Review of WEED management in NSW

Submission to the Natural Resources Commission

December 2013

- Invasive Species Council
- Australian Association of Bush Regenerators
- Greening Australia
- National Parks Association of NSW
- Nature Conservation Council of NSW

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Introduction

This is a submission from five state and national groups committed to the conservation of NSW's immensely diverse biota, and protection and restoration of its natural habitats. It is in response to the Issues Paper released by the Natural Resources Commission for its independent evaluation of the effectiveness and efficiency of weed management arrangements in NSW, requested by the Minister for Primary Industries.

We welcome the focus by the Natural Resources Commission on one of NSW's most serious and challenging environmental problems, and encourage a comprehensive analysis with recommendations for substantial reform. Weeds are transforming NSW's landscapes and threatening hundreds of native species but for many reasons – because the changes are insidious and often poorly understood, because weed management is challenging and expensive and because there is profit to be made from selling and using some invasive plants – the issue does not get the community and political attention warranted.

The submission has been compiled by the Invasive Species Council with considerable input from others, much of it based on the 2010 report *Stopping NSW's Creeping Peril* and a joint NGO submission to the 2011 review of the Noxious Weeds Act. In section 1, we set out the dimensions of NSW's weed threat – the extent and costs of weed invasion, the rate of introductions and naturalisations, and invasion drivers – and in sections 2 to 8 we propose reforms to legislation, policy, governance arrangements and funding. We particularly stress the need to fully implement a prevention focus and to develop a sustainable funding model. There has long been government endorsement of the sensible idea that priority should be given to preventing new weed problems but NSW lacks an effective system to achieve this. Restricting introductions to low risk plants is the only way to bring down the current high rate of establishment of new weeds. No substantial reforms can occur without more funding. Weed management is very poorly resourced, receiving comparatively little public funding compared to other essential government services and compared to the scale of the problem. Effective measures to prevent and manage weeds tend to have a very high benefit to cost ratio. New long-term reliable sources of funding are needed.

The submitters

The **Invasive Species Council** campaigns for better laws and policies to protect the Australian environment from weeds, feral animals and other invasive species. Email isc@invasives.org.au.

The aim of the **Australian Association of Bush Regenerators** is to promote the study and practice of ecological restoration, and foster and encourage effective management of natural areas by qualified people, based on sound ecological principles. Email secretary@aabr.org.au.

The mission of **Greening Australia** is to engage the community in vegetation management to protect and restore the health, diversity and productivity of our unique Australian landscapes. Email nswreception@greeningaustralia.org.au.

The **National Parks Association of NSW** seeks to protect, connect and restore the integrity and diversity of natural systems in NSW and beyond, through national parks, marine sanctuaries and other means. Email npansw@npansw.org.au.

The **Nature Conservation Council of NSW** aims to conserve and protect NSW's diversity of living plants and animals and unique ecosystems, and the environmental quality of NSW's land, air, urban environment, waterways and adjacent sea. Email ncc@nccnsw.org.au.

1. NSW's creeping peril – status and trends

Often pretty, sometimes useful, they can lurk benignly in gardens or paddocks for years or decades. But for the wild at heart, when the opportunity arises, fences and property boundaries are no barriers. Picked up by bird, beast or breeze, wafted on water or dumped by gardeners, they escape and set their roots in the Australian bush.

Those that flourish can do great damage. They don't prey on wildlife, but they eliminate wildlife habitat. They don't bulldoze woodlands or excavate wetlands, but they can just as surely destroy them. Out of place and out of control, weeds are a huge and growing threat to NSW.

Stopping NSW's Creeping Peril, 2010[1]

In the 230 years since European colonisation, Australians have imported thousands of exotic plant species, averaging more than 100 new species a year. As a result, there are now thousands more exotic vascular plant species in the country (about 30,000, most in cultivation) [2] than there are native species (about 20,000).[3] More than 95% have been deliberately imported for cultivation, most as garden plants and many for agriculture.[4] By moving plants into new ranges and planting them in numerous locations, sometimes in vast acreages, humans provide some species with advantages that allow them to establish in the wild and outcompete native species. In the short time since European colonisation – a blink of an eye in ecological terms – about 3000 exotic plant species have established in the wild in Australia, more than half invading natural ecosystems. The worst cases result in transformation of natural habitats, disruption of ecological processes and threats to native plants and animals (see Box 1). Although weeds already dominate many ecosystems, the worst is yet to come. Australia is still at a relatively early stage of invasion: many more introduced plants have yet to establish in the wild or become invasive. There is often a considerable time lag between introduction and invasion, sometimes more than a century.[5]

Box 1. How weeds destroy our natural heritage[6]

Weeds compete with and eliminate native species and change the structure and function of ecosystems.

- *Smotherers*: Exotic vines such as cats claw creeper, Madeira vine and kudzu blanket native plants; sometimes the sheer weight of vines causes trees to collapse.
- *Fire fuelers*: Large perennial grass invaders such as molasses grass and shrubs like gorse can add lots of flammable biomass to an environment, fueling more intense fires that favour the spread of these weeds and kill other species.
- *Gap grabbers*: Many weeds are fast germinators and can quickly fill gaps created by drought, fire, storms or clearing. Serrated tussock colonises spaces in grasslands created by drought; lantana claims clearings in rainforest.
- *Light hoggers*: Dense-leaved weeds such as willows and bitou bush can shade out other plants and prevent growth.
- *Swampers*: Vigorous weeds like coolatai grass, lantana and camphor laurel can form vast monocultures, excluding all other species.
- *Water chokers*: Aquatic weeds like alligator weed and cabomba fill creeks with a dense mass of stems and leaves, depleting oxygen and killing fish and other life.
- *Ecosystem engineers*: Weeds can physically transform ecosystems, willows affecting stream hydrology, invasive pasture grasses changing fire cycles, marram grass and biotou bush altering sand dune dynamics. Dominating weeds can greatly simplify habitat structures.
- *Harbours for pests*: Blackberries and gorse provide haven for rabbits and foxes.

Why weeds are biological victors

Humans give many weed species a passport to plant heaven: they often liberate them from natural pathogens[7] and predators, and plant them in large numbers in many habitats, sometimes selecting or breeding them for high productivity and wide tolerances. The defensive chemicals some weeds produce may be extra powerful in their new environment because native herbivores have not evolved with them. With plants favoured for cultivation, many variants may be introduced, endowing them with greater genetic amplitude than they have in their natural range.

1 Invasive Species Council (2010)

2 Downey, Scanlon et al. (2010); DAFF (2009). The DAFF (2009) Census of Cultivated Plants was compiled from public domain sources 'including over 600 Plant Nursery Catalogues spanning 200 years, Botanical and major Garden plant species lists, Australian Quarantine and Inspection Service permitted import list, State Department vegetation surveys and Commonwealth lists of imported species.' It recorded 3513 cultivated taxa that had naturalised.

3 Chapman (2009)

4 Groves, Hosking et al. (2003); Groves, Boden et al. (2005); Cook and Dias (2006); Randall (2007). Randall (2007) documented 26,242 introduced species, of which 25,448 (96.9%) were plants introduced for cultivation.

5 Groves (1999). Lags in invasion may be due to competition with other plants, unfavourable environmental conditions or stochastic events. Kowarick (1995) determined there was a mean lag of 131 years for shrubs and 170 years for trees invading Germany.

6 Excerpt from Invasive Species Council (2010).

7 For example, Mitchell and Power (2003) showed that 'naturalised species are generally strongly released from pathogens': they assessed 473 European plant species naturalised in the US and found that on average, 84% fewer fungi and 24% fewer virus species infected each plant species in its naturalised range than in its native range.

1.1 Some NSW weed statistics

FIGURE 1. NSW WEEDS AT A GLANCE

STAGES OF INVASION	Introduction	Establishment (Naturalisation)	Spread & proliferation	Significant impact (Invasion)
NSW NUMBERS	~11,000 non-indigenous (exotic and native) taxa introduced for cultivation[8]	~1665 species naturalised (26% of NSW flora, 14% of introduced taxa)	>340 'environmental weeds'[9]	>130 impacting threatened biodiversity[10] 134 ranked moderate-extreme threat[11]
MANAGEMENT OPTIONS	Prevent introduction or prevent escape. Eradicate escapees.	Eradicate, otherwise contain to prevent spread.	Contain and control to limit spread and harm.	Control to protect biodiversity and other values.

Naturalisation, invasion and threat

Naturalised species (species with self-sustaining populations in the wild)[12]

- At least 1665 plant species have naturalised in NSW.[13]
- Naturalised species now constitute about 26% of NSW's total vascular flora.[14]
- An average 7.2 species have naturalised annually in NSW since European colonisation. The rate of naturalisation has increased in recent decades (see Figure 2): an average 20 naturalised species a year have been newly recorded since 1990 (although that is due in some part to more rigorous botanical searches and more comprehensive record-keeping).[15]

Weed spread

- Weeds account for 52 (43%) of the 120 most widely distributed plant species in New South Wales.[16]
- There is no information about the extent or rate of spread of most NSW weeds but the extent of about 140 priority NSW weeds has been mapped, which can provide the basis for monitoring future spread.[17]
- It is likely that at least 90% of NSW's land area is affected by weeds, in association with the proportion of land area affected by native vegetation disturbance[18] or loss. The highest diversity of naturalised species are in coastal districts and the least in the far western plains (see Figure 3).[19] About two-thirds of all naturalised taxa are present in the most populous district, the Central Coast, and more than half are in the second most populous, the North Coast district, which can be explained, in part, by the fact that the majority of weeds are garden escapees and that weeds thrive in disturbed areas. The districts with the highest number of naturalised species are also the districts with the greatest diversity of native plant species.

8 DAFF (2009)
9 They have the ability to pose a threat to, or impact upon, biodiversity in NSW, now or within the next 5 years (Downey et al. 2010).
10 Coutts-Smith and Downey (2006)
11 Downey, Scanlon et al. (2010)
12 Naturalised' refers to non-native taxa that have been reproducing (sexually or vegetatively) in the wild for at least one generation.
13 Downey, Scanlon et al. (2010). There are likely to be many more naturalisations than have been recorded as new searches tend to turn up many more records. For example, Hosking, Conn et al. (2003) and Hosking, Conn et al. (2006) found 111 unrecorded naturalisations within 3 years.
14 NSW State Government (2009) stated that NSW has at least 4677 native plant species.
15 The number of naturalised species recorded in NSW by 1990 was 1253 (Australian National Botanic Gardens 2010, citing Hnatiuk 1990) and the number recorded by 2010 was 1665 (Downey et al. 2010). Hosking, Conn et al. (2003) and Hosking, Conn et al. (2006) recorded 111 naturalisations from 2000-2003, but noted that in many cases it was due to increased effort to record naturalised plants.
16 Stohlgren, Pysek et al. (2011). Of 13 regions assessed (including North America, Europe, South Africa, China), NSW was second highest after North America, where aliens accounted for 51.3% of the 120 most widely distributed plant species.
17 See <dpi.nsw.gov.au/agriculture/pests-weeds/weeds/weed-maps>.
18 Lake and Leishman (2004).
19 Numbers of naturalised species in each bioregion were sourced from NSW Flora Online (accessed August 2010).

FIGURE 2. NUMBER OF SPECIES RECORDED NATURALISED IN NSW[20]

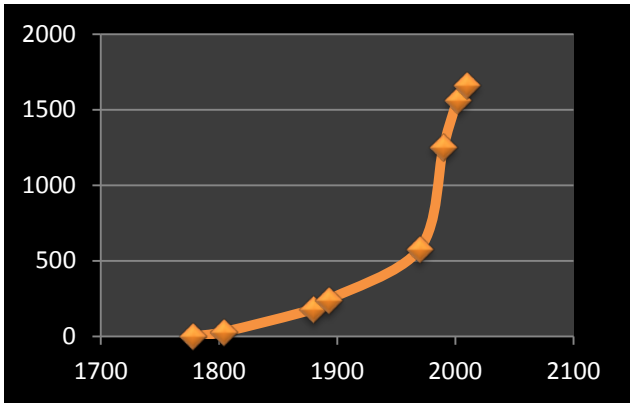
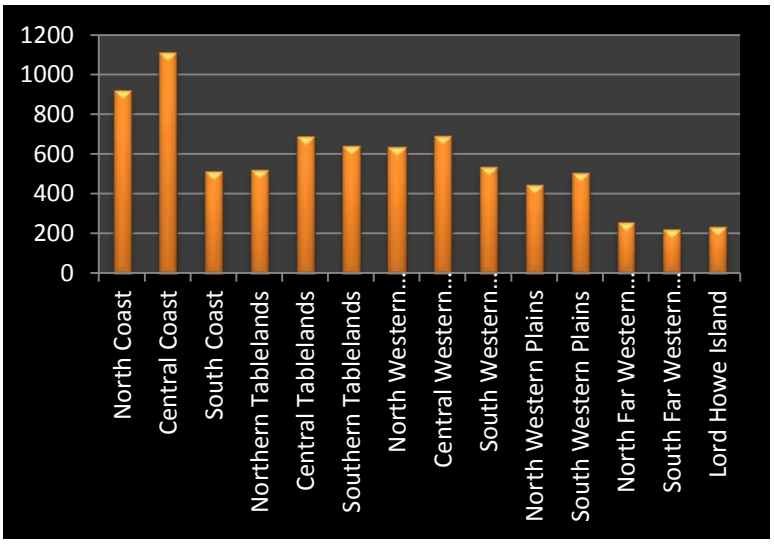


FIGURE 3. NUMBER OF NATURALISED TAXA IN EACH NSW BOTANICAL DISTRICT[21]



Environmental impacts

Little is known about the magnitude of the collective impacts of invasive species, either on biodiversity or the whole environment.

NSW State of the Environment Report 2009.[22]

At least half the naturalised plant species in Australia (about 1500 species) invade native vegetation, and about 30% are considered a 'major problem' for natural ecosystems.[23] Weeds are a threat to about 90% of nationally listed threatened ecological communities.[24] Only a proportion of plants naturalised in natural ecosystems are known to cause problems. Downey et al. (2010) assessed 134 weeds as having 'moderate' to 'extreme' impacts on NSW biodiversity. But the extent of weed threats is poorly known due to a lack of research. The impacts of weeds that have been studied tend to be considerably worse than originally realised. In 2000, invasion by bitou bush or boneseed was thought to threaten 18 plant species and 3 ecological communities. With the focus engendered by the development of a Threat Abatement Plan, bitou bush (considered the single greatest threat to NSW coastal ecosystems and coastal biodiversity) was

20 Holland and Olson (1989, citing Moore 1893); Hobbs (1993); Groves (2002); NSW State Government (2003); Australian National Botanic Gardens (2009, citing Hnatiuk 1990); Downey, Scanlon et al. (2010).

21 NSW Flora Online (accessed August 2010)

22 NSW State Government (2009).

23 Humphries, Groves et al. (1991); Groves et al. (2003), who identified 1388 environmental weeds (about 6% of total flora).

24 Invasive Species Council (2009)

recognised as a threat to 157 plant species (55 threatened) and 24 ecological communities (15 endangered), and potentially 24 animal species.[25] Lantana, invasive over 4 million hectares in eastern Australia, threatens 1322 plant species and 158 animal species, including 10% of all NSW's listed threatened species.[26]

Lantana and bitou bush were both deliberately introduced, as were more than two-thirds of Australia's weeds.[27] Despite the enormous costs to our environment and economy, the deliberate introduction and spread of known weeds continues. Fewer than 20% of NSW's moderate to extreme environmental weeds are banned from sale in all or part of the state.[28] While thousands of people labour mightily (and mostly voluntarily) to remove weeds from bushland, the same weeds are often being planted in local gardens.

Weeds threatening biodiversity

- At least 340 weeds (about 20% of naturalised species) have been assessed as having the ability to threaten or impact on biodiversity in NSW,[29] of which 134 species (8% of naturalised species) are rated in the 'moderate', 'high', 'very high' or 'extreme' priority.[30]
- In 2006, weeds were ranked as the second-biggest threat to NSW biodiversity, after land clearing and equivalent to inappropriate fire regimes (ratings were based on the number of threatened species, populations and ecological communities identified as under threat).[31]
- At least 127 weed species are an identified threat to threatened species or populations or endangered ecological communities listed under NSW legislation.[32] However, this is a considerable underestimate, due to lack of information about the impacts of many weed species, and lack of identification of particular weed threats for some threatened biodiversity.
- At least 341 threatened species (40% of the total listed under NSW legislation in 2006) are threatened by weed invasion, the majority of which are plants (271 species, 49% of all threatened plant species).[33]
- At least 64 endangered ecological communities (89% of the total listed under NSW legislation in 2006) are threatened by weed invasion.[34]
- Seven NSW Key Threatening Processes consist of individual or multiple weed species (see Table 1).
- More than 40 NSW weed species have been designated Weeds of National Significance, encompassing 24 of 32 WONS categories (Table 1).[35] Several others were nominated as candidate WONS.
- About 90% of all vegetation classes in NSW in 2009 were affected by invasive species, including weeds, an increase from 75% in 2006. From 1999-2009, 20 vegetation classes (20%) experienced increased pressure due to invasive species, and 75 (76%) remained static.[36]

Weed threats in national parks

- In 2004, weeds were a 'commonly' reported threat in 72% of NSW's parks, across 91% of the park area. Of all threats to parks in 2004, weeds affected the greatest proportion and the greatest area of parks (compared to 57% / 87% for pest animals, and 46% / 59% for inappropriate fire regimes). Weeds were reported as a 'high to severe and widespread' problem for 101 parks (22% of area), and a 'high to severe, but localised' problem for 120 parks (26% of area).[37]
- In 2007, weeds were identified as a threat in 76% of parks (580 of 759), affecting 18% of park area (1.2 million ha). Weeds were rated a 'severe' threat on 111 000 ha.[38] While the number of parks affected increased slightly between 2004 and 2007, the area under threat declined substantially.

25 Department of Environment and Conservation (2006)
26 The National Lantana Management Group (2009)
27 Groves, Boden et al. (2005); Cook and Dias (2006)
28 That figure was current in July 2011. It is possible that other species have been declared noxious since then.
29 Downey, Scanlon et al. (2010)
30 Groves, Hosking et al. (2003)
31 Coutts-Smith and Downey (2006).
32 Coutts-Smith and Downey (2006).
33 Coutts-Smith and Downey (2006).
34 Coutts-Smith and Downey (2006).
35 See <weeds.org.au/natsig.htm>
36 NSW State Government (2009)
37 NSW State Government (2005)
38 NSW State Government (2009)

TABLE 1. FEATURES AND STATUS OF NSW'S ENVIRONMENTAL WEEDS

Most common families[39]	Poaceae (grasses): 16% Asteraceae (daisies): 9% Fabaceae (legumes): 8%
Time of introduction (when first available as nursery stock in NSW)[40]	>150 years ago: 27% 50-150 years ago: 41% <50 years ago: 31%
Quarantine status (August 2011)	44% on permitted list of imports into Australia
Status in NSW (August 2011)	Banned from sale across entire state: 12% Eradication or control by landholders required across state: 4% Eradication or control required by landholders in part of state: 24% No restrictions on sale or movement or requirement for control: 68%
Key threatening processes in NSW[41]	Lantana Bitou bush and boneseed Scotch broom African olive Exotic vines and scramblers: 25 species Exotic perennial grasses: 42 species Escaped garden plants, including aquatic plants
Weeds of National Significance	Alligator weed*: Alternanthera philoxeroides* African boxthorn*: Lycium ferocissimum* Asparagus weeds*: Asparagus aethiopicus, A. africanus, A.* plumosus*, A. scandens* Athel pine *Tamarix aphylla* Bitou bush and boneseed*: Chrysanthemoides monilifera* Blackberry: *Rubus fructicosus* agg. Bridal creeper: *Asparagus asparagoides*, Brooms*: Cytisus scoparius, Genista monspessulana, G. linifolia* Cambomba*: Cabomba caroliniana* Cat's claw creeper: *Dolichandra unguis-cati* Chilean needle grass*: Nassella neesiana* Fireweed: *Senecio madagascariensis* Gorse: *Ulex europaeus* Lantana*: Lantana camara* Madeira vine*: Anredera cordifolia* Mesquite: *Prosopis* spp. Opuntoid cacti*: Opuntia robusta, O. aurantiaca, O. monacantha, O. stricta, O. tomentosa, Cylindropuntia rosea, C. fulgida* (var. mamaillata), *C. imbricata, C. tunicate*, *Austrocylindropuntia cylindrical* Parkinsonia: *Parkinsonia aculaeata* Sagittaria*: Sagittaria platyphylla* Salvinia*: Salvinia molesta* Serrated tussock*: Nasella trichotoma* Silverleaf nightshade: *Solanum elaeaginifolium* Water hyacinth*: Eichhornia crassipes* Willows: S*alix* spp.

39 Of the 340 environmental weeds listed in Downey et al. 2010.

40 Of the 340 environmental weeds listed in Downey et al. 2010; date of introduction from DAFF (2009).

41 See http://www.environment.nsw.gov.au/threatenedspecies/KeyThreateningProcessesByDoctype.htm.

Costs of weeds

Weeds are a very expensive problem – in Australia the most expensive of all natural resource management problems, exceeding the costs of salinity by at least an order of magnitude. The commonly cited figure of a $4 billion weed cost in Australia[42] is a considerable underestimate because the assessment was based only on a proportion of agricultural weeds and is now a decade old. Most estimates of weed costs do not include environmental impacts, as there is no valid method for this, or impacts on human health.

Costs to NSW agriculture

- An estimated $1.2 billion is lost annually due to production losses and control costs on NSW farms, equivalent to 14% of gross value of agriculture in 2004-05 ($8.6 billion).[43] Weeds therefore account for the loss of 1 in 8 dollars of potential agricultural revenue in NSW.
- Weeds are the most costly natural resource management problem for NSW farmers: in 2006-07, 78% reported suffering production losses and 32% increased fire risk due to weeds. Average NSW farm expenditure on weeds in 2006-07 was $10,986 .[44]

Government expenditure

- About $50-60 million of public money (local and state governments) is spent on on-ground weed management in NSW (see section 8 for estimates).

Other costs

- The costs to the environment have not been calculated (there is no accepted method to do so). However, far more weed species affect the environment than affect agriculture (Australia-wide, about 30% of naturalised plant species are considered a major problem for natural ecosystems compared to about 16% for agriculture)[45] and environmental management is typically far more difficult.
- The costs to public health, which include allergies, respiratory illness and poisoning, have not been calculated. Twenty of 25 major seasonal allergens in Australia are introduced species (mostly grasses).[46]
- Costs to the community include voluntary weeding effort for bush regeneration projects, worth many millions of dollars annually (see Section 8.3).
- Other uncosted impacts include loss of ecosystem services due to environmental degradation and increased fire hazards due to weed invasion.

Invasion drivers – new introductions and propagule pressure

Profit motivated firms meet this demand by efficiently finding, selecting, breeding, propagating, distributing, cultivating, and promoting a wide variety plants for ornament, food, and medicine. Their objective is to introduce as many plant products with commercially desirable traits to as many buyers in as broad a market as possible.

... novelty can produce premiums for the [horticultural] industry, so there is a constant pressure for breeders and plant explorers to produce new plant cultivars.

Jennifer Drew, Neil Anderson and David Andow, weed researchers, 2010[47].

The majority of weeds in Australia have been deliberately introduced, at least two-thirds as garden plants.[48] The more new plants introduced to NSW, the higher is the risk of new weeds, unless new introductions are limited to those assessed as low risk. With a strong commercial focus on product novelty in the garden industry, there is unrelenting pressure to introduce new species and cultivars.

Since 1997, new species proposed for import into Australia have been required to undergo risk assessment, which greatly reduces the risk of new invasive plants being imported. However, with about 30,000 exotic plant species already in Australia,[49] more than 99% of which can be grown in NSW without legal restrictions, and almost no restrictions on

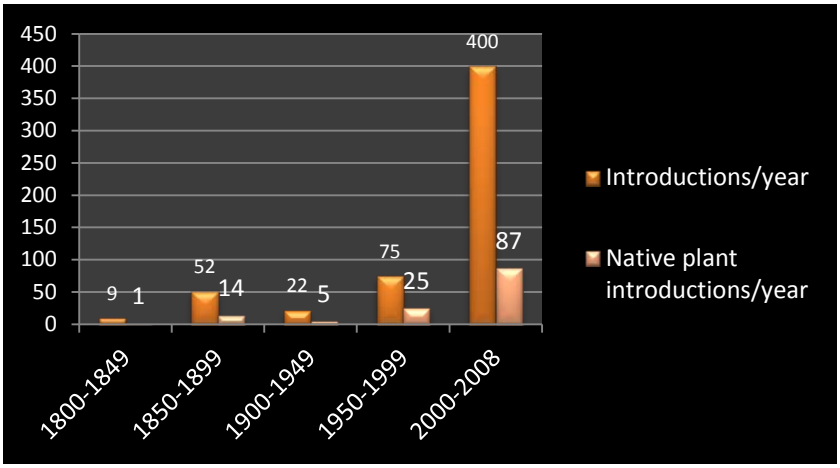
42 Sinden, Jones et al. (2004)
43 NSW Farmers Association (nd); NSW Government (nd)
44 Australian Bureau of Statistics (2008).
45 Groves, Hosking et al. (2003)
46 Australian Academy of Science (nd)
47 Drew, Anderson et al. (2010).
48 Groves and Hosking (1997): 65% of plant species that naturalised between 1971 and 1995 were introduced as ornamental plants.
49 Randall (2007); DAFF (2009)

plants native to other parts of Australia, there is already a very large pool of invasive and potentially invasive plant species in the country. As new species are introduced into NSW or into new regions in NSW without risk assessment, some proportion will eventually establish and invade.[50]

New introductions

- The rate of new introductions for cultivation has increased in NSW. Plants newly recorded as nursery stock in NSW averaged 400 taxa/year from 2000-2008 compared to 75/year from 1950-1999 (see Figure 4).[51]
- Native Australian species have accounted for about one-quarter of total cultivated plant introductions to NSW (some of which are invasive). Numbers of Australian taxa newly available as nursery stock in NSW have increased from an average of 25/year in 1950-99 to 87/year in 2000-2008, although their proportion of total new nursery stock has declined from 33% to 22%.[52] (Myrtle rust is likely to have further reduced this proportion.)
- About one-quarter (27%) of nursery stock introductions to NSW from 1998-2007 were of taxa newly introduced as nursery stock in Australia.[53] Therefore the greatest introduction pressure, three-quarters of new taxa, derives from taxa already in cultivation in Australia. This is considerably higher than in the decade prior to implementation of federal risk assessment in 1997, when about half of new introductions to NSW were new nursery stock for Australia, including both imported and native species.

FIGURE 4. PLANT TAXA (INCLUDING NATIVE SPECIES) NEWLY RECORDED AS NURSERY STOCK IN NSW (ASSUMED TO BE TIME OF FIRST CULTIVATION) [54]



Introductions of known weeds

- Of the 3802 plants newly introduced as nursery stock in NSW from 1998-2007, 20% have been recorded as naturalised somewhere in the world, including 2% in Australia, and 3% (120 taxa) have been recorded as invasive (high impact weeds).[55] The majority of known invasive taxa (95%) had already been introduced as nursery stock elsewhere in Australia prior to introduction in NSW in 1998-2007, suggesting that the main introduction risk derives from plants already in Australia rather than new imports, to be expected following the implementation of federal quarantine risk assessment in 1997.
- Federal quarantine risk assessment implemented in 1997 has not slowed the rate of new plant introductions to NSW, but has reduced the introduction of known weeds. From 1988-97, 1211 taxa were newly introduced as nursery stock, 140 (12%) of which are known to be invasive. Form 1998-2007, about three times as many taxa were introduced (3802 taxa), of which 120 (3%) are known to be invasive.[56]

50 Based on Australia-wide historical trends, more than 10% of new introductions are likely to naturalise and at least a third of these are likely to have a significant adverse impact on biodiversity.
51 Calculated based on data from DAFF (2009).
52 Calculated based on data from DAFF (2009).
53 Calculated based on data from DAFF (2009).
54 The Census of Cultivated Plants (DAFF 2009) includes data on the earliest year of introduction for each species, and was compiled from public domain sources "including over 600 Plant Nursery Catalogues spanning 200 years, Botanical and major Garden plant species lists, Australian Quarantine and Inspection Service permitted import list, State Department vegetation surveys and Commonwealth lists of imported species."
55 Calculated based on data from DAFF (2009).
56 Calculated based on data from DAFF (2009).

There is a high risk that introduction of new subspecies, cultivars and hybrids of species already in cultivation will facilitate new invasions or exacerbate the invasiveness of existing weeds. Plant breeders in Australia and overseas are developing new varieties of already weedy species to increase productivity or tolerances (eg. of drought, frost, salinity) or for ornamental novelty. This is likely to exacerbate their weed threat, and could in some cases create superweeds.[57] Some of Australia's worst weeds (lantana and blackberry, for example) have high genetic variability due to multiple introductions.

New genetic material for existing weedy species

- Of NSW's 340 environmental weeds ranked by Downey et al. (2010), almost half (148, 44%) are permitted imports, including 47 serious weeds, allowing for continued introduction of new genetic material from overseas. Of the 340 environmental weeds, almost 90% can be sold or planted in part or all of NSW, allowing for the introduction of new genetic material from elsewhere in Australia.
- From 2000-2010, new cultivars for at least 17 of NSW's environmental weeds (5% of the total listed by Downey et al. 2010) were registered as new plant breeds in Australia.[58]

Increased propagule pressure

Although worldwide modifications of natural communities caused by biological invasions have already occurred, it is probable that the major convulsion is still in store. The fact that the tree species causing the most serious problems are often those planted most widely and since the longest time supports this pessimistic conclusion...

Petit, Bialozyt et al. (2004)

One of the most robust emerging generalizations in invasion biology is that the probability of invasion increases with the time since the introduction (residence time).

Richardson and Pysek (2006)

There is a very strong correlation between propagule pressure[59] (introduction pressure) and weed invasion: the more individuals released or the more frequent the release events, the greater is the likelihood of a species' establishment and invasion. For example, the more popular ornamental trees planted in south-eastern Australian cities are more likely to have naturalised than those that were less popular.[60] A British analysis found that ornamental species that had escaped from cultivation were more frequently available and sold at lower prices than those that had not escaped.[61] Residence time is one aspect of propagule pressure: the longer an exotic species has been present in a region, the more likely it has been planted multiple times in multiple locations, and the more propagules it has been able to produce.[62] Invasive weeds in Australia have been resident longer than plants that have naturalised but are not invasive.[63]

As the majority of NSW's exotic plants in cultivation have been introduced in recent times, the strong correlation between propagule pressure and invasion implies that weed problems will escalate as more species establish and invade. It implies that a priority goal of biosecurity policy should be to limit the frequency of introductions and the extent of planting of invasive and potentially invasive species.

The major sources of propagule pressure derive from legal sales of permitted weedy plants. There are likely to also be illegal and accidental introductions, greatly facilitated by internet and mail order sales. One test of this in the United States found that more than 90% of orders for prohibited aquatic plant species were met and that more than 90% of orders contained a plant or animal species not requested, including noxious weeds. There were misidentified plants in 18% of orders and unordered seeds in 43%.[64]

57 Lowe (2009); Booth (2009)
58 Sourced from Plant Breeders Rights database at <pericles.ipaustralia.gov.au/pbr_db/> (Accessed August 2011)
59 Propagule pressure is a measure of the numbers of an exotic species introduced, incorporating both the number of release events and the number of individuals in any one introduction.
60 Mulvaney (2001).
61 Dehnen-Schmutz, Touza et al. (2007); Dehnen-Schmutz, Touza et al. (2007)
62 Rejmarek (2000); Richardson and Pysek (2006); Phillips, Murray et al. (2009)
63 Phillips, Murray et al. (2009)
64 Maki and Galatowitsch (2004)

Cultivation of existing weeds (adding to propagule pressure)

- The propagule pressure for many of NSW's environmental weeds is increasing due to continued sale and planting. About 90% of the 340 environmental weeds rated by Downey et al. (2010) can legally be sold in part or all of NSW: just 40 (12%) are banned for sale across NSW (others are no longer in fashion or are not desired for cultivation). 80% of environmental weeds rated a moderate to extreme threat can be sold in part or all of NSW. (Information current to 2011.)
- A cursory search of Australian plant catalogues on the internet in July 2011 found listings for 60 (18%) of the 340 environmental weeds ranked by Downey et al. (2010), including for 26% of those rated a high-extreme environmental threat. Other weedy species are sold privately at markets and fairs and on the internet.

Relationship between time of introduction and invasiveness

- More than two-thirds (68%) of NSW's environmental weeds (the 340 rated by Downey et al. 2010) were first introduced to NSW more than 50 years ago and about half (49%) were introduced more than a century ago.[65] This implies there is likely to be a substantially greater environmental weed flora in future as some proportion of more recently introduced species becomes invasive.
- Of plants introduced more than 50 years ago, an average 4-6% have become environmental weeds in NSW, with 6.4% of those introduced more than 150 years ago now environmental invaders. In contrast, 1.5% of plants introduced in the past 50 years have so far become environmental weeds.[66] If the rate at which introduced plants become invasive remains constant at 4-6%, many hundreds more will become environmental weeds; even an invasive rate of just 1% would triple the current number. The stricter federal quarantine system implemented in 1997 should eventually reduce the rate of new invasions, but there are thousands of invasive species already in Australia that can be newly introduced to NSW.[67]
- The relationship with time since introduction is even more pronounced for NSW's most serious environmental weeds (those rated by Downey et al. 2010 as moderate-extreme threats): 58% were introduced more than a century ago and 79% more than 50 years ago. This is indicative of a strong relationship between propagule pressure and invasion,[68] and implies that some current lower threat environmental weeds are likely to more serious threats over time.
- NSW's worst environmental weeds were introduced on average earlier than the least worst. The average introduction year for the 50 most serious environmental weeds was 1891 (120 years ago) compared to 1928 for the least worst 50 rated by Downey et al. 2010 ($p<0.0037$).[69]
- Of plants introduced more than 50 years ago, an average 2-3% have become serious environmental weeds in NSW, with 3% of those introduced more than 150 years ago now rated a moderate-extreme threat by Downey et al. (2010). In contrast, 0.4% of plants introduced in the past 50 years have so far become serious environmental weeds (Figure 5, Figure 6).[70] If the rate remains constant over time, the number of serious environmental invaders in another 50 years would almost double (the 1997 quarantine reforms and a higher rate of state declarations should reduce the rate).

65 Calculated based on data from DAFF (2009).
66 Calculated based on data from DAFF (2009).
67 Phillips, Murray et al. (2009)
68 This is consistent with Phillips, Murray et al. (2009), who compared the residence time of 133 invasive species and 335 non-invasive naturalised species, finding that that invasive weed species were significantly more likely to have been resident in Australia for a longer period of time than non-invasive species. Another factor could be that species introduced earlier during colonisation are more invasive than those introduced later. There is no evidence on this issue. On the other hand, there is considerable other evidence to support the proposed relationship between length of residence time and invasion success. Phillips et al. also found a higher rate of invasion in Australia by plants from South America compared to those from other continents, and that South American invasions had been resident for shorter times than others. With more introductions in recent times from South America, this could see invasion rates increasing over the next few decades
69 Calculated using data from DAFF (2009).
70 Calculated using data from DAFF (2009).

FIGURE 5. THE TIME OF INTRODUCTION OF ENVIRONMENTAL WEEDS RANKED BY DOWNEY ET AL. (2010) [71]

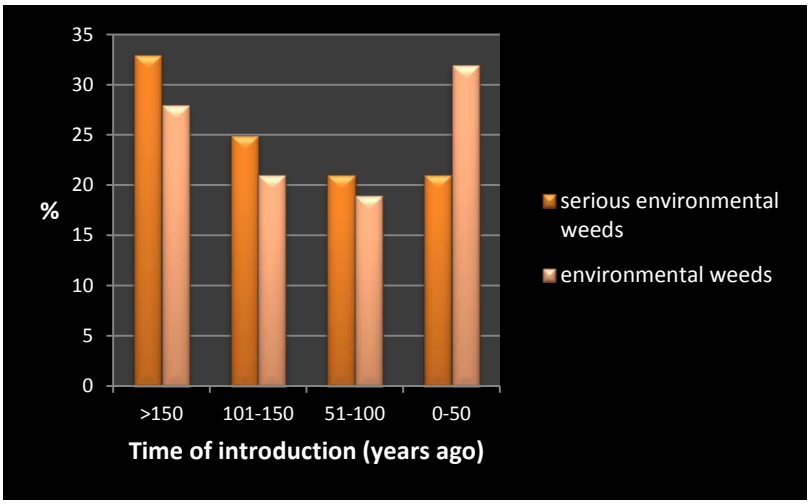
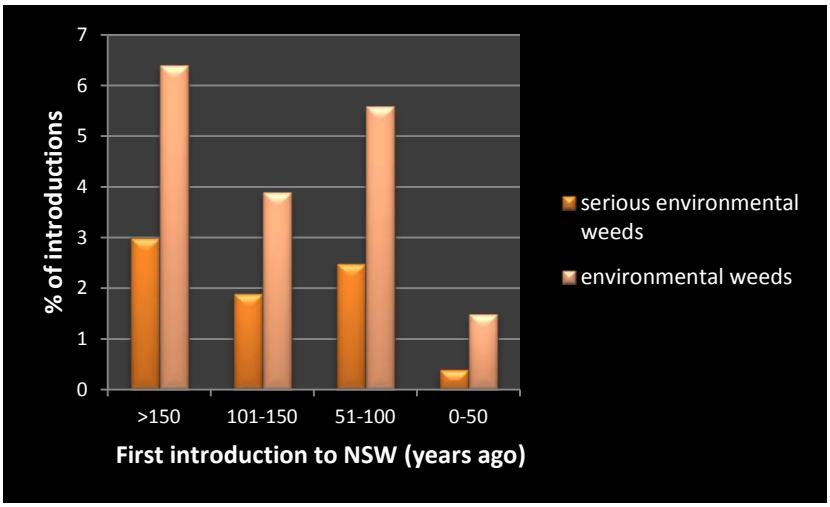


FIGURE 6. THE PROPORTION OF INTRODUCED SPECIES THAT HAVE BECOME ENVIRONMENTAL WEEDS (THOSE RANKED BY DOWNEY ET AL. 2010) OVER TIME[72]



Invasion pressures – disturbance, climate change etc

Although clearing may be slowed and fragmentation reduced, pressures on vegetation condition are still likely to increase in future due to further weed invasions and new weed incursions, the increasing effects of climate change and related changes to fire regimes. These threats are less predictable and more pervasive in nature, and hence harder to manage and plan for, than are controls on clearing.

NSW State of the Environment Report 2009

Disturbance of natural ecosystems facilitates weed invasion (although weeds also invade undisturbed areas).[73] Clearing, logging, nutrient addition, inappropriate fire regimes, and grazing, as well as natural climate events, create opportunities for weeds to establish and spread (sometimes removal of grazing also facilitates spread due to diminished weed control). A large proportion of NSW's vegetation cover has been cleared or substantially disturbed, one reason for the severe weed problems. Weed invasion can increase fire risk, promoting a fire-invasion cycle that

71 Downey et al. (2010); DAFF (2009) (for time of first introduction to NSW). The 'serious' weeds refer to those ranked by Downey et al. as 'moderate' to extreme'.
72 Data from Downey et al. (2010) (list of environmental weeds) and DAFF (2009) (time of first introduction of cultivated plants in NSW). The 'serious' weeds refer to those ranked by Downey et al. as 'moderate' to extreme'.
73 Department of Environment and Conservation (2006)

favours weed spread.[74] Some of NSW's most serious weeds both promote and benefit from fire, including gorse and coolatai grass.

Climate change is likely to increase weed establishment and spread.[75] Many weeds are mobile, opportunistic and tolerant of a wide range of climate conditions. Warmer temperatures will increase the potential range for some species, including in alpine areas. More extreme weather events could spread weeds: droughts by creating bare patches for weed colonisation and floods and storms by carrying propagules into new areas. Changed fire regimes and carbon dioxide fertilisation are also likely to benefit some weeds at the expense of native species. Human responses to climate change, such as the promotion of hardy, drought-tolerant garden and pasture plants and cultivation of biofuels, could also foster new weed problems.[76]

Trends in vegetation, population, fire regimes, grazing, climate change

- Just 11% of native vegetation in NSW remains relatively intact (the lowest proportion of all Australian states); more than half (58%) has been replaced or transformed, and 30% has been modified (Table 2). This high level of disturbance provides for high susceptibility to weed invasion. Land clearing is ongoing.
- Higher population in NSW – currently more than 7 million and projected to reach more than 10 million by mid-century[77] – is likely to drive some of these disturbance trends.
- More than 80% of NSW's vegetation classes are affected by altered fire regimes. From 1999-2009, the impacts worsened in four classes, remained unchanged in 79 classes and improved in one.[78]
- Two-thirds (66%) of NSW's vegetation classes are affected by overgrazing. From 1999-2009, this pressure increased in 24 classes (24%), remained the same in 34 classes (34%) and decreased in four classes. Recently, there has been 'increased pressures to overgraze' due to drought, especially in southern NSW.[79]
- Global greenhouse gas emissions are increasing at a rate beyond the highest scenario envisaged by the Intergovernmental Panel on Climate Change, and there is no sign of effective mitigation action. The average annual temperature in NSW has been increasing, with an annual average temperature rise of about 0.1°C per decade during 1950–80 and about 0.5°C per decade from 1990.[80]

TABLE 2. STATE OF NSW'S VEGETATION[81]

0.6% (residual bare): Areas where native vegetation does not naturally persist.
11.2% (residual): Native vegetation community structure, composition, and regenerative capacity is intact —no significant perturbation from land use or land management.
29.6% (modified): Native vegetation community structure, composition and regenerative capacity is intact—perturbed by land use or land management practice
46.1% (transformed): Native vegetation community structure, composition and regenerative capacity is significantly altered by land use or land management.
12.2% (replaced): Native vegetation has been replaced by weeds or cultivated species.
0.3% (removed): Vegetation has been removed.

74 D'Antonio and Vitousek (1992).
75 Invasive Species Council (2010)
76 Low (2008); Invasive Species Council (2010)
77 Australian Bureau of Statistics (2008)
78 NSW State Government (2009).
79 NSW State Government (2009).
80 NSW State Government (2009).
81 Lesslie, Thackway et al. (2010)

2. Recognise weeds as a state environmental priority

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)[82]

The naturalised flora of Australia has received scant attention. In particular, there has been a general lack of concern about new naturalisations. Attention has traditionally focused on 'known' weedy species, and then frequently on weeds of agriculture.

NSW botanists Hosking, Conn et al. (2003)

Environmental weed invasions are one of NSW's most severe environmental threats and also one of the most difficult to manage. One impediment to developing solutions is the historical focus on just economic weeds. Weed threats to the environment are now recognised and weed programs target both environmental and agricultural weeds but much of the structure, and many concepts and processes are still shaped by the historical agricultural focus, including the concept of 'noxious' weeds, the main weed legislation and governance structures. There needs to be much more state priority accorded to environmental weed threats and greater recognition of the distinctions between environmental and agricultural weed challenges, with natural ecosystems far more complex and less well known than agricultural systems.

2.1 The need for a dedicated environmental focus

The approach used to manage biosecurity risks to human health, food safety and the environment (including aquatic environments) needs to be consistent with the approach used to address risks that primarily affect the agriculture sector. However, comprehensive analysis will be required to guide precisely the measures to be applied along the continuum against specific risk pathways.

Beale review of biosecurity (2008)[83]

We support a 'one biosecurity' (cross-sectoral, cross-jurisdictional) approach to biosecurity but this requires recognition of the distinctive requirements of environmental biosecurity. Many invasive species have both economic and environmental impacts, and sometimes social impacts as well, warranting a joint approach. But protecting the natural environment differs in many ways from protecting industry assets and requires a distinctive ecologically based approach to biosecurity. Environmental biosecurity cannot just be a bolt-on to existing industry approaches. Here are some of the ways it differs.

The values to be protected – biodiversity and environmental health: Conservation requires a biosecurity focus on the hundreds of thousands of species, from microbes to macropods, and their populations and interactions that constitute ecosystems and ecosystem processes. In contrast, industry biosecurity is mostly focused on protecting particular species that are of economic value and number no more than a few dozen (except for the nursery industry which uses a wider range of species). The values at stake in conservation are mostly not replaceable whereas species or cultivars of value to industry can usually be replaced by new breeds or new enterprises.

Invasive species threats – scale and complexity: Because of the diversity of taxa, ecosystems and ecosystem processes to protect, there are far more invasive species that are of threat or potential threat to environmental values than production values. Many of them derive from or are introduced along with species introduced for economic purposes. The threats are more complex for they involve direct and indirect impacts arising from interactions between species, changes in ecological processes (such as fire regimes and carbon sequestration), and interactions with other threats.

State of knowledge: Much more is known about cultivated plants used in production and the invasive threats to them than about biodiversity and invasive species threats. The lack of knowledge about our native biota means that most invasive species impacts are not documented or monitored.

Predictability and timeframes: While impacts on individual cultivated species can be predicted with reasonable accuracy, there are high levels of uncertainty in predicting impacts in the natural environment due to complex

82 Department of the Environment (2008)
83 Beale, Fairbrother et al. (2008)

interactions, long timeframes (millennia) and lack of knowledge. Many impacts are synergistic with other existing and emerging threats. Climate change in particular increases the likelihood of previously benign species causing harm. Invasive impacts may not be observed for decades due to lag effects, lack of monitoring or their insidious nature. The combination of great uncertainties, long timeframes and limited management options warrants a highly precautionary approach in environmental biosecurity.

Management approaches and options: There are many more management options in relatively simple, delimited agricultural systems than there are in complex natural environments. Weeds cannot be controlled with broadacre mechanical or chemical control methods in many natural situations. Most post-border biosecurity policy focuses on controlling or proscribing a small subset of invasive species that are causing proven harm, which is inconsistent with ecological uncertainties and complexities. There are commercial incentives for industry management of invasive species but environmental biosecurity relies on government and community investment for the public good.

Stakeholders and resources: A multitude of stakeholders, often with conflicting agendas, make environmental biosecurity a much more socially and politically challenging policy area than industry biosecurity. Commercial incentives and government support also mean that industry biosecurity is much better resourced than environmental biosecurity. It is in the public interest for governments to invest in increasing the capacity of the community, including environmental NGOs, to fully participate in biosecurity.

Weeds are what is known as a 'wicked' problem: complex with no total solutions, engendering value conflicts, requiring multiple actions now to prevent damage that might not manifest until far in the future.

Stopping NSW's Creeping Peril 2010[84]

Recommendations

Environmental focus: Recognise the distinctive challenges of environmental weed management and develop policies and programs accounting for those distinctive features.

Solutions forum: Establish a high level cross-disciplinary 'solutions forum' to develop new approaches to high priority environmental biosecurity challenges, including ecological, social, legal and economic aspects.

Environmental reporting: Using state of the environment approaches, document in detail NSW's environmental weed problems, including impacts, trends and drivers, and issue regular updated reports. Require consistent reporting by public authorities and bodies using a standard methodology so that trends can be analysed over time.

2.2 Weed laws as environmental law

Although weeds are one of the greatest threats to the natural environment, the current weed law – the *Noxious Weeds Act* 1993 – lacks important elements of best practice environmental law and needs more tools and accountability to achieve the desired reduction in environmental weed impacts. There have been some substantial reforms in weed law and policy – such as risk assessment, regional weed planning and more flexible weed classes – but the focus is still mostly limited to restrictions on and control of a small subset of harmful weeds (those declared noxious), important risks are neglected and best practice elements of other environmental laws are missing. Under the existing regime, people are entitled to sell and plant hundreds of different species that will spread into bushland, and manage land in a way that guarantees weed invasion and the exacerbation of already severe problems. Under this regime, the public interest in a healthy environment is often given much less weight than private interests in selling and planting harmful weeds.

ESD and biodiversity conservation: As the Noxious Weeds Act is the main legal instrument for managing one of NSW's most serious environmental problems, it (or a replacement biosecurity law) should employ the most effective elements of environmental law. We recommend that its objects include ecologically sustainable development (ESD) and biodiversity conservation, and promote the use of a wide variety of mechanisms to achieve the objects.

As law academic Doug Fisher points out, sustainability 'in one form or another is the fulcrum around which environmental law is evolving and it is the nature of sustainability that is forcing environmental law to adopt new

84 Invasive Species Council (2010)

approaches and new mechanisms'.[85] Weed laws should be made consistent with other state environmental laws[86] by including ESD in its objects, with ESD defined to include its four well-recognised elements: the precautionary principle, intergenerational equity, conservation of biodiversity and ecological integrity, and improved valuation, pricing and incentive mechanisms. These principles are integral to sound decision-making about the environment and highly pertinent to weeds; for example, there is typically a lack of scientific certainty about the likely impacts of weeds, the impacts are often not suffered until generations after a plant is introduced and they add substantially to the costs to be borne by future generations. The Australian Weeds Committee recommended that weed **l**egislation should include a precautionary approach.[87] This proposal should not be controversial. The NSW Government formally committed to incorporating ESD principles in the 1992 Intergovernmental Agreement on the Environment, as defined in the National Strategy on Ecologically Sustainable Development 1992. Many pieces of NSW legislation include ESD in the objects, and it has a considerable history of case law in NSW and elsewhere.

Of course, there is often a large gap between the rhetoric of ESD and its application. Simply adding ESD to the objects of the Noxious Weeds Act (or replacement biosecurity legislation) won't improve practices unless its various aspects are implemented through regulation and policy and are enforceable. ESD and its principles should be clearly defined in the Act and reference made to them where they are applicable in specific provisions. Here are some examples of where ESD principles are applicable.

The precautionary principle should be applied to risk assessments and decisions about declarations, as there is often little information about the potential invasiveness of a plant and the potential for harm, particularly if it is new to cultivation. An effective permitted list approach is inherently precautionary in preventing plant introductions unless assessed as low risk. The looming threat of climate change increases uncertainty about future weed impacts and should be an explicit consideration in decisions under the Act.

Intergenerational equity is a highly pertinent consideration for declaration decisions, with deficiencies of present control programs and regulatory restrictions leading to a much greater weed burden in the future. Governments tend to be loathe to ban or restrict use of invasive plants with current commercial value but typically discount future economic interests. Most plants with commercial value in the present will have no or little commercial value in future and/or the costs of control will outweigh their commercial value. It is an important consideration in managing the cultivation of invasive species as the full impacts of escaped weeds are unlikely to be observed for generations. Potential impacts on future generations should be reflected in penalties for breaches of the Act.

Conservation of biodiversity and ecological integrity requires according appropriate priority to weeds that threaten these values (currently most weeds threatening biodiversity are not regulated at all); taking a landscape approach (eg. through regional weed plans); considering ecosystem processes, cumulative impacts and interactions with other threats (including climate change); regulating land management that exacerbates weed-mediated threats; and ensuring that weed control and particular control methods do not themselves threaten biodiversity or exacerbate ecological harm.

Improved valuation, pricing and incentive mechanisms are vital for weed management, as currently most weed costs are externalised (borne by the public or the environment) and there are few economic incentives requiring people to take responsibility for other than a small proportion of harmful weeds. ESD warrants application of the polluter pays principle, eg. in the form of levies or bonds for plants with invasive risk. It requires that both long-term and short-term economic outcomes be considered in declaration decisions.

Mechanisms: Currently, the objects of the Noxious Weeds Act limit it to 'establishing control mechanisms' as the means to reducing the negative impacts of weeds. This could be construed to exclude mechanisms such as mandatory labelling, bonds and levies, and limiting levels of disturbance. We recommend that the mechanisms by which the Act achieves impact reduction be left open to provide for use of diverse tools.

Recommendations

ESD: Include ecologically sustainable development in the objects of the Noxious Weeds Act (or replacement biosecurity law), requiring that ESD principles be applied. Define ESD to include standard ESD principles (precautionary principle, intergenerational equity, conservation of biodiversity and ecological integrity and improved valuation, pricing and

85 Fisher (2003)
86 Including Environmental Planning and Assessment Act 1979, Protection of the Environment Administration Act 1997.
87 Australian Weeds Committee (2002)

incentive mechanisms) (eg. as in s 6(2) of the *Protection of the Environment Administration Act* 1997). Develop policy to explicate how ESD and its principles should be applied under the Act.

Mechanisms: Change the objects of the Noxious Weeds Act (or replacement biosecurity law) to allow for a wide array of mechanisms (including economic, educational and control) to be used to achieve the objects (this requires replacing 'control mechanisms' with 'mechanisms' in the existing object).

3. Make prevention a priority

Currently, several thousand plant species persist as ornamentals or as naturalised populations in urban settings. They represent a vast reservoir of potential future problems. Movement of these species within Australia is effectively unconstrained and response to the issues they raise varies substantially between the States and Territories.

Alan Hawke, independent review of the EPBC Act 2009[88]

Turn the tap off before you mop up the spill: The development of a list of permitted, non-invasive taxa … could represent the most effective and timely response to the immediate threat posed by thousands of potentially invasive and unrestricted plant species.

Steve Csurhes, Rod Randall, Christian Goninon, Alice Beilby, Stephen Johnson and John Weiss, (state government weed policy officers from Qld, WA, Tas, NT, NSW, Vic) 2006[89]

The majority of weeds in NSW have been deliberately introduced, as garden or agricultural plants, without risk assessment. Since 1997, new species proposed for import into Australia have been required to undergo risk assessment, which greatly reduces the risk of new invasive plants being imported. However, with about 30,000 exotic plant species already in Australia, more than 99% of which can be grown in NSW without legal restrictions, there is already a very large pool of invasive and potentially invasive plant species in the country. Of these, thousands are weedy overseas or in other parts of Australia, but have not (yet) established in NSW. As new species are introduced into NSW or into new regions in NSW without risk assessment, some proportion will eventually establish and threaten biodiversity (and agriculture).[90]

Box 2. New cultivars of invasive perennial grass pastures

Invasive perennial pasture grasses are listed as a key threatening process in NSW. New exotic pasture varieties should receive particular attention because they can be planted on a very large scale, providing strong propagule pressure. Pasture researchers have predicted that breeding programs in the four major exotic perennial pasture grasses – phalaris, tall fescue, cocksfoot and perennial ryegrass – will result in new cultivars to increase productivity and adaptation to more soil, climatic and/or grazing management conditions.[91] More drought-hardy forms will be selected. There is also the potential for genetic engineering for traits such as pest and disease resistance. The researchers predicted that areas sown to phalaris and tall fescue may increase 2- to 4-fold over coming decades. Three of the four species are already amongst the environmental weeds identified by Downey et al. (2010). These species occupied more than 7% of the area used for pasture in NSW in 1997.[92]

There is also a high risk that new cultivars of species already in cultivation will increase problems. Plant breeders in Australia and overseas are developing new varieties of already weedy species to increase productivity or tolerances (eg. of drought, frost, salinity, see Box 2) or for ornamental novelty. This is likely to exacerbate their weed threat, and could in some cases create superweeds (Box 3).[93]

Box 3. The invasive risks of new plant cultivars[94]

…in most cases super weeds become a problem after multiple introductions from different sources. By combining this genetic variation, new genetic mutations can arise that can give the alien species the potential to adapt and turn super-invasive.

Andrew Lowe, University of Adelaide [95]

Plant breeders in Australia and overseas are developing new varieties of already weedy species to increase their productivity or tolerances (eg. of drought, frost, salinity). This is likely to exacerbate their weed threat. A kikuyu grass (*Pennisetum clandestinum*) breeding program, for example, is aiming to produce varieties that have shade and drought tolerance and better disease resistance.[96] Kikuyu is an environmental weed, one of the

88 Hawke (2009)
89 Csurhes, Randall et al. (2006)
90 Based on Australia-wide trends, more than 10% of new introductions are likely to naturalise and at least a third of these are likely to have a significant adverse impact on biodiversity.
91 Oram and Lodge (2003)
92 Pearson, Brown et al. (1997)
93 Lowe (2009); Booth (2009).
94 See Booth (2009) for more information.
95 Lowe (2009).
96 Morris (2007).

exotic perennial grasses listed as a key threatening process in NSW, and a risk for at least 16 threatened species in NSW.[97] But because kikuyu is not declared noxious anywhere in Australia, new variants can be introduced without risk assessment.

New variants can also increase invasion risk by introducing greater genetic variability and facilitating reproduction. In Australia, pampas grass (*Cortaderia selloana*) was not a major weed for decades because all the plants in gardens were female. When a new colour variant was imported, a hermaphrodite, pampas grass began setting seed and became a serious environmental weed.

3.1 A systematic, risk-based approach to prevention

Although not much heralded, one of Australia's greatest ever environmental (and agriculture) advances was the 1997 reform of federal quarantine to require risk assessment of new exotic species proposed for import into the country. This has since prevented the importation of more than 1500 potential new plant invaders.[98] But if a potentially invasive plant species is already in Australia, it is not usually subject to federal risk assessment, and unless it is banned by particular states or territories it can be freely introduced into new areas – except in Western Australia, which requires risk assessment of new introductions.

Fewer than 200 weed species are currently regulated in some way in some part of NSW. All the other 30,000 or so exotic plant species in Australia[99] can be freely sold and planted in NSW. More than 5% are already established in the wild in NSW. Another 5% or so are established elsewhere in Australia but not in NSW, and another 20% or so are weedy in other parts of the world, suggesting a potential for weediness in Australia. In addition, new invasive varieties of most existing weeds can be bred and released without a risk assessment. There are also more than 12,000 native Australian taxa in cultivation,[100] some proving invasive outside their natural range. The permissive approach to exotic plant species – allowing free movement of all but a small proportion – guarantees that new weeds will continue to establish.

The only feasible way to prevent most new weed problems is to assess the weed risk of plants proposed for introduction into new areas, and permit the sale and movement only of those that present a low risk.[101] This approach already operates for proposed new introductions to Australia (from overseas) and to Western Australia. It involves establishing a permitted (or a 'safe') list of taxa and prohibiting or requiring risk assessment of taxa (species, subspecies and variants) not on that list. A complementary prohibited list identifies plants that do not pass the risk assessment or that are already declared and prohibited.

All proposed introductions of plants not indigenous to NSW should be assessed for weed risk. This includes plants native to Australia but proposed for planting outside their natural range. Native weeds like golden wreath wattle (*Acacia saligna*) can be just as invasive as exotic weeds. Assessment should also apply to new varieties of existing introductions that could increase the weed risk.

A permitted list approach is the only feasible way to achieve the first goal of the NSW's Invasive Species Plan 2008-2015 'exclusion, to prevent the establishment of new invasive species', explained thus:

> *The most effective way to minimise the impacts of invasive species is to prevent their initial incursion. The challenge is to identify species, thoroughly assess potential invasiveness and implement effective barriers to prevent their establishment.*

The permitted list approach is based on a straightforward concept applied to many other types of goods – don't permit the sale or movement of plants unless they meet safety standards (biosecurity safety). It is required, for example, that all foods and toys meet legislated safety standards. There is strong support for a 'safe' list approach by many environment NGOs, bush regeneration groups, regional weed committees and local governments, as exemplified by the more than 40 groups that endorsed the *Stopping NSW's Creeping Peril* report attached to this submission, and from within biosecurity agencies, as exemplified by a 2006 paper by biosecurity officers from six states recommending it.[102]

97 Coutts-Smith and Downey (2006).
98 Riddle, Porritt et al. (2008). This includes species rejected and species requiring further evaluation. With no protocol for further evaluation, this amounts to at least a temporary refusal.
99 Randall (2007); DAFF (2009)
100 DAFF (2009)
101 Csurhes, Randall et al. (2006); Invasive Species Council (2009)
102 Csurhes, Randall et al. (2006)

NSW should work with other state/territory governments, particularly Victoria, Queensland and the ACT, to promote the adoption of a permitted list approach across all states, with consistent mechanisms. This would reduce confusion for plant industries and increase efficiency (allowing states to share resources). The proposal could be adopted by the Council of Australian Governments, as part of implementing recommendation 23(1) of the Hawke review of the EPBC Act: 'the Council of Australian Governments (COAG) develop criteria and management protocols for the movement of potentially damaging exotic species between State and Territories, working towards a list of 'controlled' species for which cost-effective risk-mitigation measures may be implemented.' However, this should not delay NSW's development and implementation of a permitted list approach. It is more likely that other states would follow NSW in adopting the approach.[103]

There will of course be objections raised to the safe list concept, including probably perceived problems of cost, feasibility and impacts on industry. It is important to examine how the system works in Western Australia but the system would be different in NSW because of the different circumstances applying at the NSW border. Western Australia has a commendable focus on border inspections, requiring imported plants to be inspected at a bonded warehouse facility in Perth and be treated for pests and diseases. This wouldn't be feasible for NSW. Just as occurs for many other goods, enforcement of standards would have to depend on audits of plants for sale and public reporting of breaches. There would have to be a phase-in of the approach to allow for adjustment. There will be costs involved in the setup and for enforcement, but any cost-benefit analysis should find the public benefit and economic gains far outweigh the costs.

Recommendations

Risk assessment for new introductions: Adopt a permitted list approach, requiring risk assessment of all new non-indigenous taxa not on a permitted list and allowing the sale and movement only of low-risk plants. Apply risk assessment to distinguishable variants of already introduced species to prevent the introduction of more invasive cultivars and hybrids and to limit the potential for combination with existing varieties to increase invasive risk.

Existing introductions: Apply risk assessment to already introduced species as basis for determining their status: regulatory (eg. prohibited, restricted, permitted) and management (eg. subject to eradication, containment, threat reduction, no control).

Risk assessment protocols: Use protocols that can be applied rapidly and are scientifically valid, precautionary and take climate change into account.

3.2 Surveillance and rapid response

Another aspect of prevention is surveillance focused on high-risk pathways for the deliberate or accidental introduction of new potential invaders. One important domain for surveillance is Internet sales. There need to be well-promoted ways for the public to report plants of potential concern, and there may be potential to develop community bio-surveillance within particular groups (bushwalkers, grey nomads for example) to assist in early detection of new invaders. Government capacity to respond rapidly – logistically and legislatively if need be – to eradicate or remove plants and prevent their sale or movement should be audited.

Recommendations

Surveillance: Identify high risk pathways for new unsafe introductions and develop surveillance programs, including for internet sales. Develop and promote ways for the public to report suspect new plant introductions and incursions. Investigate the potential to develop community bio-surveillance.

Response: Improve the early response capacity to deal quickly and effectively with introduction or naturalisation of potential new weeds.

103 For more details about a permitted list approach, see ISC (2009) backgrounder.

4. Strengthen environmental weed management

There is broad recognition that NSW is losing the fight against weeds…
Local Government Association of NSW and Shires Association of NSW (2009)

4.1 Systematic, science-based weed declarations

The declaration of weeds should be systematic and transparent, based on criteria consistent with ESD and based on advice by a scientific committee that includes ecologists. The required management response can then be determined – eradication, containment, control to protect particular assets – taking into account non-biological factors such as feasibility and landholder capacity.

There should be more comprehensive and rapid use of declarations to reduce the spread of weeds. The majority of environmentally harmful weeds have no formal weed status and can continue to be traded and planted, including into non-invaded areas. Of 340 environmentally significant weeds ranked by NSW Government officers in 2010,[104] about 90% can be sold in all or part of NSW, including 80% of those ranked a moderate to very high threat/ability to impact on biodiversity. This facilitates higher propagule pressure, introduction into new areas and introduction of new (potentially more invasive) varieties. The same issue applies to many agricultural weeds as well.

Declaration processes are often slow, sometimes taking more than three years. As the Sydney Weeds Committee has pointed out, the current process is too administratively burdensome, using up resources that could be devoted to control and permitting spread during long declaration processes.[105] It is also unsystematic and lacking in transparency.

There is the option for the responsible Minister to declare many more weeds (as noxious). Currently, the decision to declare weeds is at the discretion of the Minister for Primary Industries, guided by recommendations of the Noxious Weeds Advisory Committee after a technical assessment by the department. Nominations can come from a variety of sources. The NWAC has developed a policy on declarations to guide decision-making, which specifies that 'there must be a demonstrated public benefit from the proposed declaration'.

The decision to declare a weed should be scientific, based on risk or threat assessments and the potential to reduce or prevent harm, and all introduced plants meeting a certain threshold of risk or harm should be considered for declaration – for example, all plants exceeding a defined ranking in the scheme used by Downey et al. (2010), weeds listed as key threatening processes or in listing advices for a threatened species or ecological community.

The decision about the class of declaration needs to take account of factors in addition to invasive risk and harm, including the feasibility of control and capacity of land managers to implement control. We recognise that declarations of noxious weeds may impose obligations on landholders and that in some cases requirements for control are too onerous or expensive for private and public landholders, or unlikely to assist in significantly reducing existing weed impacts. In a large proportion of cases, however, banning further sale and movement of an environmentally harmful weed is likely to be of public benefit by reducing the risk of spread into new areas, potentially limiting propagule pressure, and preventing the introduction of new varieties that increase the potential for harm. Adoption of a 'managed species' class of noxious weed provides an option for continued sale of those invasive species with commercial value and risks that that can be managed. The flexibility of declaration class options reduces barriers to declaration.

Decisions about declaration can be difficult, particularly when harmful species are valued commercially or culturally. Decision-making processes would benefit from more explicit guidance about factors that must be considered in accordance with ESD, including impacts on biodiversity and ecological integrity, interactions with other threats such as climate change, the likely long-term costs to future generations (intergenerational equity), and impacts of control. Decisions about declaration should also consider the interests of other states in preventing weed spread beyond NSW's borders, which is already consistent with Class 5 weeds (restricted plants). Because it can be difficult to predict outcomes of weed invasion, the precautionary principle is important.

104 Downey, Scanlon et al. (2010)
105 Sydney Weeds Committee (2009)

We recommend that the NSW Scientific Committee be empowered to recommend declarations of environmental weeds, complementing its current responsibility for declaring threatened species and ecological communities and key threatening processes. There should be clear avenues by which the public can nominate weeds for declaration.

'Native' weeds

A wattle from Western Australia could be just as invasive in NSW as a shrub from South America. It is important to facilitate the management of any introduced species, whether Australian or exotic, under biosecurity laws. We support the principle in the NRC issues paper that there should be 'consistency in management of native and introduced invasive species' but it should only apply to introduced native species, not indigenous plants. There should be a clear distinction between plants classed as weeds (noxious weeds) and plants known as 'invasive native species' under the Native Vegetation Act 2003, which are indigenous species that are regarded as agricultural nuisances. These indigenous plants should not be managed under a biosecurity framework as the objectives of their management are very different and mostly restricted to agricultural lands. They are often important and valued plants in the natural environment and used for restoration.

Recommendation

Declarations: Develop criteria consistent with ESD under the Act to guide declaration decisions, and identify triggers/thresholds for environmental weed declaration assessments (eg. when weeds are identified in key threatening processes, as threats in listing advices for threatened species and ecological communities, or above a threshold score in the Downey et al. ranking of environmental weeds).

Native weeds: Maintain the current distinction between introduced native plant species, which should be managed as potential biosecurity risks, and indigenous species referred to as 'invasive native species' that are managed under native vegetation laws for agricultural purposes.

4.2 Eradication and containment

Given the difficulties and costliness of weed control, it is highly worthwhile to eradicate potential weeds or weeds with limited spread where this is assessed as feasible. Removing weeds from the landscape is also important in the face of climate change, which will provide opportunities for new weeds. Where a weed is too well-entrenched for eradication, it may be possible to contain it by preventing its release in new areas and eradicating outlying populations.

The second goal of the *NSW Invasive Species Plan 2008-2015* is to eliminate new invasive species or prevent their spread, with the challenge explained thus:

> *Invasive species have the ability to establish in new areas rapidly and successful control often corresponds directly with timely and rapid response. The challenge is to develop and deploy effective and efficient ways to eradicate or contain an introduced species before it becomes widespread.*

There have been few weed eradication attempts in NSW. Current targets include some species on Lord Howe Island and hawkweeds. However, there is a commendable growing emphasis on this aspect of weed management. The Department of Primary Industries has developed a New Weed Incursion Project, and in the Weed Action program there is now a priority focus on 'New weed incursions', with support for work that:[106]

- 'identifies and manages high risk species and pathways;
- develops and implements early detection capabilities;
- assists in the timely detection of new weed incursions; and
- affects a quick response to eradicate or contain new weeds.'

We recommend that the state adopt a specific eradication target and dedicate a specific proportion of funds for this purpose. This is one area where solid and rapid progress could be made on a very important weed goal, and demonstrate to the government and the community that cost-effective achievements are possible. Only by the combination of preventing new unsafe introductions and eradicating new incursions can NSW arrest the rise in weed numbers.

106 Department of Primary Industries (nd)

As well as preventing the establishment of new weeds in the state, NSW needs to prevent the spread of species already naturalised in part of NSW into new areas – prevention at regional scales. As the example of African olive in Box 4 demonstrates, the failure to prevent the sale and movement of high risk species into new regions has costly consequences. Currently, containment occurs mostly in an ad hoc way with some class 3 and class 4 declarations for weeds of potential threat. A comprehensive containment strategy should be implemented in conjunction with a permitted list approach, with containment restrictions applied to species that could invade new areas and have adverse impacts unless their sale and movement is prohibited and other containment measures applied.

Box 4. African olive

One example of where a containment approach might have limited the spread of a highly damaging and costly weed is African olive. It is thought that the species was first planted in the Camden area in south-west Sydney in the 1820s as a hedge at Macarthur's Camden Park.[107] From the 1930s until just a few years ago, it was sold in nurseries, promoted as a hardy hedge. Its spread has accelerated as it has expanded over the past 20 years from the south-west of Sydney, including on land owned by Sydney Botanical Gardens. It is now widespread in western Sydney and listed as a key threatening process under the Threatened Species Conservation Act. It is starting to invade parts of the Hunter Valley. If this species had not been sold in nurseries and a targeted eradication program had been undertaken, its spread could have been avoided.

Recommendations

Eradication: Eradicate emerging or sleeper weeds where feasible, ensuring a timely response to maximise feasibility and limit costs. Adopt a state eradication target and allocate a specific budget for eradication of high risk incursions.

Containment: Prevent weed introductions and spread into uninvaded areas of NSW through a comprehensive containment strategy operating in conjunction with the permitted list approach that bans sale and movement of weed species meeting a certain threshold of risk or threat into uninvaded regions or local government areas and requires control to prevent spread beyond containment zones.

4.3 Ecologically informed weed management

[O]vercoming mechanisms that favour weeds above native species (weed persistence), and conversely re-establishing mechanisms that favour natives above weeds (ecological resistance), remain a foremost restoration challenge.

Suzanne Prober and Georg Whiel 2011[108]

The third goal of the NSW Invasive Species Plan is to reduce the impacts of widespread invasive species, with the challenge explained thus:

> *Many invasive species are already widely established in NSW. The challenge is to manage or control these species to reduce their impact where benefits of control are greatest.*

Control and asset protection represent the most challenging and expensive aspect of weed management as many weeds are difficult to control, and their impacts and interacting ecological processes are poorly understood. Successful control requires long-term commitment, cross-tenure effort and a good understanding of weed biology and ecology. It is increasingly clear that effective weed management in natural areas needs to be part of a much broader environmental focus on ecological processes that facilitate or impede weed invasions and interactions with other processes such as fire. In natural ecosystems, much effective control is undertaken using the concepts and techniques of 'bush regeneration' (Box 5), with substantial voluntary contribution from the community sector. One hundred NSW community group respondents to a 2013 survey by the Invasive Species Council reported a voluntary effort valued at over $13 million (with $4 million in paid effort).[109]

Planning and prioritisation: There is an increasingly systematic approach to weed control, with the development of the NSW Invasive Species Plan, regional plans, the ranking of environmental weeds, and mapping of the extent of many

107 Cuneo and Leishman (2006)
108 Prober and Whiel (2011)
109 Invasive Species Council (2013)

priority weed species.[110] The NSW Government has worked with the 13 Catchment Management Authorities in NSW to develop regional weed priorities for conservation.[111]

There is no requirement under the Noxious Weeds Act for control by landholders (public and private) of many serious environmental weeds, including many recognised as key threatening processes (most of which lack a treat abatement plan). According to the 2009 State of the Environment report, 262 of NSW priorities action statements (specifying recovery actions for threatened species, populations and ecological communities) under the Threatened Species Conservation Act specified weed management as an action. This action had commenced in 214 (82%) cases.[112] No data is publicly available on the number of actions completed or their effectiveness.

Reducing invasion factors: Disturbance (eg. clearing and fire) and nutrient enrichment (Box 6) are well known to facilitate weed invasion. Effective weed management in the natural environment requires a broader focus than the 'noxious weeds' mentality of focusing on control of a single target species. Still too often, the approach to weed control is to spray or remove weeds and assume the project is completed in two to three years when the treated area is free of weeds. But without replanting in the bare patches, without addressing the factors that contributed to weed invasion in the first place and with no long-term follow-up, the original or other weeds are likely to return over the next several years. There needs to be more research and policy focused on broader ecosystem management of which weed control is one element, and interactions between weeds and other environmental factors are considered. For example, road works and road maintenance (eg. mowing) – which are environmental disturbances and also contribute substantially to weed spread (including by the planting of invasive grasses such as kikuyu next to bushland areas) – should be undertaken in ways to minimise the weed establishment and spread.

Cumulative impacts: Environmental protection requires a focus on preventing and reducing cumulative impacts of weeds, not just on reducing the adverse impacts of a small subset of the most severe weeds. Weed threats to biodiversity often involve multiple weed species, some of which on their own may not be regarded as a significant threat, and effective control to protect an asset requires a focus on multiple species, some of which may not be declared. As more species naturalise and spread, cumulative impacts will increase. Managers are often tempted to focus on particular weed targets rather than on what is needed to reduce the overall weed threat to environmental assets. We recommend specific inclusion of cumulative impacts in the objects of the Act to recognise this feature of weed threats and to ensure the focus of weed programs is broadly on protection of the environment rather than just on control of particular weed species.

A requirement to consider cumulative impacts is contained in s 228 of the *Environmental Planning and Assessment Regulation 2000* (as a factor that must be taken into account concerning the impact of an activity on the environment) and s 10 of the *Protection of the Environment Operations Act 1997* as a purpose of 'protection of the environment policies'.

Management effectiveness: There has long been a recognition that monitoring and evaluation are essential to weed management but very limited funding for it. The NSW government has recently increased its emphasis on this aspect with the development of a state Monitoring, Evaluation and Reporting strategy. The guidelines for the Weed Action program state that MER 'must be an integral component of any weed management program'. In effect, all weed programs should be treated as experimental with the potential to contribute not only to addressing a particular weed problem or site but to contribute to broader knowledge about weed management.

Recommendations

Weed programs: Implement sustained, large-scale programs (like that for bitou bush) necessary to achieve NSW's invasive species targets that include monitoring, evaluation and reporting. Complement weed management and native vegetation restoration with other management (eg. of fire and nutrients) to achieve more resilient ecological communities and restoration of ecological processes.

Ecological focus: Recognise the links between weed invasion and other environmental threats and processes (such as fire regimes, land clearing, nutrient enrichment and climate change) and focus programs on developing more effective ecological approaches to management.

110 See dpi.nsw.gov.au/agriculture/pests-weeds/weeds/weed-maps.
111 See dpi.nsw.gov.au/agriculture/pests-weeds/weeds/projects/legislation.
112 NSW State Government (2009)

Development standards: Develop enforceable standards for urban planning and development that limit the potential for weed spread – including standards for landscaping, retention of native vegetation and minimisation of land disturbance and nutrient enrichment.

Box 5. Bush regeneration[113]

Bush regeneration – an Australian term for a form of ecological restoration involving a range of treatments applied in a manner that triggers natural regeneration of surviving, dormant or nearby species – has a history of more than 50 years of effectively turning degraded natural areas into healthy, sustainable ones areas that require minimal ongoing maintenance.

Since the 1980s, bush regeneration has grown from a largely volunteer base to a major industry. A report by Australian Association of Bush Regenerators (AABR) in August 2007, 'Paying the Price of Garden Escapes', found that the cost of the bush regeneration effort over a large area of eastern Australia was $18 million, with 71% of that for paid bush regeneration.

Its effectiveness is reflected in the fact that over 95% of councils in Greater Sydney have supervised Bushcare volunteer programs, often coordinating work with contractors, and Bushfire Management Plans. Sydney has substantial areas of bushland in various states of health, and bush regeneration has saved many areas from destruction by weeds, a major achievement considering the problems of weeds, nutrients and excessive stormwater in urban areas.

While the initial stages of bush regeneration can require resources beyond the traditional methods of spraying, mowing and brushcutting, the long term maintenance costs are on a par. The problem with traditional methods is that they usually continue to degrade the natural areas and do not achieve biodiversity outcomes. Bush regeneration aims to re-establish sustainable biodiverse communities with low maintenance regimes. It can be applied to both small and large areas and to all vegetation types. There are many remnant areas in the state – eg. along roadsides, rail corridors, on private land – on which a change of management to a biodiversity focus using bush regeneration strategies would result in excellent outcomes for weed issues.

Bush regeneration has been applied very successfully on Lord Howe Island with a combination of paid bush regenerators and supervised volunteer bushcarers. Another initiative to highlight is the Hunter & Central Coast Regional Environmental Management Strategy, which has received awards for its work to restore degraded roadside vegetation.

Bush regeneration relies on appropriately skilled people at all levels. Skills training and the involvement of specialists is essential. Specialists are needed, for example, to assess areas for their potential for restoration.

Box 6. Nutrients and weeds

Sydney's bushland reserves on Hawkesbury sandstone soils are a botanical delight with more than 1500 native plant species. The sandstone soils are naturally very low in phosphorus, with concentrations on ridge tops and slopes ranging from 30 to 100 mg/kg, much less than the Australian average of about 300 mg/kg, which is much less than averages elsewhere, such as 650 mg/kg in the UK and 500 mg/kg in the US.[114]

The future of the sandstone reserves depends on maintaining nutrient poverty. Sites receiving stormwater runoff have become very weedy – where soil phosphorus levels exceed 350 mg/kg, weed cover exceeds 80%.[115] Other sources of nutrients are dumped garden rubbish, septic tank effluent and sewage overflows.

Glasshouse and field experiments showed that nutrients added to Hawkesbury sandstone soils diminish native plant survival and benefit weeds.[116] The survival of most native plants tested (seedlings and 6 months old plants) declined as phosphorus levels increased and under high phosphorus levels (typical of areas downslope of roads, 260 mg/kg) most plants died. Conversely, higher nutrient levels increased the survival and growth of exotic invaders compared to other plants.

Nutrient enrichment is thought to generally facilitate weed invasion by increasing the amount of unused resources and reducing competition from resident species for those resources.[117] The availability of resources (water, nutrients, light) can increase for many reasons – reduced use by resident vegetation (due to damage or destruction, eg. from heavy grazing or disease) or additional resources (higher rainfall, fertilisation or more light from canopy removal). This means that the invasibility of vegetation communities changes over time, as the amount of unused resources fluctuates, and that weed invasions are likely to be episodic events. It means that maintaining or restoring ecological health in many communities requires limiting nutrient additions and maintaining native species diversity to help ensure that available resources are comprehensively used.

113 Australian Association of Bush Regenerators. AABR was established in 1986. Its aim is 'to foster and encourage sound ecological restoration and management practices by qualified people, while emphasising and maintaining the pivotal role played by natural regeneration' (<aabr.org.au>).
114 Leishman, Hughes et al. (2004)
115 Leishman, Hughes et al. (2004)
116 Thomson and Leishman (2004); Leishman and Thomson (2005)
117 Davis, Grime et al. (2000)

4.4 Weeds and climate change

The ultimate outcomes 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[118]

With more extreme weather events, greater stresses on native species and ecosystems, and changes in land use, climate change is expected to create a weedier world.[119] In many cases the impacts on biodiversity of invasive species thriving under warmer temperatures and more extreme events are likely to exceed the direct impacts of climate change.[120] Patterns of expected change include:[121]

- Many weeds are likely to benefit under climate change and become more invasive and harmful – expanding their range under higher temperatures, spreading in floods, storms and fires, colonising bare ground in drought. For example, serrated tussock benefits from bare patches created by droughts, bitou bush from storms and willows from floods.
- Some weeds create positive feedback loops that may be exacerbated by climate change and result in ecosystem transformations – flammable weedy pasture grasses that both promote fire and are promoted by fire, for example.
- Declining native species may be less able to adapt to climate change when under threat from weeds, and climate refuges may be less secure (for example, if invading grasses increase fire risk in refuge areas).
- Some responses to climate change – for example, the production of weedy biofuels or hardier invasive pasture and garden plants – will increase the weed threat. Behavioural changes in response to extreme weather events often facilitates weed invasion: weed control is a lower priority when there are floods or droughts and overgrazing during droughts promotes unpalatable weeds.

Weed laws and policies should be designed within the context of rapid climate change. The former NSW Department of Environment and Climate Change and Macquarie University investigated various impacts of climate change on weeds in NSW, including modelling the potential distribution of significant weeds under climate change, and investigating impacts of elevated temperature and CO_2 on competitive interactions between exotic and native plant species.[122] But there is no indication of any change in laws and policies yet to take the interaction of climate change and invasive species into account.

Recommendations

Climate change adaptation: Adaptation programs should focus on weed management as a priority adaptation: reduce weed threats to support the capacity of native species to adapt to climate change, manage weeds likely to benefit under climate change, and prevent unsafe new introductions, ensuring that responses to climate change such as the cultivation of biofuels do not worsen invasive species problems.

4.5 Public land management

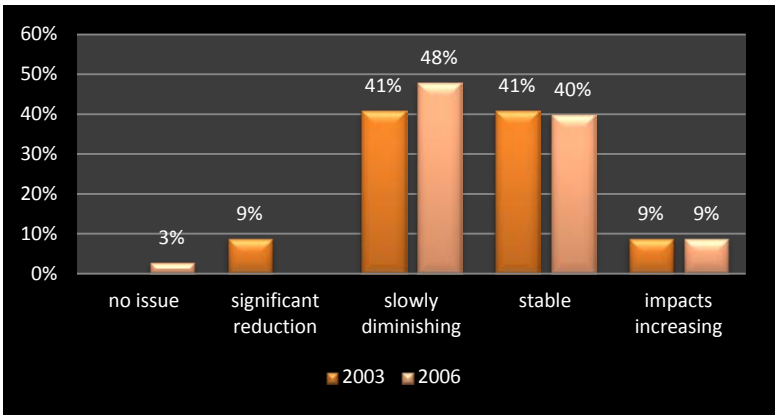
.. the intensive control [of invasive species] that is necessary to improve the condition of flora and fauna is largely limited to some conservation reserves.

NSW State of the Environment 2009[123]

Agencies that manage public land have a special responsibility to manage weeds, to be accountable to the public, and to ensure exemplary exercise of a duty of care. In recent years there has been high priority accorded to weed management in national parks and substantial funding increases for invasive species management. Their progress is monitored and the agency has published reports on progress (Figure 7).

118 Garnaut (2008).
119 Low (2008); McFadyen (2008); Invasive Species Council (2010)
120 Steffen, Burbidge et al. (2009).
121 Invasive Species Council (2010)
122 <environment.nsw.gov.au/pestsweeds/climatechange.htm>
123 NSW State Government (2009).

FIGURE 7. EFFECTIVENESS OF WEED MANAGEMENT IN NSW NATIONAL PARKS (2003-2006)[124]



However, for other government agencies and public authorities weed management is a low priority and deficient. There are currently no mechanisms for them to be accountable to the public on whose behalf they manage the land. For example, although Forests NSW (now the Forestry Corporation of NSW) has published annual reports with a 'sustainability' section, the only weed-relevant factor they have reported is expenditure on invasive species management (which is at a low level). There is no information about the weed status of forestry lands (2.4 million hectares of public land) or effectiveness of management despite the high invasion risks associated with logging and the high conservation values of much of the forestry estate. The Forestry Corporation should be subject to the highest standards for weed management and much more accountable to the public for their management of public lands.

This deficiency applies also to many other agencies responsible for public land management, including departments for planning, lands, education and transport (roads, railways and ports). The Department of Planning holds many large properties in western Sydney, often with high conservation values, as a land bank for future conservation or other uses. There is a long history of poorly managed weed problems on these lands. Railways and roads present unique challenges due to the high perimeter to area ratios, the passage of trains, cars and trucks that carry seeds, high nutrient loads and the propensity of land managers to favour spraying over long-term weed management. There is often little weed control on Crown land reserves where community support is lacking. The national parks agency, which generally has sophisticated and effective weed management programs, is insufficiently funded to manage some lands adjacent to urban areas. There needs to be an assessment of the technical and resource capacity of public land managers to effectively manage weeds. Without more funding and access to expertise, simply ordering them to control weeds may not result in any change.

Weed management should be reportable core business of all government agencies and public authorities with land management responsibility, with standardised weed mapping and reporting systems that provide sufficient information for the public to assess the effectiveness of weed management. To demonstrate a duty of care, government agencies and public authorities with land management responsibility should be required to demonstrate compliance (with independent monitoring) with approved codes of practice and weed management plans. There should be coordination of weed management programs between agencies.

Public authorities are currently exempt from requirements under the Act for weed control. We recommend that the Noxious Weeds Act be amended to give public authorities the same noxious weed control responsibilities as private land owners. NSW's Bush Fires Act was recently amended to ensure that public authorities are subject to control orders in the same way private landholders are. The same approach should be taken with weed management. This will boost community and landholder confidence in the work of government if everybody has to meet the same standards.

Recommendations

Public land managers: Make weed management a reportable core business of all regulatory authorities with land management responsibility, with standardised weed mapping and reporting systems. Require government agencies and authorities to demonstrate compliance with a duty of care through compliance with approved codes of practice and

124 NSW State Government (2005); NSW State Government (2007)

weed management plans. Treat public authorities in the same way as other landowners for control of class 1, 2 and 3 weeds. Improve the land management capacity and skills of all land-holding agencies and ensure that weed management programs are coordinated across the public land estate.

Public land audits: Conduct regular weed audits of public lands, particularly those with high conservation values, to assess weed problems and management effectiveness and identify capacity needs.

5. Inculcate greater responsibility

The problem that seems inadequately treated currently is that a … benefit to a few has more political weight than a substantial cost that might be borne forever by all.

Invasion biologist Daniel Simberloff (2005)[125]

It seems remarkable that I can be fined several hundred dollars for littering, an act of environmental vandalism that can be fixed in ten seconds and generally causes no lasting damage, but those responsible for introducing plants and animals that pollute the nation forever and cost the Australian economy millions get off 'scott free'.

Ecologist Hugh Possingham, University of Queensland

The weed problem is largely a problem of human motivation. Many weed invasions are preventable and result from people failing to take responsibility for the introduction or spread of weeds, due to thoughtlessness, ignorance, or a presumed lack of consequence for themselves. How do you compel, encourage and entice humans to use live organisms and manage land responsibly to prevent and control invasive species problems?

The motivational issues are particularly challenging for weed management because of the multiplicity of pathways and actors involved and the long timeframes and wide and varied landscapes over which consequences accrue. Actions that seem benign – planting a garden – can result in major environmental impacts. In no other domain of environmental activity, can such minimal actions have such large consequences.

Simplistically, people have to know what their responsibilities are and what to do to reduce risk/threats (eg. by education, codes of practice, management plans, labelling) and be motivated to comply by risk of penalty (eg. prosecution, loss of bond), positive incentive (eg. reduced levies, higher value property), social pressure (eg. to comply with a code of practice or regulation, participate in control activities) or sense of duty.

There is need for much more research to assess what approaches are most effective for particular circumstances. We recommend a systematic gap analysis and review of tools to motivate responsibility by different actors for different weed pathways. What is effective for businesses and public agencies may not be so for individual landholders. What can be applied to retail nurseries may be difficult to apply to plant sellers at markets and on the Internet.

We briefly address three major motivational categories – law, education and economics – but it is a much bigger topic than we can do justice to here and needs a rigorous review as part of the NRC review.

Recommendation

Tools for motivation: Conduct a systematic gap analysis and review of tools to motivate responsibility amongst different actors for actions relevant to weed management.

5.1 Duty of care

Because many introductions are irreversible, it is important to cultivate a strong duty of care to prevent unsafe plantings and weed spread. Currently, weed laws mostly focus on managing a small subset of invasive and potentially invasive species, those declared noxious. However, effective weed management under ESD requires people to take responsibility for activities involving many other species with invasive risk and for land management practices and activities that facilitate weed spread. This could be facilitated by explicating a general duty of care under the Act.

We recommend that the Act requires everyone, including companies, government agencies and public authorities, to take responsibility for preventing and minimising harmful or potentially harmful weed impacts. The recommended duty would require everyone to "take all reasonable and practical steps" to meet their obligation. We use the term 'duty of care' here, but it could be called an 'obligation' or expressed in other more appealing terms ('sustainability obligation'?).

125 Simberloff (2005)

It is particularly appropriate to apply a broad duty of care requirement for weeds given the potential long-term and irreversible consequences of poor practices and the multiple pathways for weed spread. One person's action in planting a weedy species can ultimately have adverse impacts across vast areas and on many people and species for centuries to come. It can cost future taxpayers millions of dollars in control. There is no way of explicitly regulating all actions potentially resulting in invasive impacts, so requiring that people exercise care and assisting them with information and resources to do so can fill in some gaps. It is consistent with the principle that biosecurity is a shared responsibility. Requiring a duty of care complemented by public education is essential to promote widespread attitudinal and behavioural change, and to motivate a more serious approach akin to that of hygiene and public health. Currently, littering is likely to attract more social opprobrium than weed spread.

Currently, the Noxious Weeds Act limits duties to controlling noxious weeds as required under a weed control order, with slightly different duties specified for private landholders, public authorities and control authorities in sections 12, 13 and 14. There is no explicit requirement in the Act to take reasonable care to prevent the introduction and spread of weeds not subject to a control order. For example, there is no explicit onus on managers of plantations and other commercial plantings to control escapees.

A broader duty of care is consistent with the recommendation in the 1998 report by the then Industry Commission, *A full repairing lease: Inquiry into ecologically sustainable land management*, for a statutory duty of care for the environment to 'require everyone who influences the management of the risks to the environment to take all "reasonable and practical" steps to prevent harm to the environment that could have been reasonably foreseen'.[126] 'Reasonable and practical' are fair limits to the duty, preventing overly onerous demands on people and varying according to circumstances. Factors to be considered when determining what is 'reasonable and practical' could be specified to include the potential harm caused, state of scientific knowledge and financial implications.

The general biosecurity obligation in Queensland's Biosecurity Bill 2013 provides a good model (Box 7). The obligation applies broadly to anyone dealing with a biosecurity matter or carrier, or carrying out an activity likely to pose a biosecurity risk. The obligation includes preventing or minimising biosecurity risk, preventing or minimising adverse effects on a biosecurity consideration and minimising the likelihood of causing a biosecurity event. Failure to discharge the obligation is an offence, and may be an aggravated offence. There is a defence of 'due diligence'.

Box 7. General Biosecurity Obligation, *Biosecurity Bill 2013* (Queensland)

Part 1 General biosecurity obligation

23 What is a *general biosecurity obligation*

(1) This section applies to a person who deals with biosecurity matter or a carrier, or carries out an activity, if the person knows or ought reasonably to know that the biosecurity matter, carrier or activity poses or is likely to pose a biosecurity risk.

(2) The person has an obligation (a *general biosecurity obligation*) to take all reasonable and practical measures to prevent or minimise the biosecurity risk.

(3) Also, the person has an obligation (also a *general biosecurity obligation*)—

(a) to prevent or minimise adverse effects on a biosecurity consideration of the person's dealing with the biosecurity matter or carrier or carrying out the activity; and

(b) to minimise the likelihood of causing a biosecurity event, or to limit the consequences of a biosecurity event caused, by dealing with the biosecurity matter or carrier or carrying out the activity; and

(c) not to do or omit to do something if the person knows or ought reasonably to know that doing or omitting to do the thing may exacerbate the adverse effects, or potential adverse effects, of the biosecurity matter, carrier or activity on a biosecurity consideration.

Examples of things that may exacerbate the adverse effects, or potential adverse effects, of biosecurity matter, a carrier or an activity—

• failing to isolate an infected animal from a herd

• failing to wash footwear before leaving a property on which anthrax is present

• inappropriately disposing of leaf litter containing a plant virus or disease

• failing to take reasonable steps to reduce contaminants in plants and animals, including, for example, by allowing designated animals (not including bees) to graze on land contaminated with heavy metals or by using water that may contain a contaminant to irrigate crops

• failing to manage the impact of invasive plants and animals on a person's land

126 Australian Weeds Committee (2002) recommended a duty of care as one of nine key principles for weed legislation in their Principles of Weeds Legislation Discussion Paper.

24 General biosecurity obligation offence provision

(1) A person on whom a general biosecurity obligation is imposed must discharge the obligation.

Maximum penalty—

(a) if the offence is an aggravated offence—3000 penalty units or 3 years imprisonment; or

(b) if the offence is not an aggravated offence—

(i) for a breach in relation to prohibited matter—1000 penalty units or 1 year's imprisonment; or

(ii) for a breach in relation to restricted matter—750 penalty units or 6 months imprisonment; or

(iii) otherwise—500 penalty units.

(2) If the offence is not an aggravated offence, it is a defence for the person to show that the person had a reasonable excuse for failing to discharge the obligation.

25 Effect of regulation for discharge of general biosecurity obligation

(1) This section applies if a provision of a regulation (*regulation provision*) is identified in the regulation as a provision that prescribes a way of discharging a person's general biosecurity obligation.

(2) Unless otherwise stated in the regulation, the regulation provision does not prescribe all that a person to whom the provision applies must do, or must not do, to discharge the general biosecurity obligation.

(3) However, for applying the general biosecurity obligation offence provision, the person fails to discharge the general biosecurity obligation if the person contravenes the regulation provision.

26 Effect of code of practice for discharge of general biosecurity obligation

(1) This section applies if a code of practice states a way of discharging a person's general biosecurity obligation.

(2) Unless otherwise stated in the code of practice, the code of practice does not state all that a person to whom the code of practice applies must do, or must not do, to discharge the person's general biosecurity obligation.

(3) However, for applying the general biosecurity obligation offence provision, the person fails to discharge the general biosecurity obligation if the person—

(a) contravenes, or otherwise acts inconsistently with, the code of practice; and

(b) does not follow a way that is as effective as, or more effective than, the code of practice for discharging the general biosecurity obligation.

(4) Also, for applying the general biosecurity obligation offence provision, if a regulation requires a person to comply with the whole or a stated part of a code of practice to discharge the person's biosecurity obligation, the person fails to discharge the general biosecurity obligation if the person contravenes, or otherwise acts inconsistently with, the code of practice or stated part.

27 Aggravated offences—significant damage to health and safety of people or to the economy or environment

(1) An offence is an *aggravated offence* if the commission of the offence causes significant damage, or is likely to cause significant damage, to the health and safety of people or to the economy or the environment.

(2) To prove an aggravated offence, the prosecution must prove that the person who committed the offence—

(a) intended the person's conduct to cause significant damage to the health and safety of people or to the economy or the environment; or

(b) was reckless as to whether the conduct would cause significant damage to the health and safety of people or to the economy or the environment.

28 Defence of due diligence

(1) In a proceeding for an offence against the general biosecurity obligation offence provision, it is a defence for a person to prove that the person took all reasonable precautions and exercised proper diligence to prevent the commission of the offence by the person or by another person under the person's control.

(2) Without limiting the ways in which a person proves the matter stated in subsection (1), a person proves the matter if the person proves that—

(a) the conduct alleged to constitute the offence was due to—

(i) an act or default of another person; or

(ii) reliance on information supplied by another person; and

(b) the person made all reasonable enquiries about—

(i) whether any animal, plant or other thing was the carrier of prohibited matter or restricted matter the subject of the offence alleged; and

(ii) any necessary treatments that may be required for any carrier of any biosecurity matter to rid the carrier of the biosecurity matter; and

(c) any of the following applied—

(i) the person carried out all checks on the health of any biosecurity matter or carrier of any biosecurity matter as were reasonable in all the circumstances;

(ii) if another person carried out checks on the health of any biosecurity matter or carrier of any biosecurity matter, it was reasonable in all the circumstances to rely on the checks carried out by the other person;

Example—

checks carried out by a veterinary surgeon

(iii) it was reasonable in all the circumstances to rely on checks carried out by another person who supplied any

biosecurity matter or carrier of any biosecurity matter to the person; and

(d) the person took the precautions that were reasonable in all the circumstances to prevent the spread of any biosecurity matter.

(3) Also, without limiting the ways in which a person proves the matter stated in subsection (1) or (2)(c)(i), a person proves the matter if the person proves that—

(a) if a regulation prescribes a way in which a person's general biosecurity obligation can be discharged to prevent or minimise a biosecurity risk posed by the relevant biosecurity matter or carrier of the biosecurity matter—the person followed the prescribed way; or

(b) if a code of practice states a way in which a person's general biosecurity obligation can be discharged to prevent or minimise a biosecurity risk posed by the relevant biosecurity matter or carrier of the biosecurity matter—the person adopted and followed the stated way.

(4) This section is not intended to exclude the operation of the Criminal Code, section 24.

(5) In subsection (2)(a) and (c)—

another person does not include a following person—

(a) an employee or agent of the defendant;

(b) in the case of a defendant that is a body corporate, a director, employee or agent of the defendant.

For a duty of care to be effective, people need to be aware of what it requires (definition and examples of what is required under the duty, and information about options for compliance). There would need to be careful analysis of what constitutes 'reasonable and practical' (courts are likely to be conservative in interpreting a duty of care to ensure it is not overly onerous) and that it is responsive to circumstances. For example, if a plant escapes from cultivation, what is reasonable and practical would depend on the level of risk it posed and may range from notification of authorities to paying for eradication and implementing measures to prevent future escapes, and vary depending upon whether the land manager was operating a commercial enterprise. To be effective, a duty of care must come with penalties for breaches and be subject to public enforcement, as is the case for other environmental laws.

Recommendation

Duty of care: Develop a wide and enforceable duty of care (or obligation similar to that in Queensland's Biosecurity Bill 2013) that requires anyone undertaking any activity with potential to increase adverse weed impacts to take all reasonable and practical measures to prevent or minimise biosecurity risks. Define and exemplify what a duty of care requires and specify penalties for breaches.

5.2 Codes of practice

Implementing an approved code of practice (or management plan) are recognised ways of demonstrating compliance with a duty of care. Certain activities with risks of weed spread may be amenable to management via codes of practice or regulation, including some forestry practices, cultivation of species with invasive risk, field trials of potentially invasive plants, landscaping of residential developments and streetscaping, and the sale of some potentially invasive species. The code of practice/management plan approach to 'managed species' proposed in the issues paper released by the DI&I in 2010 for the review of the Noxious Weeds Act could be one way for land managers to demonstrate they are exercising a duty of care. Approved codes of practice can set the industry standard by which courts can determine the threshold for a duty of care.

However, there are good reasons to be sceptical about voluntary industry codes of practice, as they often substitute for adequate regulation, and lack adequate reporting and compliance measures. It is important to distinguish between activities best explicitly managed by regulation, particularly where there is a high risk of harm or where compliance is otherwise likely to be an issue, and those amenable to codes of practice. Effectiveness requires that codes of practice are linked to legislation to ensure the standards proposed are adequate to demonstrate compliance with a duty of care, and that they are enforceable. Accountability will be improved with wide standing for enforcement and requirements for public reporting.

Compliance with a code of practice could also be linked to economic incentives with businesses not demonstrating compliance with a code liable to higher 'risk creation' levies or bonds. Any codes of practice require a regular review to assess whether objectives are being met, and changes in the code or a shift to regulation if the objectives are not being met.

Recommendation

Codes of practice: Provide for approved codes of practice under biosecurity legislation as one way of demonstrating compliance with the proposed duty of care (or obligation). Develop criteria to determine when activities are best subject to regulation or codes of practice, with high-risk activities to be subject to regulation.

5.3 Managing 'conflict' species

In its 2010 issues paper for the review of the Noxious Weeds Act, DI&I proposed the creation of a special 'managed species' category to address one of the large gaps in weed laws – the management of cropped invasive (or potentially invasive) species. Invasive species with commercial value are a particular problem not only because there is industry resistance and political reluctance to prohibit these species but because they are often cultivated over large areas, creating a high propagule pressure that substantially increases the risk of invasion.

The proposed mechanism of a 'managed species' must not be the default approach to any commercial species. It shouldn't serve to justify a permissive regime permitting the cultivation of any commercially valued species, as a substitute for declaring species and prohibiting them where this warranted by the invasion risk and hazard for biodiversity, health or economy. 'Managed species' must only be used in a very limited set of circumstances where risks can be confidently minimised. Some risks are not amenable to management, such as when seeds are bird-dispersed or there is a risk of floods spreading propagules, or if the crop is high volume and low value implying few resources for weed management (as is the case for some biofuel crops) In other cases, such as biofuel crops, there are low-risk crop species available, which warrants banning those with invasive risks.

To inform decisions about which commercial species should be declared 'managed species', we recommend a risk assessment process that includes a realistic assessment of management options. There has been little field testing of the success of different management options to prevent weed spread, so a precautionary approach should be taken. There should be recognition of the limitations due to extreme events and human lapses, and criteria to distinguish between crops amenable to management and those that are not. As is consistent with ESD, the long-term costs of managing an invasive species versus banning it should be considered. We recommend that an expert body be established to advise on which species are appropriate for classification as 'managed species' and methods by which they must be managed, and to regularly review the effectiveness of management. This body could be funded by contributions from industries with managed species. Recommended declarations and proposed management requirements should be subject to public consultation.

Some species or some aspects of management are best managed via regulation (particularly where the potential for harm is high and non-compliance is likely), others via a code of practice or management plan. Effectiveness will rely on transparency and enforceability. Penalties should be sufficient to motivate compliance and should include options for remediation orders. There should be provision to require bonds (for control of escaped species and removal of the crop should the business fail) and levies (including to cover the costs of independent monitoring).

Recommendation

Managing risk: Adopt a category of 'managed species' with criteria to define which species are amenable to management. Establish an expert body to advise on declarations and management requirements and review effectiveness. Subject declarations and management requirements to public consultation. Ensure that the proposed mechanisms of codes of practice or management plans are transparent and enforceable, including by the community. Include requirements for a bond and/or levy to cover costs of independent monitoring or control.

5.4 Mandatory labelling and other forms of education

New garden plants should be treated less like exciting new products to brighten our lives and more like wild organisms harbouring the drive to escape.

Tim Low, *Feral Future*[127]

Many gardeners would be aghast if they knew what environmental horrors their gardens harboured. When we buy herbicides, we can read a label to find out what the potential impacts are and how they should be used to avoid harm,

127 Low (1999).

but there is usually nothing about weed risks when people buy plants. Many gardeners think they are doing a good thing for the environment when they buy a so-called 'native' plant, not knowing that some natives are amongst the worst of Australia's weeds. Many gardeners and land managers are also unaware of their responsibilities to manage weeds. There is a great need for much better weed education targeted to change behaviour and provide vital information for high-risk pathways.

Garden plants constitute the largest proportion of weeds in NSW and aquarium plants are a high risk category of plants. Fundamental to building awareness and engendering responsibility is the ready availability of information to gardeners and aquarium keepers about weed risks and safe practices. Information is required at the point of purchase. The ENGOs recommend that the Act require mandatory labelling of all garden and aquarium plants at point of sale. Information should include taxonomy, invasion risk and recommended practices. Ideally, this would be a national scheme but NSW may have to lead the way by initiating a state scheme. There are many precedents for mandatory labelling, of foods, chemicals, energy efficiency and water efficiency.

There needs to be consideration of what information to require on labels and how/whether to apply labelling laws to plants sold on the Internet and in the informal economy (such as at community markets and fairs).

Recommendations

Labelling and education: Require labelling of garden plants as a condition of sale – to include taxonomic identification, natural distribution, invasive status and any precautions that should be taken. (Ideally, this would be a national scheme.) Undertake education to alert landholders and land managers to their responsibilities for weed control and about how to control particular weed priorities.

5.5 Promoting economic motivations

ESD requires the internalisation of environmental costs (by implementing the polluter pays principle) and highlights the value of using economic (valuation, pricing and incentive) instruments to promote responsibility. This is particularly appropriate when weed spread is promoted through commercial activities. Economic instruments are potentially powerful motivators and recommended in Australia's Biodiversity Conservation Strategy 2010–2030.

Applying the **'polluter pays' principle** – that whoever causes environmental harm should bear the costs of remediation – to weeds would drive much greater precaution. Mechanisms for applying the polluter pays' principle could include a requirement for bonds for the use of plants with a certain risk rating and a levy on the sale of non-indigenous species.

Under this principle, those who generate pollution should bear the costs of containment, avoidance or abatement (as in *Protection of the Environment Administration Act 1997*, s 6(2)(d)). Weed invasion can be regarded as a form of bio-pollution, although it operates over longer time scales than most forms of pollution. However, costs of weed control are typically borne not by those responsible for weed spread but by the community (funding and participating in weed control programs) and private land managers. In other words, costs are externalised, limiting the economic incentives to prevent or contain weed spread.

We recommend implementation of the polluter pays principle for weed spread, where possible, to ensure that control costs are shared by those responsible for weed spread and to provide an economic incentive for responsible behaviour. The most effective and fair mechanisms need analysis and we do not recommend a particular regime here.

Penalties under biosecurity laws should include orders for remediation. However, as it can be difficult to trace responsibility for weed spread to a particular person, it is important to particularly focus on risk-creating behaviours with a 'risk creator pays' approach – so that anyone engaging in activities that carry a risk of weed spread (above a certain threshold of risk) – such as planting a high-risk crop or selling potentially invasive plant species – is required to bear the cost of managing that risk, for example by paying a bond (to be used for control of escapees or remediation) and/or levy (eg. for independent monitoring). Responsible behaviour could be promoted by requiring lower bonds or levies for operators demonstrably taking actions to reduce risks, such as by complying with a code of practice. An obvious candidate for the payment of a bond is radiata pine plantations. Plantation wildings have invaded neighbouring bushland over distances of several kilometres. If the owner does not undertake work to remove escaped wildlings, the bond should be used to do so.

Another economic incentive to better manage weed risks could be applied by requiring that information be provided about the weed status of properties for sale. At the very least relevant weed control orders should be disclosed. However, many weeds that affect the value of a property are not declared and not subject to weed control orders. Weed management is typically the most expensive NRM problem for farmers and probably also for landholders managing land for lifestyle or conservation purposes. So, the weed status of a property beyond declared weeds is important information for many purchasers. In addition, there is a high public benefit in promoting links between land value and weed status as it will motivate landowners to control weeds that may compromise sale value.

We recommend requiring a weed inspection report for properties of a certain size and/or type so that buyers are fully aware not only of their legal liabilities for weed control but more generally of weed problems. The type and detail of required disclosure could vary depending on size, purpose and location of the property. One model to consider is the 2010 Commonwealth Commercial Building Disclosure Program that requires energy rating certification on the sale of commercial properties.

Recommendations

Polluter pays: Develop legal mechanisms, such as bonds and levies, by which those responsible for weed introductions and escapes are required to pay for or contribute to weed eradication and control.

Disclosure of weed status: Require a weed inspection report for land sales to ensure potential buyers are aware of weed problems and promote weed control to improve property values. Disclosure could take the form of a rating certification.

5.6 Enforcing weed laws

Enforcement of laws is essential to their effectiveness. We are concerned that breaches of the Act are widespread and that this is due in part to deficient enforcement. We do not know of any assessment of the extent of enforcement of, and compliance to, weed laws. Numbers of prosecutions do not necessarily reflect enforcement effectiveness. But that there has been only one prosecution under the Act (the only one reported on the Austlii website) – Merriwa Shire Council v Castlebar Holdings Pty Ltd [2004] NSWLC 2 – is strongly suggestive of a serious lack of enforcement. Although there is likely to be greater use of other enforcement tools, such as Penalty Notices (s 63, with a maximum penalty of $220), we have no information about the frequency and effectiveness of their use. Use of Penalty Notices is likely to vary considerably across local government areas. Anecdotally, we are aware of widespread lack of enforcement. Assessment of enforcement is vital for assessing the effectiveness of the Act and should be reviewed.

Jurisdiction: To improve the capacity for enforcement of the Act, we recommend shifting jurisdiction to a court with appropriate expertise, providing open standing to enforce some provisions and ensuring that penalties are sufficiently high and flexible. Adoption of these reforms would bring weed laws more up to the standard of other environmental laws.

Most environmental prosecutions in NSW are heard in the Land and Environment Court, a specialist court for cases to do with the environment, development and local government. The Land and Environment Court would be the most appropriate court to hear cases involving breaches of the Noxious Weeds Act, as its judges have the expertise and experience to assess environmental evidence, appreciate the potential impacts of breaches and apply appropriate penalties. Judges in Local Courts, which currently deal with proceedings under the Act (s 61), do not usually have experience with environmental matters and are therefore likely to underestimate the seriousness of weed impacts (or at least to vary in the degree of seriousness they treat weed offences). Having cases heard in the one specialist court would assist in achieving consistent outcomes and build a coherent body of case law. The Land and Environment Court already has a small role under the Act, to hear appeals against Weed Control Notices (s 25).

Open standing: One of the essential elements of most modern environmental legislation is wide standing provisions to allow for community enforcement. Such capacity is particularly appropriate for weed laws given the serious environmental impacts and huge public costs of weed invasions and the current low rate of enforcement. The public has multiple strong interests at stake: as landowners affected by weed invasion, as taxpayers paying for control programs, as consumers of affected ecosystem services, and as enjoyers and defenders of the natural environment. In NSW most environmental legislation has ‘open standing’ to allow any person to take civil proceedings to remedy or restrain a breach of the law. This not only facilitates enforcement if governments fail to do so but the potential for

community enforcement can motivate public authorities and prosecuting agencies to be more rigorous in their enforcement duty.

Take the following scenarios:

- A water authority is failing to control a declared weed on the banks of a stream from where it could spread throughout the catchment, and cause serious environmental and economic harm.
- A bush regeneration group has spent hundreds of voluntary hours and public funds to control a noxious weed that threatens an endangered species. But a nearby property owner (public or private) is failing to prevent escape of that weed from their property into the habitat of the endangered species.
- A business is cultivating a commercial crop species which is escaping from the property and invading a high-value wetland. The weed is not declared noxious because of its commercial value but will destroy the values of the wetland.

In each case, if government authorities fail to act, shouldn't the community have the right to seek an order from the Court for actions to prevent environmental and economic harm?

NSW has led the way in providing open standing under environmental laws including under the *Environmental Planning and Assessment Act 1979* and the *Protection of the Environment Operations Act 1997*. The latter Act in s 253 provides that 'any person' may bring proceedings in the Land and Environment Court to restrain a breach or threatened breach of any Act if the breach is causing or is likely to cause harm to the environment. Other NSW environmental legislation has similar provisions.

More than 30 years of experience in NSW has shown that community enforcement improves environmental outcomes and has not resulted in a flood of vexatious litigation. The extensive preparation and costs needed to undertake a court case means that there is a high barrier to commencing proceedings and typically only the most serious cases and those where the public is highly motivated progress. The former Chief Judge of the Land and Environment Court Justice Jerrold Cripps is one of many to observe this:

> *It was said when the legislation was passed in 1980 that the presence of section 123 would lead to a rash of harassing and vexatious litigation. That has not happened and, with the greatest respect to people who think otherwise, I think that that argument has been wholly discredited.*[128]

There are some differences between the Noxious Weeds Act and other environmental legislation relevant to community enforcement. Most other enforcement provisions are about stopping potentially damaging action whereas in some cases action under the Noxious Weeds Act would be about a failure to take positive action to prevent weed spread. There are also sometimes logistical impediments – lack of resources or techniques – that limit landholders' capacity to control weeds. But the Court can weigh up such factors and apply the 'reasonable and practical' test of a duty of care. In addition, restrictions on access to private properties would limit the capacity for community to gather evidence and thus limit the cases that could be brought. Wide standing provisions could be useful to a farmer whose business is threatened by the failure of another landholder to control weeds. In many cases, just the potential for the community to take enforcement action is likely to be sufficient to motivate more serious enforcement action by agencies with prosecution powers.

All persons and authorities should be treated equally under provisions subject to community enforcement, unless there are good reasons in specific instances to exempt public authorities. Equality before the law requires removing the blanket exemption currently in the Act for public authorities. It is appropriate that each side pay their own way as is often the case for environmental legislation where the community acts for the public good and has limited resources.

Penalties: The Noxious Weeds Act includes penalties for a range of offences with the highest of 100 penalty units for failure to comply with a weed control notice by a local control authority (s 19) and breach of a quarantine order (s 34A). Currently, with a penalty unit worth $110, the maximum penalty under the Act is thus $11 000. With the penalty for selling a notifiable weed just $5500, there is very little commercial disincentive for a businesses to have strict quality control to ensure they don't inadvertently sell notifiable weeds.

128 Cripps (1990)

Having regard to the serious harm that can result from breaches of the Act, we consider current maximum penalties far too low. In contrast, maximum penalties under weed laws in Queensland are $60 000, in South Australia $100 000 and 2 years imprisonment, and in Western Australia $100 000 and 1 year imprisonment. Under NSW's Pesticides Act 1999, the maximum penalty for causing harm to non-target plants and animals (by negligent or reckless use of a pesticide) is $250 000 for a corporation and $120 000 for an individual. We strongly recommend that penalties be increased in the Weeds Act to reflect the degree of harm that can result from breaches. Where an action is reckless and at the extreme end of severity, prison sentences should be available as penalties.

We also recommend including in the Act the potential for other types of penalties. Environmental legislation often includes the potential for remediation orders, for example, which is appropriate for weed management.

Recommendations

Enforcement: Review the effectiveness of enforcement under the Act and audit compliance levels.

Jurisdiction and legal standing: Shift jurisdiction to the Land and Environment Court. As is standard with environmental laws, provide open standing under the Noxious Weeds Act (or replacement biosecurity law) for community enforcement.

Penalties: Increase maximum penalties under the Noxious Weeds Act (or replacement biosecurity law) to reflect the potential for serious and ongoing environmental harm from breaches, to provide a commercial incentive for compliance and to be consistent with other environmental legislation. Increase the range of penalties, including prison sentences for extreme offenses and the potential for remediation orders.

5.7 Apply weed laws to all landholders

Currently, the Noxious Weed Act (s 70(2)) exempts the Minister and public authorities in NSW (or people acting under the direction of the Minister or authority) from any proceedings brought in any court to prevent or remedy a breach of the Act.[129]

There may be some instances in which it is appropriate to exempt categories of authorities or persons from the Act but the blanket exemption is unwarranted and unhelpful for achieving the objects of the Act, given that public authorities manage large areas of land and that breaches by them can have serious impacts. It is also inequitable for the other landowners subject to the Act and would undermine the capacity for community enforcement of the Act. We request the government to remove this blanket exemption. If there is warrant for particular exemptions, they should be subject to public consultation.

Recommendation

No exemptions: Remove the exemption in s 70(2) of the Noxious Weed Act and require all people and authorities to be liable to proceedings brought under the Act for breaches of the Act.

129 "No proceedings in any court may be brought against the Minister, a local control authority or a public authority, or a person acting under the direction of the Minister or an authority, for an order to remedy or restrain a breach or a threatened or apprehended breach of this Act by the Minister, authority or person as an occupier of land or in any other capacity under this Act."

6. Improve the knowledge base

Australia has a relatively poor knowledge of the biosecurity threats to its natural environment. This is largely a function of the absence of commercial incentives to research and monitor environmental pests and diseases. As a result, the principal responsibility for biosecurity research as it relates to the natural environment lies with governments and the community. These activities have not received a high priority for funding. Unlike incursions that impact on primary production, where active engagement by business is motivated by self-protection, the effort required to respond to an incursion affecting the environment must be provided primarily by governments.

2008 Beale review of federal biosecurity

6.1 Research

More research across many disciplines is needed to improve weed management capacity and to shape better policies on invasive plants. Basic information about the impacts of most weeds on biodiversity is lacking. The development of the NSW threat abatement plan for bitou bush saw the number of recognised at-risk species rise from six to 158.[130] Other than for a few significant weeds, there is virtually no research being conducted on weed impacts. There is need for more research into effective methods of control, particularly focusing on ecologically informed solutions that take account of ecological processes that affect weed establishment and spread. There is also need for research on the human dimensions of weed invasion – the social, cultural and economic drivers of invasions and effective interventions to promote responsible behaviours.

But while weed problems worsen, weed research capacity has declined. Australia lost a vital part of its weed management capacity when the Australian Government did not renew funding for the Weeds Management Cooperative Research Centre in 2007. Now there is piecemeal funding, and no overall strategic national research program. A national research program is needed but the NSW government should identify priority weed research issues and allocate funding for research to help it achieve its targets.

Recommendation

Research: Identify research priorities, including weed biology and ecology, management techniques and human dimensions. Dedicate a proportion of biosecurity funding to priority research questions. Advocate for a national weed management research centre.

6.2 Taxonomy

[If] you don't actually know what your organisms are then the rest of the science is empty.

Taxonomist Ryonen Butcher 2008[131]

Taxonomy is an essential science for weed management – needed to identify new weeds and establish their distribution, to distinguish native from non-native plants, assist with enforcement of weed laws and provide insights into the origins and relationships of serious weeds to provide options for management, including biocontrol. Failure to quickly and correctly identify a newly naturalised weed or a high-risk plant being sold can lead to invasions with high environmental and economic costs. But taxonomy in Australia is 'a discipline in crisis' with shrinking resources and a much depleted workforce.[132] A 2003-2006 survey by the Australian Biological Resources Study found that the taxonomic workforce was aging rapidly and declining, with a net loss of 2.5–3 taxonomic positions annually. About 30% of the Australian taxonomic workforce consisted of retirees working voluntarily. NSW lacks dedicated weed taxonomists. There is a particularly problematic gap with grass taxonomy. Exotic grasses are amongst the most serious weeds and often difficult to identify, but there is currently no full-time grass taxonomist at the Royal Botanic Gardens.

Recommendation

Taxonomy: Do a gap analysis of NSW's taxonomy capacity relevant to weed management, provide resources to fill the gaps and develop a plan to retain essential taxonomic services in the long-term.

130 Department of Environment and Conservation (2006).
131 <abc.net.au/radionational/programs/scienceshow/taxonomy/3198976#transcript>
132 Federation of Australian Scientific and Technological Societies (2008)

6.3 Monitoring and evaluation

We have much to learn from the successes and failures of past and current weed management (and bush regeneration) programs. There is now an increasing emphasis in NSW weed programs on monitoring, evaluation and reporting (in Weed Action grants for example) but there is often little or no funding for these elements. Ideally all programs should be treated as experimental, with monitoring, evaluation and reporting regarded as essential elements.

Recommendation

Learning while doing: Build monitoring, evaluation and reporting requirements into all weed programs to promote learning and adaptive management.

6.4 Data and information management

One of the many challenges of weed management is to collect and share relevant data and information from many different sources (academic, government, community). Current information on different aspects of weed management is widely dispersed and often unavailable. A central repository of information is needed with mechanisms to allow for information contribution from many sources. (Information management and dissemination was one of many great benefits provided by the Weeds CRC.)

Recommendation

Information management: Develop an information repository and data management centre to optimise collection, analysis and dissemination of information.

7. Optimise governance arrangements

For effective weed management in NSW, governance arrangements should reflect the seriousness and complexity of weed threats to both the environment and agriculture, promote cooperation and efficiency, and provide sufficient state and regional authority to implement weed plans and evaluate and report on their outcomes.

Currently, NSW's environmental agency has large landholder responsibilities for weed management (particularly in national parks) but no authority to regulate movement and sale of environmental weeds. Joint governance between environmental and agricultural agencies should be fostered, with regulatory authority consistent with portfolio responsibilities. Governance structures should foster cross-tenure, landscape-scale weed management. Currently, there are no bodies with sufficient authority to coordinate weed management across tenures at a regional level.[133] With cross-sectoral and cross-tenure representation, regional weed committees have evolved over 20 years into dynamic forums for promoting cooperation and sharing expertise. Cooperation needs to be complemented by authority to implement regional weed plans, to ensure that effort is directed to priorities and outcomes are monitored and evaluated.

Promoting cooperation should be explicitly recognised as an object in weed laws because it is so integral to the effective operation of the Act. Meaningful participation by the community sector is also essential for effective governance and effective weed management.

7.1 Legislative responsibility

Weeds are NSW farmers' most expensive natural resource management problem, so it is appropriate that the State's primary industries agency has a major role in weed management. However, environmental threats are at least as serious as those for agriculture, probably more so, and considerably more difficult to manage. The majority of newly invading species in NSW are environmental rather than agricultural threats. Of the 142 NSW weeds identified as priorities, 72% have an environmental impact and 43% an agricultural impact, with 18% a shared problem.[134] But NSW's environmental agency has a limited regulatory and formal policy role for weeds, which reflects the historical primary focus on agricultural weeds.

At present, the environment minister and the environment department have no legislated role or responsibility for environmental weeds beyond weed management as a land manager and in overseeing threatened species recovery efforts and threat abatement plans. Their influence on law and policy relies on agreements and relationships with the primary industries portfolio. The environment minister is hobbled in his/her responsibility for threatened biodiversity and key threatening processes by not having any capacity to directly regulate weeds that threaten biodiversity. A clear statutory responsibility for the environment minister would also justify greater investment in the coordinating and implementation role of the environment department.

This proposal is not intended as a criticism of staff or ministers involved in weed management in either department, or to imply that DPI are only interested in agricultural weeds. Legal arrangements should function to give environmental threats appropriate priority regardless of current incumbents and relationships. Biodiversity conservation is not an overall priority for the Department of Primary Industries, with its mission of *'Supporting diverse, profitable and sustainable food and fibre industries'.*

Institutional arrangements should maximise the potential for both environmentally and agriculturally responsible decisions under weed laws, no matter which individuals make the decisions. There is greater potential for this if environmental agencies have a strong role (and if there is meaningful involvement of the community sector). Both the environmental and agricultural sectors are likely to benefit from a structure that strengthens collaboration between agencies and increases the overall governmental focus on invasive species. A collaborative arrangement would increase the involvement of the environmental sector in weed policy, helping increase the priority accorded to biosecurity within government.

133 Joint Northern Weed Advisory Committees (2009).

134 <dpi.nsw.gov.au/agriculture/pests-weeds/weeds/weed-maps/nsw-weed-maps> (Accessed December 2013)

The environment agency has portfolio responsibilities that require responses to threatening processes beyond the boundaries of the conservation estate. A greater role for the environment agencies is likely to increase linkages with the management of other environmental threats such as land clearing. Conflicts of interest can be avoided by separating responsibility for regulation and enforcement from industry promotion and development. Agricultural agencies and ministers for example may have conflicts of interest over agricultural plants that threaten the environment. Collaboration will help ensure a good understanding of the various perspectives on such issues.

We recommend that under the Noxious Weeds Act or replacement biosecurity legislation, the environment and primary industries ministers have equivalent authority or authority relevant to their portfolio responsibilities, and that biosecurity, including weeds, be administered by a joint agency. One potential model for joint control is the NSW Marine Parks Authority, which reports both to the primary industries and environment ministers. This ensures that the interests of both portfolios are considered in administering the legislation. There would also need to be strong links with other agencies with land management responsibilities to promote responsible weed management.

7.2 Governance principles and structures

With the complexities and difficulties of weed management (hundreds of weed species with varying legal status, and multiple ecosystems, land tenures, land uses, sectors and government agencies), designing an effective governance system is challenging. There is no perfect system. We nominate the following principles and propose some structural arrangements.

Some structural principles

- Weed management is essential for both ecological health and agricultural prosperity. The distinctive requirements of environmental biosecurity are recognised.
- Public interest priorities in weed management are transparently determined and are based on the well recognised hierarchy of prevention, eradication, containment, control and asset protection.
- Coordination of weed management programs is at the landscape (regional) level. Weed management and monitoring is coordinated across all tenures.
- Weed management is a shared responsibility across government, land managers, industry and the community. Cross-sectoral cooperation is fostered and there is meaningful participation in decision-making by all relevant sectors. Representation of the environmental and community sector in cross-sectoral processes is consistent with the severity and diversity of weed impacts on the natural environment.
- There is authority at appropriate levels to achieve efficient implementation of weed management policies and plans and to monitor and evaluate effectiveness. It is clear who is accountable for which elements of weed management and biosecurity.
- There is a systematic scientific approach to weed risk assessment and weed declarations.

TABLE 3. OPTIONS FOR GOVERNANCE STRUCTURES

Desired outcome / principles	Tasks	Structure options
Ministerial level The environment and primary industry ministers have biosecurity powers that are consistent with their portfolio responsibilities.	Statutory biosecurity functions. Representation in national processes. Biosecurity advocacy within government.	The two ministers have equivalent powers under biosecurity laws, and jointly or in turn represent NSW interests at the national level.
State government level In recognition of the severity of weed impacts on both the environment and agriculture, there is joint responsibility by the environment and agricultural departments for development of biosecurity policy and administration of biosecurity laws.	Biosecurity policy development. Administration of biosecurity laws. Development and implementation of a permitted list approach to weed regulation. Administration of grants. Coordination of public land management, including monitoring and reporting on outcomes of programs on public land. Threat abatement plans. Participation in state and regional coordination of weed management programs. Statewide quarantine and compliance.	A joint DPI and OEH biosecurity unit reporting to both the environment and agricultural ministers.
Local government level Local governments play a lead role in prevention and control at a local level.	Control and eradication on council lands. Support community efforts. Community education. Compliance. Local listings and plans.	Structures and processes to engender strong input from community, experts and land managers. Maintain participation within regional committees OR via input through Local Land Services (see below).

State-wide coordination and integration with pest management There is state-wide coordination of weed management, in conjunction with coordination of pest management. Invasive species management is also better integrated with other land management functions such as fire management.	State-wide coordination of regional weed management planning and implementation. Setting of standards and targets. Evaluation and reporting on outcomes. Assessment of funding needs (standards of cover approach). Coordination with other relevant land management bodies (such as bushfire management). Coordination with other states on cross-border weeds.	A cross-sectoral state-coordinating committee – similar to Bushfire Coordinating Committee. Includes environmental and community representation. Invasive Species Commissioner with powers to co-ordinate and direct land managers (state and private) in programs to prevent and control invasive species.
Regional coordination Weed management is coordinated regionally and involves all major sectors. There is sufficient regional authority to achieve effective cross-tenure implementation.	Regional weed plans – development, implementation, monitoring, evaluation, reporting. Advise on regional listings. Possible compliance role. Community education.	Regional cross-sectoral authority – eg. regional weed committees or local land services. Use the most practical boundaries for weed management, which are likely to be existing regional weed committee boundaries. Model must ensure representation of community and environmental interests.
Weed listing Weed declarations are systematic and based on science, including ecology, with economic and social criteria taken into account for the assignment of management categories.	Assessment of weed status. Oversight of weed risk assessments. Scientific advice to government and coordinating committees. Identification of weed research priorities.	A scientific weeds committee oversees weed risk assessment and provides advice (or makes decisions) on weed declarations and other weed matters, including research priorities. NSW scientific committee (TSC Act) to be given similar powers for weeds impacting on threatened species.
Public land management Best practice weed management on all public lands with conservation values.	Weed management – coordination, planning, implementation, monitoring, evaluation and reporting. Participation in relevant state, regional and local bodies.	Land management agencies and authorities develop and implement invasive species management plans and report publicly on outcomes according to standardised criteria.

Recommendations

Structural principles: Identify the governance principles that should shape the structure and processes of biosecurity institutions, including the distinctive requirements of environmental biosecurity, transparent determination of public interest priorities, weed management as a shared responsibility, the value of meaningful public participation, authority at the appropriate level to achieve efficient implementation, and a systematic scientific approach to risk assessments and weed declarations.

Invasive species coordinating committee: Establish a multi-sector decision-making body modelled on the Bushfire Coordinating Committee to oversee statewide management of invasive species.

Joint responsibility across agencies: Develop a cross-agency invasive species unit, involving agencies with environmental, agricultural and land management responsibilities. Promote cooperation between agencies with overlapping responsibilities and promote integrated responses to weed problems.

Environmental and agricultural regulatory authority: Provide authority to both the environment and primary industries ministers for regulation of weeds relevant to their portfolio responsibilities.

Restructure to provide most efficient and accountable governance. Nominate structure.

Regional committees: Provide regional weed committees or their equivalent with legal, technical and resource capacity to oversee efficient implementation of regional weed plans.

7.3 Fostering cooperation and public participation

Because cooperation by many different government and non-government bodies is essential to effective weed management, 'fostering cooperation' is worthy of inclusion in legislation as an object to guide governance arrangements. Cooperation should extend beyond state borders – weeds do not respect borders and responses to many weed problems benefit from a national approach or interstate cooperation. This could include, for example, declarations in NSW to assist bordering states to achieve their weed management goals and, where possible, use of consistent definitions and mechanisms to increase harmonisation of laws between states. It would be ideal to implement a consistent permitted list approach across the eastern states and have a national mandatory labelling scheme.

Australia's Biodiversity Conservation Strategy 2010–2030 states:

> *'It is everyone's responsibility to conserve biodiversity. Governments will play a critical role, but unless the whole community works together to take up the challenge, then we are unlikely to stop the decline in biodiversity.'*

The environment is a public good and the community has both a strong interest and responsibility in protecting the environment (and the economy and community) from weed invasion. Implementation of weed targets would be strengthened by providing for increased transparency and meaningful public participation in decision-making and enforcement. This is a standard element of many environmental laws, helps develop trust between those with different roles and is a necessary part of enlisting the efforts of individuals and community groups.

Recommendation

Cooperation: Include an object in the Noxious Weeds Act (or replacement biosecurity law) about promoting cooperation and participation by the various governments and public bodies with responsibility for weed management and for public involvement in implementation along the lines of: 'To promote local, regional and national trans-border cooperation between all levels and agencies of government and their constituencies, and provide for public participation in decision-making and implementation.' Develop policy to outline how these objects will be achieved.

8. Develop a sustainable funding model

Relative to the economic and ecological costs of other forms of environmental pollution, the costs of nonindigenous species are … of particular concern because they are likely to be borne over very long time frames.

David Lodge & colleagues, Ecological Society of America, 2006[135]

There are enormous environmental and economic benefits in preventing and controlling plant invasions, and much more to be lost if we don't. This is widely accepted but often ignored when it comes to government policies and programs.

Stopping NSW's Creeping Peril, 2010

The greatest hurdle for weed management is inadequate – often woefully inadequate – funding. There is a compelling rationale for much more public funding for environmental weed management – due to the high level of threat, the environmental and economic benefits of reducing weed impacts, and to prevent escalating costs in future. Instead, governments have generally been reducing spending (although weed management in national parks has received a substantial boost) and there is little optimism that this will change. There is need to develop a new funding model for weed management and to identify new sustainable funding sources. Effective weed management requires reliable, long-term funding and a skilled, well-supported workforce. The NSW government has recognised the need for increased capacity with goal 28 of the NSW state plan being: 'Build capacity within local government, community groups and landholders to effectively manage invasive species.'

Investment in weed management, particularly prevention, can bring very high returns. But there is poor accounting of the cost of weeds to the environment and society, and therefore a limited understanding of the benefits of prevention, early action and ongoing management. The costs to agriculture are more readily determined and so there is greater government willingness to allocate resources (and enact strong regulation) to limit these costs. The *NSW Biosecurity Strategy 2013-2021* suggests an 'indicative' economic return of 1:100 for prevention and 1:25 for eradication. The real benefits are likely to be substantially greater, particularly over ecologically relevant timeframes. If the costs and benefits of inaction versus action were more clearly identified and quantified, the case for greater resources and improved regulation would be more compelling. We believe that the true costs to the environment and to society from weeds are considerably under-rated.

As most recommendations to improve weed management will have funding implications, it is essential that the NRC review addresses the following resource issues:

Accounting for weed impacts: Improve measurement of weed impacts on the natural environment and society to develop a more compelling economic case for additional resources and improved regulation.
Funding levels: Determine what level of funding is needed to achieve targets (including that in NSW's 2021 Plan to reduce the impact of invasive species by 2021) and what the current shortfalls are.
Funding sources: Identify new sustainable sources of funding, ensuring reasonable and fair contributions from different levels of government and different sectors.
Risk creators: Ensure that those who create weed risks contribute to mitigation and remediation.
Funding duration: Increase the duration of funding for programs. Effective weed management requires long-term action; the seed banks for many weed species can last 10 years or more.
Priorities: Prioritise targets for public funding in a transparent way, ensuring, in particular, a strong focus on habitat-transforming weeds.
Voluntary contributions: Assess, support and maximise the potential for voluntary effort to contribute to the highest weed management priorities.

8.1 Current resource levels and sources

Despite weeds being the second largest threat to biodiversity and accounting for the loss of one in eight dollars of agricultural revenue, relatively little public money goes to weed management. The NSW government can spend more to build 1 kilometre of freeway than it does for weed management each year.[136]

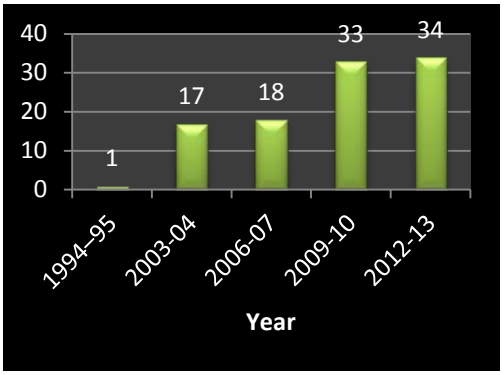
135 Lodge, Williams et al. (2006)
136 Parliament of NSW Legislative Assembly (2009). Costs per kilometre of road building typically range from $10-30 million per km.

The full extent of current funding is not clear. We have made a very rough estimate of the total public investment in weed management in NSW – about $60 million annually (excluding federal government grants). Private agricultural investment in weed control on a per hectare basis substantially exceeds that by governments.

TABLE 4. A VERY ROUGH ESTIMATE OF CURRENT LEVELS AND SOURCES OF FUNDING FOR ON-GROUND WEED MANAGEMENT IN NSW

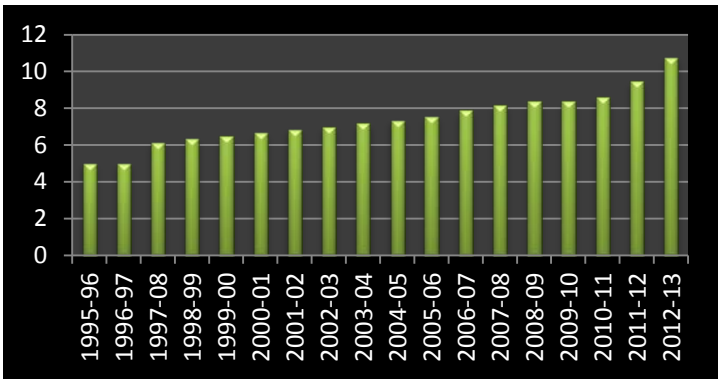
Source	Program	Area of focus	Estimated funding	Per hectare
State government	National parks	6.8 million ha (8.5% of NSW)	$17 million (assuming half of the $34 million budget for invasive species, 2012-13)[137]	$2.50
State government	State forest	2.2 million ha (3% of NSW)	$0.7 million (assuming half of the $1.4 million budget for invasive species, 2010-11)[138]	$0.32
State government	Weeds Action Program (grants)	State & regional projects	$9.7 million (2012-13)[139]	
Local government	Local government areas	9.3 million ha	$20-30 million (2009 and 2011 estimates)[140]	$3.20
Catchment Management Authorities	NRM projects		$3.5 million (half of $7 million for invasive species, 2008-09)[141]	
State government	Community Bush Regeneration grants		$2 million (assuming one-quarter of $8 million is spent on weeds, 2011)[142]	
Environmental Trust	Restoration and Rehabilitation grants		$1 million (assuming one-quarter of $4 million is spent on weeds, 2012)[143]	
Agricultural businesses	Farms	58.6 million ha (73% of NSW)	$475 million (2006-07)	$10.52
Bush regeneration, landscape restoration & other non-profit and voluntary groups	Landcare, Bushcare (councils), Coastcare, CVA, Greening Australia, NPA branches, Friends groups etc.	Mostly in bushland near areas of high population density	$100s of millions in-kind labour, as well as paid labour	

FIGURE 8. FUNDING FOR MANAGEMENT OF INVASIVE SPECIES IN NATIONAL PARKS (INCLUDING WEEDS)[144]



137 Annual report 2012-13
138 Annual report 2010-11
139 Hodgkinson (2013)
140 Local Government Association and Shires Association of NSW (2009); Local Government and Shires Association of NSW (2011).
141 Robertson (2010)
142 <environment.nsw.gov.au/grants/2011BushGrants.htm>
143 <environment.nsw.gov.au/grants/restoration.htm>
144 NSW State Government (2005); NSW State Government (2007); NSW State Government (2009); NSW Government (2013)

FIGURE 9. STATE FUNDING FOR WEED MANAGEMENT GRANTS ($ MILLION)[145]



Resources should be allocated based on transparent methods of prioritisation and be sufficient to achieve high priority goals. To better match funding to needs, we recommend an approach similar to that of 'standards of fire cover': to determine what level of resources is needed to provide an acceptable degree of protection to a particular area or value or to achieve a particular goal. Habitat-transforming weeds should be a high priority. The level of contribution by different funding sources – landholders, different levels of government and industry/businesses (including beneficiaries of weed control and sources of weed problems) – should be determined in a transparent and equitable way. An argument often heard is that the resource problem is not so much funding levels as it is an issue of prioritisation. This is wrong. While there can be improvements in prioritising, the current level of funding, however allocated, won't achieve NSW's invasive species targets. More funding is needed across the spectrum of weed management and for research.

8.2 Polluter pays principle

There is no requirement for those responsible for unsafe plant introductions and spread to take responsibility for the costs of managing weeds. The polluter pays principle, which is part of ESD, is not implemented for weed management. Typically, those managing weeds and paying for weed management are not those who created the problem.

8.3 Voluntary contributions

There is a very high voluntary contribution to weed management in NSW through the efforts of many individuals and groups. In a recent national survey (May-June 2013) of management effort on invasive species, the Invasive Species Council received 215 responses from organisations operating in NSW, 87% focused on weeds (Figure 10). They have a total of 57,547 volunteers (as well as paid staff). The annual contribution of these respondent organisations to weed management was equivalent to about 1500 full-time staff, consisting of the equivalent of 569 full time volunteers and 900 full time staff, which can be valued at $28.4 million and $50.0 million of effort respectively.[146]

145 Currently combining grants through the Weed Action Program and Weed Innovation Fund
146 Invasive Species Council (2013), with some additional analysis.

FIGURE 10. SURVEY RESPONDENTS INVOLVED IN NSW WEED MANAGEMENT, BY SECTOR

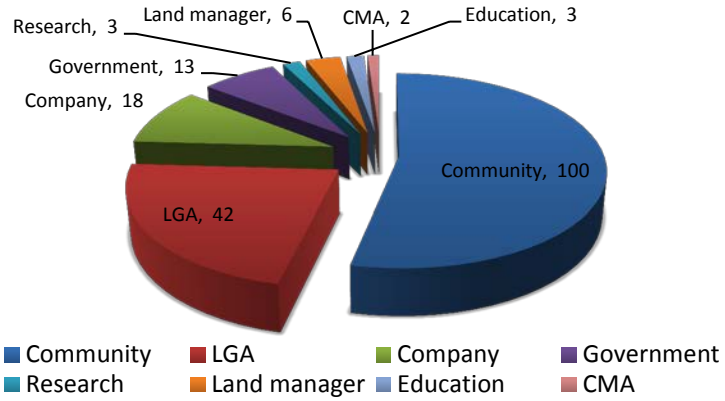


FIGURE 11. THE NUMBER OF PEOPLE INVOLVED IN WEED MANAGEMENT IN NSW (VOLUNTARY AND PAID, SURVEY RESPONDENTS ONLY)

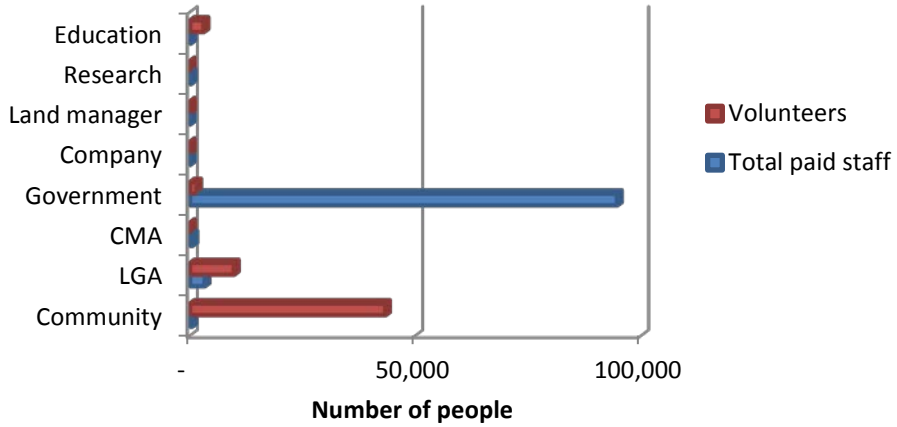
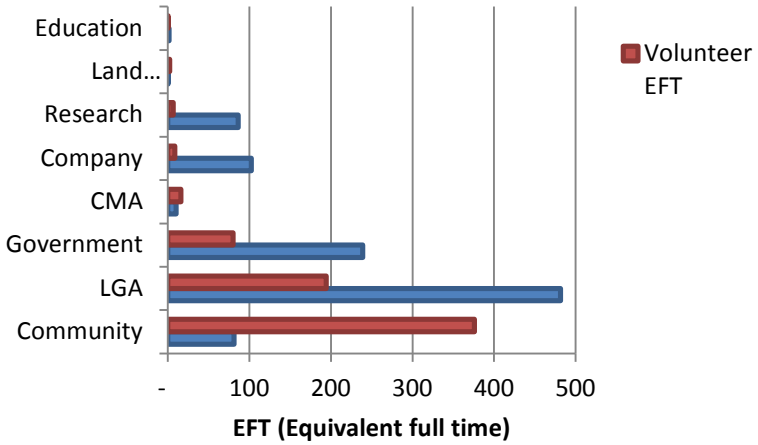


FIGURE 12. EFFORT (FULL-TIME EQUIVALENT) ON WEED MANAGEMENT IN NSW (VOLUNTARY AND PAID, SURVEY RESPONDENTS ONLY)



The effort recorded in the survey is only a proportion of the total voluntary and paid effort tackling weeds in NSW. By analysing sectors in NSW where the total size of the sector is known, the survey data can be extrapolated for a rough estimate of the total contribution of that sector. For example, Landcare Australia Limited records 1782 Landcare groups

carrying out on-ground activities in NSW.[147] The 27 NSW Landcare survey respondents that reported weed activities in the survey (half of the NSW Landcare survey repondents) represent 1.5% of all Landcare groups in NSW. Assuming that half of NSW's Landcare groups do weed management, a rough estimate of their total contribution to weed management, based on the average reported in the survey, is $47 million per year. Similar projections can be made for other sectors and sub-sectors based on the national averages of the contributions of each sector/subsector and the relative size of the survey sample. Using this methodology, the national contribution to invasive species management across Australia from voluntary and paid efforts is about $1.6 billion dollars each year. The NSW effort on weed management would represent a significant proportion of this effort and must be in the order of hundreds of millions of dollars.

More research on the value of volunteer and paid contribution to managing weeds and other invasive species and the capacity needs of the various sectors would be extremely useful. Note that the value of the yearly effort represents the willingness of funders (mostly government and private land managers) and the community (mostly through volunteer effort) to address the impacts of weeds, but not the cost of weed damage, which is largely uncosted.

Information on the size of the state and national research and development capacity on biosecurity can be found in a recent report to the Department of Agriculture, Fisheries and Forestry in 2012.[148] This report should be used careful because of the limited sources surveyed. It does not capture the capacity of the community sector, the environment departments, local government and academic contributions.

8.4 Potential new or enhanced sources of resources

Here are some options for addressing resource shortfalls and developing sustainable funding streams:

- Landholder levy: Such levies are already collected by Livestock Health and Pest Authorities (to be part of Local Land Services), and from several Trusts (eg. Hunter Catchment Management Trust and the Upper Parramatta River Catchment Trust) and through council rates to fund bushfire authorities. In Victoria, a levy is charged on all Melbourne residents via water rates to partly fund management of public parks and national parks managed by Parks Victoria. Levied funds can be used to support landholder capacity to manage weeds by investing in state and regional capacity. Because landholders have little capacity to influence activities beyond their boundaries, they are beneficiaries of improved regional weed management.
- Levies or bonds from risk creators: Consistent with the 'polluter pays' principle, industries or individual businesses responsible for introductions of potential weeds should be required to contribute to risk mitigation and threat remediation. Candidate industries include pine plantations and nurseries.
- Increased funding from general revenue – to a level commensurate with the environmental and economic impacts of weed invasions and the high priority that many citizens place on a healthy environment.
- Increased funding from council rates, either through special environmental levies or general contributions.
- Increased funding from public funds, including the NSW Weed Action program and the federal environment department.
- Utilisation of existing environmental levies, such as the waste levy that funds the NSW Environment Trust.
- Carbon offsets – managing invasive species can prevent and reduce greenhouse gas emissions.
- Development offset funding - more effective management of invasive species is a worthy focus for offsets required as part of development approvals under federal and state regimes.
- Philanthropic funding (although this is usually just for particular projects).
- Environment lottery (similar to lotteries in Western Australia and the Netherlands).
- Support for the voluntary community sector and landholders with conservation properties to optimise their contribution to effective weed management.

Recommendations

Needs assessment: Undertake a 'standards of weed cover' assessment to establish the levels of funding necessary to achieve effective weed management at a regional scale and NSW's invasive species targets.

147 Landcare Australia (2013).
148 IGAB (2012)

Funding model: Develop a funding model for weed management by which to determine a fair level of contribution from landholders, governments and industries/businesses. This should include a fair contribution from risk creators.

Funding sources: Investigate new potential sources of sustainable funding, including levies from risk creators and beneficiaries and landholders.

Prioritisation and duration: Develop a prioritisation process to ensure that resources are transparently directed to where they are most needed and most effective, including a strong focus on prevention and eradication, and on habitat-transforming weeds. Develop programs with long-term funding guaranteed to maximise the potential for success.

Optimising voluntary contributions: Strengthen the capacity of community groups willing to undertake weed monitoring and control and landholders with conservation properties to undertake work that contributes to state and regional weed goals – by providing long-term funding, training and technical support.

9. Compiled recommendations

1. Recognise weeds as a state environmental priority

Environmental focus: Recognise the distinctive challenges of environmental weed management and develop policies and programs accounting for those distinctive features.

Solutions forum: Establish a high level cross-disciplinary 'solutions forum' to develop new approaches to high priority environmental biosecurity challenges, including ecological, social, legal and economic aspects.

Environmental reporting: Using state of the environment approaches, document in detail NSW's environmental weed problems, including impacts, trends and drivers, and issue regular updated reports. Require consistent reporting by public authorities and bodies using a standard methodology so that trends can be analysed over time.

ESD: Include ecologically sustainable development in the objects of the Noxious Weeds Act (or replacement biosecurity law), requiring that ESD principles be applied. Define ESD to include standard ESD principles (precautionary principle, intergenerational equity, conservation of biodiversity and ecological integrity and improved valuation, pricing and incentive mechanisms) (eg. as in s 6(2) of the *Protection of the Environment Administration Act* 1997). Develop policy to explicate how ESD and its principles should be applied under the Act.

Mechanisms: Change the objects of the Noxious Weeds Act (or replacement biosecurity law) to allow for a wide array of mechanisms (including economic, educational and control) to be used to achieve the objects (this requires replacing 'control mechanisms' with 'mechanisms' in the existing object).

2. Make prevention a priority

Risk assessment for new introductions: Adopt a permitted list approach, requiring risk assessment of all new non-indigenous taxa not on a permitted list and allowing the sale and movement only of low-risk plants. Apply risk assessment to distinguishable variants of already introduced species to prevent the introduction of more invasive cultivars and hybrids and to limit the potential for combination with existing varieties to increase invasive risk.

Existing introductions: Apply risk assessment to already introduced species as basis for determining their status: regulatory (eg. prohibited, restricted, permitted) and management (eg. subject to eradication, containment, threat reduction, no control).

Risk assessment protocols: Use protocols that can be applied rapidly and are scientifically valid, precautionary and take climate change into account.

Surveillance: Identify high risk pathways for new unsafe introductions and develop surveillance programs, including for internet sales. Develop and promote ways for the public to report suspect new plant introductions and incursions. Investigate the potential to develop community bio-surveillance.

Response: Improve the early response capacity to deal quickly and effectively with introduction or naturalisation of potential new weeds.

3. Strengthen environmental weed management

Declarations: Develop criteria consistent with ESD under the Act to guide declaration decisions, and identify triggers/thresholds for environmental weed declaration assessments (eg. when weeds are identified in key threatening processes, as threats in listing advices for threatened species and ecological communities, or above a threshold score in the Downey et al. ranking of environmental weeds).

Native weeds: Maintain the current distinction between introduced native plant species, which should be managed as potential biosecurity risks, and indigenous species referred to as 'invasive native species' that are managed under native vegetation laws for agricultural purposes.

Eradication: Eradicate emerging or sleeper weeds where feasible, ensuring a timely response to maximise feasibility and limit costs. Adopt a state eradication target and allocate a specific budget for eradication of high risk incursions.

Containment: Prevent weed introductions and spread into uninvaded areas of NSW through a comprehensive containment strategy operating in conjunction with the permitted list approach that bans sale and movement of weed species meeting a certain threshold of risk or threat into uninvaded regions or local government areas and requires control to prevent spread beyond containment zones.

Weed programs: Implement sustained, large-scale programs (like that for bitou bush) necessary to achieve NSW's invasive species targets that include monitoring, evaluation and reporting. Complement weed management and native vegetation restoration with other management (eg. of fire and nutrients) to achieve more resilient ecological communities and restoration of ecological processes.

Ecological focus: Recognise the links between weed invasion and other environmental threats and processes (such as fire regimes, land clearing, nutrient enrichment and climate change) and focus programs on developing more effective ecological approaches to management.

Development standards: Develop enforceable standards for urban planning and development that limit the potential for weed spread – including standards for landscaping, retention of native vegetation and minimisation of land disturbance and nutrient enrichment.

Climate change adaptation: Adaptation programs should focus on weed management as a priority adaptation: reduce weed threats to support the capacity of native species to adapt to climate change, manage weeds likely to benefit under climate change, and prevent unsafe new introductions, ensuring that responses to climate change such as the cultivation of biofuels do not worsen invasive species problems.

Public land managers: Make weed management a reportable core business of all regulatory authorities with land management responsibility, with standardised weed mapping and reporting systems. Require government agencies and authorities to demonstrate compliance with a duty of care through compliance with approved codes of practice and weed management plans. Treat public authorities in the same way as other landowners for control of class 1, 2 and 3 weeds. Improve the land management capacity and skills of all land-holding agencies and ensure that weed management programs are coordinated across the public land estate.

Public land audits: Conduct regular weed audits of public lands, particularly those with high conservation values, to assess weed problems and management effectiveness and identify capacity needs.

4. Inculcate greater responsibility

Tools for motivation: Conduct a systematic gap analysis and review of tools to motivate responsibility amongst different actors for actions relevant to weed management.

Duty of care: Develop a wide and enforceable duty of care (or obligation similar to that in Queensland's Biosecurity Bill 2013) that requires anyone undertaking any activity with potential to increase adverse weed impacts to take all reasonable and practical measures to prevent or minimise biosecurity risks. Define and exemplify what a duty of care requires and specify penalties for breaches.

Codes of practice: Provide for approved codes of practice under biosecurity legislation as one way of demonstrating compliance with the proposed duty of care (or obligation). Develop criteria to determine when activities are best subject to regulation or codes of practice, with high-risk activities to be subject to regulation.

Managing risk: Adopt a category of 'managed species' with criteria to define which species are amenable to management. Establish an expert body to advise on declarations and management requirements and review

effectiveness. Subject declarations and management requirements to public consultation. Ensure that the proposed mechanisms of codes of practice or management plans are transparent and enforceable, including by the community. Include requirements for a bond and/or levy to cover costs of independent monitoring or control.

Labelling and education: Require labelling of garden plants as a condition of sale – to include taxonomic identification, natural distribution, invasive status and any precautions that should be taken. (Ideally, this would be a national scheme.) Undertake education to alert landholders and land managers to their responsibilities for weed control and about how to control particular weed priorities.

Polluter pays: Develop legal mechanisms, such as bonds and levies, by which those responsible for weed introductions and escapes are required to pay for or contribute to weed eradication and control.

Disclosure of weed status: Require a weed inspection report for land sales to ensure potential buyers are aware of weed problems and promote weed control to improve property values. Disclosure could take the form of a rating certification.

Enforcement: Review the effectiveness of enforcement under the Act and audit compliance levels.

Jurisdiction and legal standing: Shift jurisdiction to the Land and Environment Court. As is standard with environmental laws, provide open standing under the Noxious Weeds Act (or replacement biosecurity law) for community enforcement.

Penalties: Increase maximum penalties under the Noxious Weeds Act (or replacement biosecurity law) to reflect the potential for serious and ongoing environmental harm from breaches, to provide a commercial incentive for compliance and to be consistent with other environmental legislation. Increase the range of penalties, including prison sentences for extreme offenses and the potential for remediation orders.

No exemptions: Remove the exemption in s 70(2) of the Noxious Weed Act and require all people and authorities to be liable to proceedings brought under the Act for breaches of the Act.

5. Improve the knowledge base

Research: Identify research priorities, including weed biology and ecology, management techniques (including biological control) and human dimensions. Dedicate a proportion of biosecurity funding to priority research questions. Advocate for a national weed management research centre.

Taxonomy: Do a gap analysis of NSW's taxonomy capacity relevant to weed management, provide resources to fill the gaps and develop a plan to retain essential taxonomic services in the long-term.

Learning while doing: Build monitoring, evaluation and reporting requirements into all weed programs to promote learning and adaptive management.

Information management: Develop an information repository and data management centre to optimise collection, analysis and dissemination of information.

6. Optimise governance arrangements

Structural principles: Identify the governance principles that should shape the structure and processes of biosecurity institutions, including the distinctive requirements of environmental biosecurity, transparent determination of public interest priorities, weed management as a shared responsibility, the value of meaningful public participation, authority at the appropriate level to achieve efficient implementation, and a systematic scientific approach to risk assessments and weed declarations.

Invasive species coordinating committee: Establish a multi-sector decision-making body modelled on the Bushfire Coordinating Committee to oversee statewide management of invasive species.

Joint responsibility across agencies: Develop a cross-agency invasive species unit, involving agencies with environmental, agricultural and land management responsibilities. Promote cooperation between agencies with overlapping responsibilities and promote integrated responses to weed problems.

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Funding sources: Investigate new potential sources of sustainable funding, including levies from risk creators and beneficiaries and landholders.

Prioritisation and duration: Develop a prioritisation process to ensure that resources are transparently directed to where they are most needed and most effective, including a strong focus on prevention and eradication, and on habitat-transforming weeds. Develop programs with long-term funding guaranteed to maximise the potential for success.

Optimising voluntary contributions: Strengthen the capacity of community groups willing to undertake weed monitoring and control and landholders with conservation properties to undertake work that contributes to state and regional weed goals – by providing long-term funding, training and technical support.

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