and pathogens.

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The Invasive Species Council campaigns for better laws and policies to protect the Australian environment from weeds, invasive animals and exotic pathogens.

Formed in 2002, we were the first environment group in the world to focus solely on invasive species.

With introduced pests one of the top and growing threats to native species and ecosystems, involving complex biological and social interactions, this specialist focus is needed.

A non-profit organisation, we work with other groups on policy and legal reform, campaigning for action on high priority pests.

We have a strong commitment to using the best science available to inform our advocacy work and through our board, staff and membership have access to excellent in-house weed and pest expertise.

The Invasive Species Council is committed to fostering community participation and activism, supporting our members to have a voice on invasive species issues.

Barriers to Effective Climate Change Adaptation: Invasive Species and Biodiversity Conservation

A submission to the Productivity Commission, December 2011

As an environmental NGO that has done considerable work to highlight the risks for biodiversity due to interactions of climate change and invasive species[1], the Invasive Species Council welcomes the Productivity Commission's inquiry into the regulatory and policy barriers to effective adaptation to climate change.

Our focus in this submission is adaptation measures for biodiversity under unavoidable climate change. We strongly recommend that the Productivity Commission identify more effective policies on invasive species as a high priority adaptation goal.

In the following submission, we justify this recommendation with an overview of (i) the likely synergistic and cumulative impacts of invasive species and climate change, (ii) priority reform categories and measures to facilitate adaptation, and (iii) barriers to reforms.

More effective management of invasive species will deliver great benefits for biodiversity, the economy and human wellbeing under climate change; however, there is, as yet, limited information on which to base cost-benefit assessments.

1. Environmental adaptation to climate change requires invasive species management

> *The ultimate outcomes [of climate change] are expected to be declines in biodiversity favouring weed and pest species (a few native, most introduced) at the expense of the rich variety that has occurred naturally across Australia.*
>
> The Garnaut Climate Change Review[2]

Climate change will benefit some species (native or exotic) and harm others (see Attachment 1 for an outline of three models that describe likely responses of species to climate change[3]). Unfortunately, climate change winners are likely to include many invasive species that will exacerbate the damaging impacts of climate change on biodiversity. Invasive species are likely to cause greater harm under climate change because:

- Many invasive species are highly adaptable, tolerant of a wide range of conditions and benefit from disturbance.
- Extreme events often facilitate biological invasions, eg by dispersal of invasive species or creating openings for establishment.
- Native species under stress are less competitive with invasive species and more vulnerable to damage from invasive species.
- Human responses to climate change are likely to result in new species introductions, provide more opportunities for establishment and compromise control.

Adaptation measures to assist native biodiversity to survive climate change will need to focus on invasive species management to:

- Maximise the resilience of native species to climate change by reducing the threat of invasive species (see 1.1).
- Limit the threat of invasive species that will thrive under climate change, including extreme events (see 1.2).
- Ensure that human responses to climate change do not exacerbate invasive species threats (see 1.3).

1.1 Resilience, climate change and invasive species

> *The most frequently cited threats in listings under the EPBC Act and resulting recovery plans are habitat fragmentation and the spread of invasive species.* State of the Environment 2011[4]

> *'The impacts of invasive species are now considered to pose a threat to Australian biodiversity of the same order as habitat loss and climate change.'* Federal Environment Department (2008)[5]

[1] For example, see our *Double Trouble* ebulletin at http://www.invasives.org.au/page.php?nameIdentifier=ebulletin

[2] Garnaut, R. 2008. The Garnaut Climate Change Review. Final Report, Commonwealth of Australia.

[3] Invasive Species Council. 2010. Invasive species and climate change. Backgrounder.

[4] Hatton, T., S. Cork, et al. 2011. State of the Environment 2011. Independent report to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities, Australian Government.

If Australia is to maximise the potential for biodiversity to survive climate change, it is essential to reduce existing invasive species threats to species, ecological communities and climate refugia.

Even without climate change, substantially improving invasive species management in Australia is essential for biodiversity conservation and to meet our national and international obligations (Box 1). Climate change increases the imperative and the challenge.

Box 1. Australia's International and national obligations for environmental biosecurity

Article 8(h) of the international Convention on Biological Diversity states that:

> *Each contracting Party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species.*

Target 9 of the Strategic Plan for Biodiversity 2011-2020 (under the Convention on Biological Diversity) is:

> *By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.*

Target 7 of the Australian Biodiversity Conservation Strategy is:

> *By 2015, reduce by at least 10% the impacts of invasive species on threatened species and ecological communities in terrestrial, aquatic and marine environments.*

Native species already under pressure due to invasive species will be more vulnerable to climate change. Likewise, species under stress from climate change will be more vulnerable to invasive species threats. Declines and extinctions are typically caused by multiple stressors, the most common being habitat loss and invasive species. Federally listed threatened species are on average threatened by 2.6 processes, and more than 75% face multiple threats.[6]

Habitat loss and invasive species are currently the greatest threats to Australia's biodiversity, with climate change a looming third major threat. Inappropriate fire regimes, which interact with invasive species and climate change threats, are also a major threat. Invasive species have already been responsible for the majority of animal extinctions in Australia and are a threat to the majority of threatened species and ecological communities in Australia (see Table 1). The 2011 State of the Environment Report has assessed invasive species as 'very high impact' (the highest category), with a deteriorating trend. More than 60% of threatened species listed under the EPBC Act and 80% of threatened ecological communities are threatened by invasive species (for a summary of invasive species threats see Attachment 2).[7]

Table 1. Threats affecting nationally listed threatened species in Australia[8]

Threatening process	% EPBC-listed threatened species affected
Habitat loss	81
Introduced species	61
Inappropriate fire regimes	43
Overexploitation	20
Disease (most due to introduced pathogens)	15
Natural causes	15
Native species interactions	15
Pollution	14

[5] Department of the Environment, Water, Heritage and the Arts. 2008. Submission to the Quarantine and Biosecurity Review, Australian Government.

[6] Evans, M., J. Watson, et al. 2011. The spatial distribution of threats to species in Australia. *Bioscience* 61(4): 281-289.

[7] Booth, C. 2009. Invasive Species: One of the Top Three Threats to Australian Biodiversity, Invasive Species Council.

[8] Evans, M., J. Watson, et al. 2011. The spatial distribution of threats to species in Australia. *Bioscience* 61(4): 281-289.

Native species and ecosystems stressed by climate change will be less competitive with and more vulnerable to invasive species. Stressed plants, for example, are more vulnerable to introduced diseases such as phytopthora (*Phytophthora cinnamomi*) dieback and myrtle rust (*Puccinia psidii s.l.*), and displacement by weeds. Climate-stressed animals are also more vulnerable to disease: during drought southern hairy-nosed wombats are more susceptible to mange caused by an exotic mite, for example.[9] More fires under climate change can lead to less vegetation cover for native species, such as endangered eastern bristlebirds,[10] exposing them to more predation by foxes and cats.

Invasive species can undermine the suitability of climate refuges for some species and can dominate 'rare climatic spaces' (eg. sites that are unusually cool, wet, humid, or protected from fire[11]). Rainforest patches in northern Australia, for example, are often monopolised and damaged by feral cattle and pigs.[12]

Various facets of climate change (changes in rainfall, temperature, extreme events or fire) are likely to constitute additional stressors in many ecosystems already under severe stress from invasive species and other threats, which will interact in often unpredictable ways, potentially leading to irreversible cascades of change and loss.

[9] Ruykysa, L., D. A. Taggart, et al. 2009. Sarcoptic mange in southern hairy-nosed wombats (Lasiorhinus latifrons): distribution and prevalence in the Murraylands of South Australia. *Australian Journal of Zoology* 57: 129-38..

[10] Lindenmayer, D., C. MacGregor, et al. 2009. What factors influence rapid post-fire site re-occupancy? A case study of the endangered Eastern Bristlebird in eastern Australia. *International Journal of Wildland Fire* 18: 84-95..

[11] Low, T. 2011. Climate Change and Queensland Biodiversity. An independent report commissioned by the Department of Environment and Resource Management (Qld), Queensland Government.

Low explains rare (or special) climatic spaces as follows: 'The survival of some species will increasingly depend on them using locations that are unusually cool, wet, humid, or protected from fire. Such locations could include the largest rock piles and logs, the deepest accumulations of litter, and the shaded southern sides of steep hills. The conservation of rare climatic spaces should become an important management goal.'

[12] Stanton, P. and D. Fell. 2005. The Rainforests of Cape York Peninsula, Cooperative Research Centre for Tropical Rainforest Ecology and Management.

1.2 Invasive species benefiting under climate change

> *'Climate change will create winners and losers among invasive species, with the impacts of the winners likely to exceed the direct impacts of climate change on biodiversity in many cases'.*
>
> Steffen et al. (2009).[13]

Many invasive species are generalists and highly adaptable, able to tolerate or take advantage of change and disturbance. The expected increase in extreme events in particular will offer new opportunities for invasive species to proliferate and spread.

As noted in the 2009 assessment of the vulnerability of Australia's biodiversity to climate change by Steffen et al., increased threats from invasive species benefiting from climate change may exceed the direct threats of climate change to many native species (see quote above). Following are some examples of how climate change will exacerbate invasive species threats to the environment.[14] Other examples are provided in the Invasive Species Council's Double Trouble ebulletin.[15]

Changed rainfall patterns: Southwest Western Australia is in the grip of a plant disease – phytophthora dieback (dubbed the 'biological bulldozer) – that has infected a million hectares of native bush, threatening dozens of endemic species.[16] Climate change is expected to bring more rain during summer, which would spread the disease more rapidly because the spores travel with flowing

[13] Steffen, W., A. Burbidge, et al. 2009. Australia's Biodiversity and Climate Change: A strategic assessment of the vulnerability of Australia's biodiversity to climate change. Technical synthesis of a report to the Natural Resource Management Ministerial Council commissioned by the Australian Government. Canberra, Department of Climate Change.

[14] These examples mostly come from the following reports and backgrounders:

Low, T. 2008. *Climate Change and Invasive Species: A Review of Interactions*. Canberra, Biological Diversity Advisory Committee, Invasive Species Council. 2010. Invasive species and climate change. Backgrounder, Invasive Species Council. 2010. Weeds and climate change. Fact sheet.

[15] See http://www.invasives.org.au/page.php?nameIdentifier=ebulletin

[16] Cahill, D. M., J. E. Rookes, et al. 2008. *Phytophthora cinnamoni* and Australia's biodiversity: impacts, predictions and progress towards control. *Australian Journal of Botany* 56(4): 279-310..

rainwater. This could result in plant extinctions and ecosystem collapse.[17] The disease could also worsen in southeastern Australia if there are wetter summers and warmer winters under climate change.[18]

More-intense cyclones, more floods: Lurking in many gardens in the Wet Tropics are exotic plants that have not yet had the right conditions to spread beyond the garden fence. Many are rainforest plants that could colonise clearings in rainforest.[19] More-intense cyclones under climate change bringing forest damage and flooding will provide opportunities for their spread.

Cyclones and storms can damage enclosures and precipitate the release of invasive species from aviaries, zoos, outdoor ponds and farms. Cyclone Larry caused the escape of more than 200 deer of five species by damaging fences at a deer farm in Queensland's Wet Tropics.[20]

Floods in the 1970s spread carp (*Cyprinus carpio*) throughout the Murray-Darling system[21] and athel pine (*Tamarix aphylla*) along hundreds of kilometres of the Finke River in central Australia.[22] Carp are now the most abundant big fish in the Murray-Darling and athel pine is a weed of national significance.

More droughts: When plants die due to drought and other climate stresses, their place is likely to be taken by weeds such as serrated tussock (*Nasella trichotoma*), which are often rapid colonisers.[23] Invasive species can dominate drought refuges, compromising the survival of native species reliant on those refuges.

Warmer temperatures: Foxes are increasing their numbers at higher altitudes in the Australian Alps as the climate warms. Vulnerable native animals include the endangered mountain pygmy possum and broad-toothed rat. Weeds too will spread further up the slopes, pushing out less competitive native species.[24]

Aquarium fish are one of the biggest sources of invasive species in Australia. Most are from tropical waters, so increases in average water temperatures will provide more habitat for released or escaped fish species.[25]

More fire: Exotic pasture grasses in northern Australia up to 4 metres tall fuel fires so intense they can kill trees. In a damaging cycle that can turn native woodlands into exotic grasslands, such fires promote yet more grass invasion.[26] Climate change is likely to increase the frequency of fires, facilitating the further invasion of exotic grasses such as gamba grass (*Andropogon gayanus*) and buffel grass (*Cenchrus ciliaris*).

Less effective control of invaders: Some biological control agents may become less effective under climate change. Under experimental conditions of high CO_2 and temperature, a leaf-miner (*Dialectica scalariella*) introduced as biocontrol for Paterson's curse (*Echium plantagineum*) became less effective because of

[17] Invasive Species Council. 2009. Killer plant disease could devastate WA biodiversity hotspots. *Double Trouble Ebulletin* Edition 1(February 2009)..

[18] Department of Sustainability and Environment. 2008. Victoria's public land *Phytophthora cinnamomi* management strategy. Melbourne, Victorian Government..

[19] Low, T. 2008. *Climate Change and Invasive Species: A Review of Interactions*. Canberra, Biological Diversity Advisory Committee..

[20] Low, T. 2008. Climate change and invasive species: a review of interactions. Canberra, Department of the Environment, Heritage, Water and the Arts.

[21] Koehn, J., A. Brumley, et al. 2000. Managing the impacts of carp. Canberra, Bureau of Rural Sciences..

[22] Agriculture & Resource Management Council of Australia & New Zealand and Australian & New Zealand Environment & Conservation Council and Forestry Ministers. 2000. Weeds of National Significance Athel Pine (*Tamarix aphylla*) Strategic Plan. Launceston, National Weeds Strategy Executive Committee..

[23] Weeds CRC. 2003. Serrated tussock – *Nassella trichotoma*. Weeds of National Significance. Weed Management Guide., CRC for Australian Weeds Management..

[24] McDougall, K., J. Morgan, et al. 2005. Plant invasions in treeless vegetation of the Australian Alps. *Perspectives in Plant Ecology, Evolution and Systematics* 7: 159-71.; Low, T. 2008. *Climate Change and Invasive Species: A Review of Interactions*. Canberra, Biological Diversity Advisory Committee..

[25] Corfield, J., B. Diggles, et al. 2007. Review of the impacts of introduced aquarium fish species that have established wild populations in Australia. Draft final report for public comment. Canberra, Department of the Environment and Water Resources, Australian Government..

[26] Rossiter, N. A., M. M. Douglas, et al. 2003. Testing the grass-fire cycle: Alien grass invasion in the tropical savannas of northern Australia. *Diversity and Distributions* 9: 169-176..

reduced nutritional quality of leaves.[27] (Conversely, some biocontrol agents are likely to become more effective.) Glyphosate, the most important herbicide, is also likely to become less effective under climate change.[28]

1.3 Invasive species impacts arising from human responses to climate change

Many human responses to climate change – including mitigation (eg. biofuel crops) and adaptation (eg. new agricultural crops) – are also likely to exacerbate invasive species impacts. Protecting biodiversity will require constraining responses to climate change to limit the introduction and spread of high risk species.

New agricultural and horticultural products: There are plans to grow vast areas of biofuels such as giant reed (*Arundo donax*) in Australia. Giant reed is a catastrophic riparian weed in the US, costing millions of dollars to control.[29] Most of the species attracting attention in Australia as potential biofuel crops have a substantial history as weeds.[30]

Breeders are developing new drought-tolerant and hardier plant varieties for gardens and pastures. Many of the species are already weedy, and hardier cultivars could increase their invasion into natural areas.[31] With an increased potential for hybridisation and genetic recombination, some could become super-invaders .[32] New drought-hardy breeds of goats could breed with feral goats, exacerbating their impacts, for example.

Climate change adaptation will undermine some agricultural enterprises and open up other opportunities. Warming, for example, will increase heat stress on livestock and could precipitate a switch in some areas to hardier goats with adverse consequences for rare plants, as the extract in Box 2 discusses. Feral goats are already a very serious threat, and numbers have risen dramatically in some areas.[33] In Queensland, numbers increased from about 100,000 in the mid 1980s to more than one million by 2001, despite high levels of harvesting.

Box 2. Feral goats and climate change

Extract from 'Climate Change and Queensland Biodiversity':[34]

Goats have the potential to exacerbate three aspects of climate change. Firstly, like camels, they will worsen the impact of declining water availability by reducing the quality of remaining water, as Parkes et al. (1996) noted: 'Goat dung can be deposited around waterholes and springs to a depth of several centimetres. Dung, together with the bodies of goats that fall into the water and perish and decompose, are likely to eutrophicate the water and to have a major effect on freshwater biota ... Goats can also reduce the amount of water available to native animals; aggressively exclude some species … and cause the water levels in rock holes to be so lowered as to exclude other animals or cause animals to fall in, drown, and pollute the supply.'

Goats in high numbers will also exacerbate the impact of higher temperatures on ground fauna, by removing shade. The impacts can be 'devastating', according to Henzell (2008): the goat 'removes virtually all foliage below 1.8 metres (or even

[27] Johns, C. V. and L. Hughes. 2002. Interactive effects of elevated CO2 and temperature on the leaf miner *Dialectica scalariella* Zeller (Lepidoptera: Gracillariidae) in Paterson's Curse, *Echium plantagineum* (Boraginaceae). *Global Change Biology* 8: 142-52..

[28] Ziska, L. H. and G. B. Runion. 2007. Future weed, pest, and disease problems for plants. Agroecosystems in a Changing Climate. Advances in Agroecology series, Vol 12. P. C. D. Newton, G. Edwards, A. Carran and P. Niklaus. Boca Raton, CRC Press..

[29] Low, T. and C. Booth. 2007. The weedy truth about biofuels, Invasive Species Council, Inc..

[30] Low, T., C. Booth, et al. 2011. Weedy biofuels: what can be done? *Current Opinion in Environmental Sustainability* 3: 55-59.

[31] Booth, C., G. Carr, et al. 2009. Weedy pasture plants for salinity control: sowing the seeds of destruction, Invasive Species Council..

[32] Wilson, J. R. U., E. E. Dormontt, et al. 2009. Something in the way you move: Dispersal pathways affect invasion success. *Trends in Ecology and Evolution* 24: 136-45.; Booth, C. 2009. The invasion risks of introducing new genetic variants of exotic plants and animals, Invasive Species Council..

[33] Discussed in Low, T. 2011. Climate Change and Queensland Biodiversity. An independent report commissioned by the Department of Environment and Resource Management (Qld), Queensland Government.

[34] Ibid.

higher if it can climb a plant or bend it down) and kills all plants within its reach.' Henzell also noted how combined grazing by goats and rabbits can remove seedlings of favoured tree and shrub species so comprehensively that when mature plants die they are not replaced, resulting, presumably, in a landscape with less shade.

Goats can also exacerbate declining rainfall by causing severe erosion on slopes (Norris and Low 2005; Henzell 2008). They have contributed to desertification in many countries. Goats erode upper soil layers, which often hold more water than lower layers because of their high organic content, thereby compromising the capacity of slopes to retain water, as described by Parkes et al. (1996): 'Feral goats can deplete the soil's protective cover of vegetation and break up the soil crust with their hooves (Mahood 1983). In droughts this leads to wind erosion, in rain storms it leads to water erosion, and in steep lands it can cause slips.'

This report has found that many plants with small distributions may prove resilient to significant levels of climate change (see section 5), but they will be indirectly threatened by climate change if landholders turn more to feral and domesticated goats. Goats are catholic in their diet and known to feed on threatened plant species (Norris and Low 2005).

Introductions in new areas: There is considerable prospect of agriculture moving north as conditions become drier in southern Australia under climate change. This would inevitably result in the introduction of new potentially invasive species into environments already at grave risk of mammal and bird extinctions due in substantial part to invasive species.[35]

Less control effort: A recent NSW survey found that feral animal numbers did not decline as expected during a drought, which was attributed to fewer control efforts by farmers under economic stress.[36] The multiple challenges to land managers of coping with climate change, in particular extreme events, would very likely compromise the control of pests and weeds. Both landholders and governments may have less money to direct to such efforts. During emergency responses, attention and resources are often diverted from programs regarded as lower short-term priorities, such as weed and pest control.

1.4 Synergies and negative feedback loops

Some interactions between invasive species and climate change are particularly worrisome because they generate negative feedback loops – problems cyclicly begetting worse problems.

Flammable invasive pasture grasses such as gamba grass (*Andropogon gayanus*) and mission grass (*Pennisetum polystachion*) promote fire by providing unprecedented, very high levels of dry fuel for fire.[37] They also benefit from fire by increasing in its wake. Climate change is likely to intensify fire regimes, which in turn will promote more exotic grass invasion, tree death and higher greenhouse gas emissions from increased biomass burnt each year.

The damage by storms and cyclones to rainforests promotes invasion by exotic vines such as blue thunbergia (*Thunbergia grandiflora*) and turbina (*Turbina corymbosa*). Vine invasion prevents canopy recovery, rendering forests more vulnerable to future cyclone damage and vine invasion. Climate change is predicted to increase the intensity of cyclones, exacerbating this cycle.[38]

Tree pathogens that benefit under climate change – *Phytophthora cinnamomi* in southwest Australia, for instance – can render trees more vulnerable to the impacts of climate change (eg. drought or fire) and contribute to greenhouse gas emissions when trees are killed. Due to high levels of propagule pressure in many areas, weeds may take the place of trees killed.

There are human-based feedback loops as well. The more invasive species that establish, the less people are inclined to do about it – due to the feeling that the problem is too big and hopeless. Climate change will exacerbate this trend by driving even more environmental problems. Promoting motivation to avert invasive species threats is a key climate change challenge.

[35] Woinarski, J., S. Legge, et al. 2011. The disappearing mammal fauna of northern Australia: context, cause, and response. *Conservation Letters* 4(3): 192–201.

[36] West, P. and G. Saunders. 2007. Pest animal survey: 2004-2006. A review of the distribution, impacts and control of invasive animals throughout NSW and the ACT., NSW Department of Primary Industries..

[37] Rossiter, N. A., M. M. Douglas, et al. 2003. Testing the grass-fire cycle: Alien grass invasion in the tropical savannas of northern Australia. *Diversity and Distributions* 9: 169-176.

[38] Low, T. 2008. *Climate Change and Invasive Species: A Review of Interactions*. Canberra, Biological Diversity Advisory Committee..

2. Invasive species management for climate change adaptation

The interventions necessary for climate change adaptation directed at invasive species are broadly those essential to protect biodiversity from invasive species regardless of climate change. Climate adaptation measures should address invasive species threats in three categories:

- Reduce existing invasive species threats to increase the capacity of native species and ecosystems to adapt to climate change (see 2.1).
- Control invaders or potential invaders likely to benefit under climate change (see 2.2).
- Ensure that responses to climate change do not create new invasive species problems or exacerbate existing invasive species threats (see 2.3).

Without being comprehensive, following are some examples of measures needed. We have not identified the particular policy changes required to implement these reforms as they are many and various. We are happy to provide more particular recommendations in further submissions if requested.

2.1 Reduce invasive threats to increase capacity for adaptation

Extinctions are often (probably typically) the result of cumulative or synergistic impacts from multiple threats. Reducing other threats is essential to providing species with the best prospects of surviving and adapting to climate change. With invasive species one of the top threats to biodiversity, they should be a very high priority in efforts to facilitate adaptation to climate change.

Some species have survived past climate change by retreating to refuges. Therefore, identification and protection of refuges from invasive species and other threats should be a high priority. Fire refuges, for example, need protection from invasion by flammable weeds and drought refuges from predation by cats and foxes and competition from introduced animals.

- Reduce invasive species and other threats to native species and ecological communities likely to decline under climate change.
- Protect likely climate change refuges and ‘rare climatic spaces’ from invasive species threats.

2.2 Control invaders likely to benefit under climate change

Climate change will change priorities for managing invasive species, with new threats emerging, some existing threats increasing and others declining. It is prudent to substantially reduce the number of potential invasive species (eg. eradicate sleeper weeds) and control species likely to exert the most serious threats. For example, there should be programs to eradicate garden plants that could spread into the Wet Tropics after cyclones or invade warming alpine areas. A national priority should be fighting the dieback disease *Phytophthora cinnamomi*, as it is a major threat that could get much worse in some areas under climate change.

Develop programs to prevent potential invasive species threats under climate change, including eradicating potential weeds from gardens in the Wet Tropics and alpine areas.

Direct strong research and control efforts to invasive species likely to exert the highest threats to biodiversity under climate change, eg. Phytophthora cinnamomi and flammable invasive pasture grasses.

2.3 Ensure responses to climate change do not exacerbate invasive species threats

While Australia has a risk assessment process for introductions of new species from overseas, most species imported prior to 1997 (when risk assessment was introduced) have never been assessed and can be freely imported. Most states and territories regulate the use of only a small proportion of invasive species, and permit new introductions of plants mostly without risk assessment.

It will be important to ensure that any translocation of native plants and animals to more suitable habitats under climate change does not lead to them becoming invasive.

- Adopt a permitted list approach to exotic species at the state level that permits release only if they are found on risk assessment to pose low invasive risks.
- Ensure that all new cultivars or breeds of existing weedy or pest species undergo risk assessment and are permitted for import or release only if they pose low risk.

- Subject biofuel crop species and other species proposed for widespread cultivation to risk assessment, permitting cultivation only for low-risk species (see Box 3).
- Develop a national policy on translocation of native plants and animals that requires rigorous risk assessment of the invasive threat.

Box 3. High risk biofuel crop species

Attachment 3 *Weedy Biofuels: What Can be Done?*[39] analyses policy options for reducing the risk of invasive biofuel crop species provides a case study of issues associated with the prevention and management of invasive species that are also valued economically. The authors conclude:

> *As high-volume, low-value crops with many of the attributes of weeds, biofuels present a dangerous combination of high propagule pressure and limited landholder capacity for weed management. For these reasons, the biofuels industry warrants high levels of weed precaution: the risks and costs of invasion are high and long-term while the benefits may be transient. Government regulators should assess the risk of proposed biofuel crops before research or producer investments are made and only permit the cultivation of species assessed as low-risk. Weed risk assessment protocols are available to assist this. Governments should be realistic about the limited potential for regulations or codes of practice to prevent weed escapes, given their poor track record in other arenas and the difficulty of managing for low-frequency extreme events. A precautionary approach to biofuels does not compromise the industry's future because there are many low-risk species, including native species, that can be used instead of invasive species.*
>
> *The emerging biofuels industry offers the opportunity to implement well-recognised principles of prevention in weed management, and to show that the lessons of past failures have been learnt.*

[39] Low, T., C. Booth, et al. 2011. Weedy biofuels: what can be done? *Current Opinion in Environmental Sustainability* 3: 55-59.

3. Barriers to effective adaptation

The existing threats of invasive species demonstrate the insufficiency of current laws, policies and programs. Even without climate change, Australia is failing to meet biodiversity goals to manage invasive species, and threats are growing. Current impediments are many-fold, including the following.

3.1 Gaps in environmental and biosecurity laws

Biosecurity is managed under a mishmash of biosecurity and environmental laws and policies, with pre-border biosecurity handled by the federal government and most post-border functions handled by states and territories. There are major holes (and some inconsistencies) in these laws, and we provide just a few examples here.

Preborder biosecurity: There have been major reforms of federal biosecurity laws. Since 1997, there have been requirements to assess all new introductions for invasion risk. However, there are many thousands of invasive species freely imported that have never been assessed because they were already in the country prior to the 1997 reforms and are not under formal control. These gaps guarantee the continued importation of high-risk species that will threaten biodiversity.

There is also no requirement for assessment of new genetic variants of permitted species that could be more invasive and exacerbate invasive impacts.[40] A kikuyu grass (*Pennisetum clandestinum*) breeding program, for example, is aiming to produce varieties that exhibit shade and drought tolerance and resistance to disease.[41] Kikuyu is an environmental weed, one of the exotic perennial grasses listed as a key threatening process in NSW, and a threat to at least 16 threatened species in NSW.[42] But because kikuyu is not declared noxious anywhere in Australia, any new variant can be bred domestically or imported without a risk

[40] Booth, C. 2009. The invasion risks of introducing new genetic variants of exotic plants and animals, Invasive Species Council.

[41] See www.agcsa.com.au/static/atm_articles/html/9_4_3b.html. "Promising selections" include "aggressive forms suitable for pasture production."

[42] Coutts-Smith, A. J. and P. O. Downey. 2006. The impact of weeds on threatened biodiversity in NSW. Technical series no.11. Adelaide, CRC for Australian Weed Management Systems.

assessment. The release of new genetic variants can dramatically worsen impacts on biodiversity.

Postborder biosecurity: One major gap recognised by the 2009 review of the federal *Environment Protection and Biodiversity Conservation Act* 1999 was the lack of regulation over the sale and deliberate spread of thousands of weedy plants within Australia. The independent reviewer found that the several thousand plant species persisting as ornamentals or as naturalised populations in urban areas 'represent a vast reservoir of potential future problems' and that their movement within Australia 'is effectively unconstrained'.[43] State and Territory responses to this problem were criticised as representing 'a substantial failure of State and Territory-based environmental regulation'.

Despite prevention being recognised by all jurisdictions as primary in a hierarchy of measures to manage invasive species, the majority of states and territories permit the free sale and movement of all but a few declared plant species without having assessed the risk.[44] This includes species native to Australia introduced to areas outside their range, where they can become just as invasive as species from overseas.

The majority of existing environmental weeds in Australia have been deliberately imported as garden plants, and many that are threatening biodiversity are unregulated and remain for sale. A NSW assessment of 2005 found that more than a quarter of weeds identified as threats to listed species and ecological communities were still being sale. A substantial proportion of invasive plants threatening to biodiversity have been planted for agricultural purposes, and like nursery plants they too are mostly unregulated. One example is Tall Wheat Grass (*Lophopyrum ponticum*), the most popular cultivar of which was released by the Victorian Government in 1999 with no risk assessment.[45] It is one of Victoria's worst emerging weeds, threatening several nationally listed species and ecological communities, and listed as a potentially threatening process, but there has been no move to prevent it being sold and planted. The Victorian Government continues to promote it as a pasture species.

Although the federal government has a head of power to implement laws to protect biodiversity it takes a narrow approach to invasive species. Section 301A of the EPBC Act was intended to be used to regulate invasive species within Australia, but has never been implemented. Although invasive species can be listed as a key threatening process under the EPBC Act, there are no federal powers to require that threat abatement plans be implemented.

Biosecurity laws lack many best practice elements of environmental laws. They generally don't incorporate a polluter pays approach, require a duty of care, include the precautionary principle, or provide legal standing for the community to enforce laws.

Examples of reforms needed:

- Reform biosecurity and environmental laws to limit the deliberate introduction and spread of invasive species, eg. adopt a permitted list approach to non-native plants, permit the introduction only of low risk genetic variants of invasive species.
- Harmonise state laws to ensure a more consistent and precautionary approach to invasive species threats.
- Improve the capacity of the EPBC Act to address invasive species threats, by using s301A to regulate trade and movement of invasive species threatening to biodiversity and requiring implementation of threat abatement plans.
- Include best practice elements of environmental law in biosecurity laws (including polluter pays principle, duty of care requirement, precautionary principle, third party legal standing).

3.2 Insufficient resources

Current expenditure on invasive species management is far from sufficient to halt declines in biodiversity. Some of it is also poorly directed, for example on programs that are too short-term or limited to achieve biodiversity recovery. New Zealand researchers have determined that funding for weed and pest management in New

[43] Hawke, A. 2009. The Australian Environment Act: Report of the Independent review of the Environment Protection and Biodiversity Conservation Act 1999. Canberra, Department of the Environment, Water, Heritage and the Arts.

[44] Invasive Species Council. 2009. Stopping weed invasions: a 'white list' approach.

[45] Booth, C., G. Carr, et al. 2009. Sowing the Seeds of Destruction: Weedy Pasture Plants for Salinity Control, Invasive Species Council and The Wilderness Society.

Zealand needs to increase by 9 to 25 times to protect biodiversity.[46] No such analysis has been conducted for Australia, but we concur with the New Zealand researchers that the resource deficiency in Australia is likely to be of a similar scale. There is an urgent need to assess the level of resources needed and identify funding options.

While it is unrealistic to expect governments to provide the entirety of this shortfall, there is a strong case for substantially increased and long-term funding for invasive species management – because the threats are so substantial, and because there is a benefit-cost ratio, which underpinned the recommendation of the 2002 Prime Minister's Science, Engineering and Innovation Council that it be one of four priority areas for investment.[47] The theme report on biodiversity for Australia's 2006 state of environment report, Cork and colleagues comment:[48]

> *It has been noted that public resources committed to invasive organisms appear to be small, particularly compared with expenditure on other natural resource management issues, the economic and environmental impacts of invasives compared with other issues, and the relatively high benefit-cost ratios reported from analyses of research and development on invasive organisms (Agtrans Research and Dawson 2005).*

There is a perception that managing entrenched invasive species is a 'black hole for money'. A more constructive view is that not managing these threats is economically imprudent and breaches the fiduciary duty of government to pass on an environment of undiminished productive capacity to upcoming generations and to protect biodiversity.

Examples of reforms needed:

- Assess the level of resourcing needed to manage invasive species to halt declines in biodiversity.
- Increase public funding for long-term management programs that address high priority conservation goals.
- Develop alternative and reliable funding streams for invasive species management.

3.3 Prioritisation of private goods

Many invasive species problems arise from a failure to balance private and public goods, or even to account for public goods at all. Most invasive species were introduced for private benefit – as garden plants, agricultural products, pets – without any consideration of the costs to other species and other humans, including taxpayers. There has been a failure to implement the polluter pays principle for invasive species, which means that those who introduce and spread invasive species are generally not held responsible and do not even contribute to costs of their management (the costs are externalised). Self-regulation has been ineffective in reducing the irresponsible use of potentially invasive species, as studies have shown for the nursery industry.[49]

The priority accorded to private benefits from invasive species continues in many respects despite considerable improvements in decision-making about the importation of new species. Invasive plants promoted for biofuels exemplify the issue, as discussed in Low et al. (2011)[50]:

> *The problem of balancing private and public goods is compounded by a lack of methodology for directly comparing costs and benefits (including economic costs and benefits) of short-term production and long-term sustainability. The paradigm of economic productivity is poorly integrated with that of natural resource and ecosystem management.*
>
> *Weedy biofuel crops epitomise the problem. They may provide immediate economic benefits while diminishing future land use options and productivity and biodiversity. With biofuel proponents promoting only the benefits, often unrealistically, and landholders often ill-equipped to evaluate the risks,*

[46] Choquenot, D. and M. Clout. 2011. Another inconvenient truth: How much pest control will it take to halt the decline in biodiversity? Security from the impact of vertebrate pest animals.15th Australasian Vertebrate Pest Conference. Sydney.

[47] Prime Minister's Science, Engineering and Innovation Council,. 2002. Sustaining our Natural Systems and Biodiversity, Australian Government.

[48] Cork, S., P. Satler, et al. 2006. Biodiversity theme commentary prepared for the 2006 Australian State of the Environment Committee. Canberra, Department of the Environment and Heritage.

[49] Caton, B. 2005. Availability in Florida nurseries of invasive plants on a voluntary 'do not sell' list, United States Department of Agriculture & Animal and Plant Health Inspection Service.

[50] Low, T., C. Booth, et al. 2011. Weedy biofuels: what can be done? *Current Opinion in Environmental Sustainability* 3: 55-59.

governments have a vital role to play in assessing and managing risks on behalf of the wider community.

- Examples of reforms needed:
- Ensure that public interests are accorded priority in decision-making about the sale and use of exotic species
- Implement the polluter pays principle (or variations) for invasive species

3.4 Institutional limitations

Although invasive species are one of the top threats to biodiversity, biosecurity functions are mostly managed by agricultural agencies whose missions are economically rather than environmentally focused. Environmental agencies are primarily focused on on-ground management of invasive species in conservation reserves or for threatened species. Environmental biosecurity lags industry biosecurity in preparedness, research, stakeholder engagement, funding and many other respects.

Primary industry agencies have carriage over most biosecurity policy at national and state/territory levels. The mission and culture of these agencies is, not surprisingly, oriented more towards industry than biodiversity. For example, the Federal Department of Agriculture, Fisheries and Forestry's mission is 'Increasing the profitability, competitiveness and sustainability of Australian agricultural, fisheries, food and forestry industries and enhancing the natural resource base to achieve greater national wealth and stronger rural and regional communities.' Similarly, federal and state/territory government biosecurity agreements have been mostly developed by the Primary Industries Ministerial Council, whose mission is 'to develop and promote sustainable, innovative and profitable agriculture, fisheries/aquaculture, and food and forestry industries'.

Although primary industries agencies acknowledge responsibility for environmental biosecurity, in practice they give priority to industry biosecurity goals and have much stronger engagement with industry stakeholders. An agricultural bias in biosecurity was noted both by the2008 Beale review of biosecurity and the 2009 Hawke review of the EPBC Act, with the latter noting that:[51]

> *'A risk of integrating environmental, health and primary production considerations under a single biosecurity regime is that environmental outcomes could be compromised if the primary focus remains on trade and primary production – a problem of "culture".*

Industry bodies are closely engaged in biosecurity policy-making, such as through the industry-government bodies Animal Health Australia and Plant Health Australia. Although environment groups and the community sector conduct a large proportion of biodiversity-focused on-ground management of invasive species, they have only limited engagement in the policy arena. Improved environmental biosecurity is reliant on much greater engagement of the community in all aspects of biosecurity, including policy development, as emphasised in the 2008 Beale review of biosecurity:[52]

> *Engagement with business and the general community on biosecurity must occur consistently and continually at several levels, from policy setting through co-regulatory alternatives to actions by individuals and companies, before, at and after the border.*
>
> *The message of One Biosecurity: a working partnership needs to be made available to a wide audience. Effective awareness campaigns and education that target all facets of the biosecurity continuum are essential, but particularly focusing on areas that have lacked representation in the past. These include aquatic and environmental biosecurity... This will require a more concerted involvement from the general community, the environment sector....*

The community contributes much of the effort in managing invasive species threats (through private land management, voluntary contributions to bush regeneration and pest control, philanthropic support of invasive species management). Much greater community engagement in invasive species policy development is essential to maximise the degree and effectiveness of these contributions and to generate the political support necessary for more appropriate levels of public funding.

Other institutional limitations arise from the federalist approach to biosecurity under which post-border biosecurity is mostly managed by state and territory governments, under different regulatory approaches, which make for complexity

[51] Hawke, A. 2009. The Australian Environment Act: Report of the Independent review of the Environment Protection and Biodiversity Conservation Act 1999. Canberra, Department of the Environment, Water, Heritage and the Arts.

[52] Beale, R., J. Fairbrother, et al. 2008. One Biosecurity — a working partnership. Independent review of Australia's Quarantine and Biosecurity Arrangements., Australian Government.

and some inconsistency, as discussed above. This is evident, for example, in the conflicting approaches of state governments to feral deer, a serious and rapidly increasing threat to biodiversity, which could eventually be a threat of the magnitude of feral goats and pigs. In NSW, Victoria and Tasmania, feral deer are protected for hunters with a conservation status close to that provided for native species, despite them being listed as a threatening process in the former two states. Other states recognise them as a feral pest species, although control programs are lacking in many areas.

Examples of reforms needed:

- Establish a national body that brings together major participants in environmental biosecurity, effectively involves the community sector, and facilitates a cross-jurisdictional, cross-sector collaboration to achieve much stronger environmental biosecurity (akin to the industry bodies Plant Health Australia and Animal Health Australia).
- Develop institutional arrangements that foster collaboration between environmental and biosecurity agencies and ensure environmental biosecurity is accorded priority commensurate with the threat of invasive species to biodiversity, eg. biosecurity units as joint responsibility of environmental and agricultural agencies.

3.5 Information deficiencies

The invasive species target of the Australian Biodiversity Conservation Strategy is: 'By 2015, reduce by at least 10% the impacts of invasive species on threatened species and ecological communities in terrestrial, aquatic and marine environments.' But there is no baseline by which to assess progress towards this goal. There is generally poor information about the status, range and impacts of invasive species on biodiversity, with good information for a small proportion of the high-impact species. The 2011 State of Environment Report concludes that the availability of information for reporting on invasive species pressures on biodiversity is 'poor nationally', and notes variously that:

- 'No institutions currently conduct ongoing assessments of the impacts of weeds on biodiversity.'
- 'There are major gaps in our understanding of the impacts of invasive species and pathogens on biodiversity. '
- 'There are very limited data on which to assess whether efforts to address problems are having an impact.'

Examples of reforms needed:

- Develop a national accessible system for data collection essential to establish a baseline and monitor progress
- Identify high priority questions for research
- Develop a national clearing house for invasive species information

Note: These functions could all be most effectively undertaken by the national body proposed in 3.4

Conclusion

The current scale and trends in invasive species threats to biodiversity are testament to very serious policy barriers and deficiencies that are essential to address for biodiversity conservation, regardless of climate change. The predicted exacerbation of invasive species threats under unavoidable climate change adds significantly to both the challenge and the imperative.

This submission shows that the reforms needed are substantial and diverse. We would be pleased to provide more detail on particular reforms needed. Australia urgently needs a more ecological, coordinated and collaborative approach to environmental biosecurity. We highlight in particular the need for a national body to facilitate cross-sectoral and cross-jurisdictional collaboration, as recommended in section 3.4. It is an essential basis for developing the institutional capacity and engendering community participation required to reform management of invasive species. It would be an ideal body to take responsibility for developing new policy approaches for climate change adaptation relevant to invasive species. We urge the Productivity Commission to recommend its establishment. (More information is provided in Attachment 4, which we provide on a confidential basis).