

Weed risk assessment of twenty plant species used for revegetation or farm forestry in South Australia

Rachel L. Melland and John G. Virtue

Animal and Plant Control Commission, GPO Box 1671, Adelaide, South Australia 5001, Australia

Summary Concerns have been raised over the weed risk to natural ecosystems potentially created by the mass planting of revegetation species in South Australia. A weed risk ranking system devised by the Animal and Plant Control Commission (APCC) of South Australia (SA) was applied to 20 species which have been or are being used for revegetation and which were nominated for investigation by the SA State Revegetation Committee. The system considers the invasiveness, impacts and potential distribution of each species to give a weed importance score, and in this case the focus was on potential threats to areas of native vegetation in SA. Weeds were scored based on information collected from a widely distributed questionnaire, the SA herbarium, field observations across the state and from GIS analysis of climatic and soil preferences.

On a statewide scale, species which scored as a very high weed risk to native vegetation were; *Pinus halepensis* (Aleppo pine), *Pinus brutia* (Calabrian pine), *Acacia saligna* (golden wreath wattle), and *Ehrharta calycina* (perennial veldt grass). *Acacia cyclops* (western coastal wattle) scored as a high weed risk. *Pinus radiata* (Monterey pine) and *Casuarina glauca* (swamp sheoak) were medium weed risk species. Species which scored as a low weed risk were: *Eucalyptus globulus* (Tasmanian blue gum), *Eucalyptus cladocalyx* (sugar gum), *Eucalyptus platypus* (round leaf moort), *Chamaecytisus palmensis* (tagasaste), *Medicago sativa* ssp. *sativa* (lucerne), *Thinopyrum ponticum* (tall wheatgrass) and *Puccinellia ciliata* (perennial sweet grass). Species which had negligible weed risk were: *Eucalyptus grandis* (flooded gum), *Eucalyptus occidentalis* (flat-topped yate), *Eucalyptus saligna* (Sydney blue gum), *Atriplex nummularia* ssp. *nummularia* (old man saltbush), *Atriplex amnicola* (river saltbush), and *Themeda triandra* (kangaroo grass). Implications for the future use and management of these species in South Australia are discussed.

Keywords Weed risk assessment, environmental weeds, revegetation, farm forestry, South Australia, *Eucalyptus globulus*, *Eucalyptus cladocalyx*, *Eucalyptus grandis*, *Eucalyptus saligna*, *Eucalyptus occidentalis*, *Eucalyptus platypus*, *Pinus radiata*, *Pinus halepensis*, *Pinus brutia*, *Casuarina glauca*, *Acacia cyclops*, *Acacia saligna*, *Chamaecytisus palmensis*, *Atriplex nummularia*, *Atriplex amnicola*, *Medicago*

sativa, *Thinopyrum ponticum*, *Puccinellia ciliata*, *Ehrharta calycina*, *Themeda australis*.

INTRODUCTION

Internationally, invasive species are the second greatest threat to biodiversity after habitat destruction (Pimm *et al.* 1995). Environmental weeds, plant species that invade natural habitats beyond their native range, are a major component of this biodiversity threat. Such species have often been introduced from overseas for agricultural or ornamental use in Australia (Groves 1998). There are also Australian natives that are environmental weeds; for example, Cootamundra wattle (*Acacia baileyana* F.Muell.) from New South Wales and Western Australian bluebell (*Sollya heterophylla* Lindl.) have both invaded SA bushland. There are limited resources to tackle weeds in natural areas and a preventative approach is the most cost-effective. There is a need to limit the use of species with environmental weed potential, and to manage the risks of such species spreading where there is no satisfactory alternative.

The wide scale planting of species for revegetation, forestry, agriculture and horticulture increases the likelihood that some species will naturalise and invade native vegetation or other land use systems (e.g. Mulvaney 2001). However, the majority will be of negligible weed risk; Williamson and Fitter (1996) estimated that around ten per cent of naturalised plant species become weeds of significant economic and ecological impact. Concerns about the environmental weed risk of species promoted for revegetation and farm forestry have been raised by various SA government and conservation bodies. In 2001 the PIRSA Revegetation Program and the State Revegetation Committee of South Australia commissioned the Animal and Plant Control Commission (APCC) to undertake a weed risk assessment of 20 plant species (Table 1). The species have been or are currently being used in SA for forestry, farm revegetation (e.g. for shelterbelts, dryland salinity management, soil stabilisation), amenity uses or for fodder/pasture. The plant species list consists of ten tree, five shrub, one herbaceous perennial and four grass species. This paper is a summary of a technical report (Virtue and Melland 2002) which has been produced by the APCC as a result of this work.

MATERIALS AND METHODS

Data and knowledge regarding the invasiveness, impacts and potential distribution of each of the 20 species were collected in several ways. Locations of past naturalisations were accessed from the South Australian Biodiversity Centre (formerly the South Australian Herbarium). The locations of current weedy (or non-weedy) sites were requested from people via email, post and newsletter articles, resulting in approximately 150 responses. A literature review and internet search were conducted, the latter targeting plant databases and international herbaria sites. Field trips were undertaken throughout regional SA to conduct interviews and meetings, and to undertake site visits of weed infestations.

The potential distributions of each species in SA were estimated by GIS analysis, selecting sections of native vegetation that met soil attribute and climate preferences for each species. Proportional areas at risk were calculated for seven regions of SA (Figure 1). The CLIMATE model (Pheloung 1996) was used for matching temperature and rainfall preferences based on current Australian and/or overseas native and naturalised distributions.

The APCC Weed Assessment Scoresheet (Virtue 2000) was used to rank the potential weed threats of each species to native vegetation in the seven regions of SA. The scoresheet consists of a series of multiple choice questions, grouped into three criteria; *Invasiveness*, *Impacts* and *Potential Distribution*. Scores for the criteria (each ranging from 0 to 10) are then multiplied to give a *Weed Importance* score.

RESULTS

Table 1 shows regional weed risk ratings for the 20 species. Scientific names are used for brevity (see Summary for common names).

Trees The eucalypt species were considered to have low invasive ability, which would result in low naturalised densities in native vegetation and thus minimal impacts. *E. globulus* is limited by rainfall combined with the availability of high fertility, non-alkaline, well-drained soils (which have largely been cleared for agriculture), and so the species poses a negligible weed risk in most areas and a low risk in the Mt. Lofty Ranges/Adelaide Metropolitan (MLR/Metro) and Kangaroo Island (KI) regions. *E. cladocalyx* is

Table 1. Weed risk categories for the 20 species in the seven regions. VH = very high (Weed Importance score >100), H = high (score >40), M = medium (score >20), L = low (score >0), N = negligible (score 0), I = indigenous.

Species	Eyre	NAD	MLR/ Metro	KI	MDB	SE	Range /AL
<i>Eucalyptus globulus</i> Labill. ssp. <i>globulus</i>	N	N	L	L	N	N	N
<i>Eucalyptus cladocalyx</i> F.Muell.	I	I	H	I	M	H	I
<i>Eucalyptus grandis</i> W.Hill ex Maiden	N	N	N	N	N	N	N
<i>Eucalyptus saligna</i> Sm.	N	N	N	N	N	N	N
<i>Eucalyptus occidentalis</i> Endl.	N	N	N	N	N	N	N
<i>Eucalyptus platypus</i> Hook.	N	L	N	N	N	L	N
<i>Pinus radiata</i> D.Don	N	N	VH	VH	L	VH	N
<i>Pinus halepensis</i> Mill.	VH	VH	VH	VH	VH	VH	L
<i>Pinus brutia</i> Ten	VH	VH	VH	N	VH	VH	L
<i>Casuarina glauca</i> Sieber ex Spreng.	L	M	L	M	L	H	N
<i>Acacia cyclops</i> A.Cunn. ex G.Don	I	H	M	VH	VH	VH	N
<i>Acacia saligna</i> (Labill.) H.L.Wendl.	VH	VH	VH	N	H	VH	N
<i>Chamaecytisus palmensis</i> (H.Christ) F.A.Bisby & K.W.Nicholls	N	N	H	L	L	M	N
<i>Atriplex nummularia</i> Lindl. ssp. <i>nummularia</i>	I	I	N	N	I	N	I
<i>Atriplex amnicola</i> Paul G. Wilson	N	N	N	N	N	N	N
<i>Medicago sativa</i> L. ssp. <i>sativa</i>	L	L	L	N	L	L	N
<i>Thinopyrum ponticum</i> (Podp.) Z.-W.Liu & R.R.-C.Wang	L	M	L	M	L	H	N
<i>Puccinellia ciliata</i> Bor	L	L	L	L	N	L	N
<i>Ehrharta calycina</i> Sm.	VH	VH	VH	VH	VH	VH	H
<i>Themeda triandra</i> Forssk.	I	I	I	I	I	I	I

indigenous to three regions (the Eyre, Northern Agricultural Districts (NAD) and KI) and therefore poses no weed risk, assuming that the indigenous form of the species is planted in those areas. *E. cladocalyx* has naturalised outside its range at medium densities in SA, giving it a moderate impacts score (data not shown). This in combination with a high suitability to the MLR/Metro and South-East (SE) regions gives *E. cladocalyx* a high weed risk for these two regions. It is also a medium weed risk for the Murraylands region. *E. grandis*, *E. saligna*, *E. platypus* and *E. occidentalis* are negligible weed risks in all regions of SA. For the first two species this is primarily due to them requiring a higher rainfall than is present in this state. *E. platypus* and *E. occidentalis* are limited in the availability of their soil type preferences (i.e., areas of native vegetation with alkaline clay soils and shallow standing water respectively).

Pinus radiata is a very high weed risk for the MLR/Metro, KI and the SE regions. *P. radiata* had high Impacts and Invasiveness scores (data not shown), but its potential distribution is limited to areas of higher rainfall and cooler temperatures. *P. halepensis* and *P. brutia* scored highly for Invasiveness, Impacts and Potential Distribution, and were a very high weed risk across most southern SA regions. *C. glauca* posed a high weed risk to native vegetation in the SE region, and a medium risk for the KI and NAD regions. *C. glauca* forms dense monocultures which gave it a high impacts score, but was limited in potential distribution by access to permanent high groundwater tables.

Shrubs *A. cyclops* had a very high risk rating for the KI, Murray Darling Basin (MDB) and SE regions. The species was a high risk to the NAD and a medium risk to the MLR/Metro region. For the Eyre region we have treated it as indigenous and therefore not a weed risk. There is contention over the indigenous range of this dominant and competitive species in SA. *A. saligna* poses a very high weed risk in the Eyre, NAD, MLR/Metro and SE regions. The species poses a high weed risk in the MDB, and a negligible risk in the other regions, due to poor climate matches. *C. palmensis* generally poses a low to negligible weed risk. However, in the SE and MLR/Metro regions it poses medium and high weed risks respectively. This was due to much of the remaining native vegetation in these regions being on favourable well-drained, acidic soils. However, the weed risk of *C. palmensis* needs to be kept in perspective to other weedy legumes. Gorse (*Ulex europaeus* L.), Scotch broom (*Cytisus scoparius* (L.) Link) and Cape broom (*Genista monspessulana* (L.) L.A.S.Johnson) had impacts scores (and subsequently Weed Importance scores) 2.5 to 3

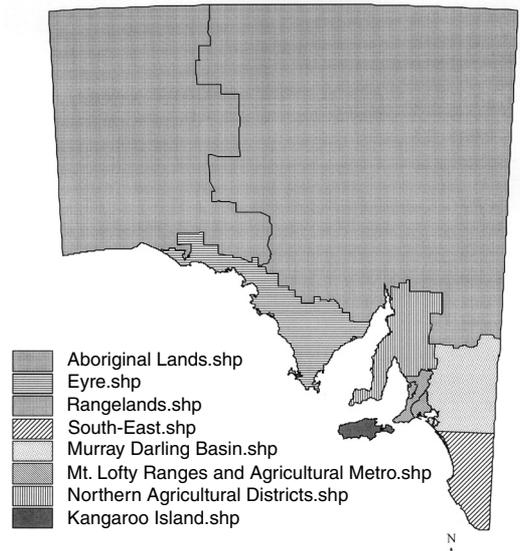


Figure 1. The seven regions used in the project (based on former NHT regions). The regions are Rangeland and Aboriginal Lands, Eyre, Northern Agricultural Districts (including Yorke Peninsula), Mt. Lofty Ranges and Adelaide Metropolitan, Kangaroo Island, Murray Darling Basin and South-East.

times higher than tagasaste (APCC data, not shown). *A. nummularia* is indigenous to most of SA and presents a negligible weed risk. The Western Australian species, *A. amnicola*, also scored as a low weed risk, limited in invasiveness and thus impacts, and also the availability of heavy clay soils in arid SA. *M. sativa* presented a low to negligible weed risk to all areas of SA, and does not have a reputation as an environmental weed in Australia or overseas, despite being widely planted.

Grasses The weed risk ratings of *T. ponticum* vary widely across the state, despite a high Impacts score (monocultures were common). This was largely due to differences in the relative areas of remaining native vegetation associated with shallow soil water tables. It is a high risk to the SE region and a medium risk to the NAD and KI regions. *P. ciliata* presented a low to negligible weed risk across SA, being a poor competitor and restricted to wet, saline sites. *E. calycina* had very high weed risk ratings for native vegetation for all southern regions. It had a high weed risk rating for the Range/AL region. *T. triandra* is indigenous to almost all areas of SA and so was not classed as a weed risk at all. However, if it were not indigenous this native grass would present a high weed risk in most regions

of SA, largely due to climate suitability and wide soil preferences.

DISCUSSION

In recommending risk management options for specific species, three other criteria also need to be considered aside from weed risk: the value of native vegetation threatened, feasibility of controlling spread and the utility or profitability of the species. The following recommendations were made:

Noxious weed declaration Owing to their very high weed risk, relative ease of seedling control and limited distribution, feral *P. radiata* and *P. halepensis* should be considered for mandatory control, in a similar manner to feral olives in SA.

Forestry Industry's duty of care Timber plantation managers should undertake routine control of any pine seedlings spreading into adjacent native vegetation. SA Forestry has been doing this for many years and deserves credit for their environmental responsibility. Whilst eucalypts were a low weed risk it would also be precautionary to control any volunteer seedlings, especially after a fire event.

Limiting spread Planning and management guidelines need to be developed to limit spread from plantings of high weed risk but high utility species (i.e., *P. radiata*, *P. brutia*, *A. saligna*, *E. cladocalyx*, *C. glauca*, *C. palmensis*, *E. calycina* and *T. ponticum*). This includes restrictions on use (e.g. *E. calycina* for grazing but not dune stabilisation), buffer distances from native vegetation or waterways, limiting seed production (e.g. through grazing pressure or coppicing), and routine monitoring and control of escapees (using safe and effective techniques).

Responsible plant ownership Community awareness is needed of the high weed risk of some species, as a disincentive for non-economic use where safe alternatives exist (e.g. ornamentals, windbreaks). Noxious weed legislation is currently limited in that plants spreading to a neighbouring property become the recipient's legal responsibility for control. Consideration of the 'polluter-pays' principle is needed in reviewing legislation.

Site-led weed control Where high weed risk species are widely planted and/or naturalised (e.g. *A. saligna*, *A. cyclops*, *E. calycina*) then regional control programs should focus on protecting areas of high conservation value from invasion. A similar focus should apply to species with high impacts restricted to relatively

uncommon environments (e.g. *T. ponticum* threatening native saltmarsh).

Genetic selection *P. brutia* and *A. saligna* are potential future agroforestry industries and selection of genetic lines should include a focus on reduced reproductive ability (e.g. low seed production, delayed time to seeding, poor seedling establishment).

Indigenous versus native to SA The original distribution of *A. cyclops* in South Australia needs determining. If the species is found to be non-indigenous to the Kangaroo Island, South-East, lower and eastern Eyre, Yorke and/or Fleurieu Peninsula regions, then regional weed management strategies should be developed to limit further planting and implement control of this high weed risk species. Forestry plantings of *E. globulus* and *E. cladocalyx* should be kept distant from indigenous populations to maintain genetic integrity of local provenances. Similarly, *T. triandra* plantings should use local seed.

ACKNOWLEDGMENTS

The authors would like to thank the many people within South Australia and interstate who enthusiastically provided time and information towards this project.

REFERENCES

- Groves, R.H. (1998). 'Recent incursions of weeds to Australia 1971–1995.' CRC for Weed Management Systems Technical Series, No. 3.
- Mulvaney, M.J. (2001). The effect of introduction pressure on the naturalisation of ornamental woody plants in south-eastern Australia. In 'Weed risk assessment,' eds R.H. Groves, F.D. Panetta and J.G. Virtue, pp. 186-93. (CSIRO Publishing, Collingwood, Victoria).
- Pheloung, P.C. (1996). CLIMATE: A system to predict the distribution of an organism based on climate preferences. Agriculture Western Australia.
- Pimm, S.L., Russell, J.L., Gittleman, J.L. and Brooks, T.M. (1995). The future of biodiversity. *Science* 269, 347-50.
- Virtue, J.G. (2000). Weed assessment guide 2000. Animal and Plant Control Commission, Adelaide, South Australia. (Unpublished, available on application).
- Virtue, J.G. and Melland, R.M. (2002). Technical report: Weed risk assessment of twenty plant species used for revegetation or farm forestry in South Australia. (Animal and Plant Control Commission, Adelaide, South Australia).
- Williamson, M. and Fitter, A. (1996). The varying success of invaders. *Ecology* 77, 1661-6.