

# The Parable of Pines in Australia

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## Abstract

This article discusses the introduction and present status in Australia of *Pinus radiata* D. Don (known as Monterey Pine, Californian Pine, Radiata Pine, or Remarkable Pine) and speculates why expressions, such as 'environmental weeds' and 'invasive alien species' have been applied to it. It questions whether moves to remove this introduced species in the interests of conservation are based on science or cultural values of particular groups and touches on the implications for how we value and manage our 'natural' environments.

**Keywords:** Radiata Pine; environmental weeds; invasive alien species; Australian weeds

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## Introduction

*'...If that the pine on Pelion's slopes had never felt the axe, and fallen to put oars Into those heroes' hands, who went at Pelias' bidding to fetch the golden fleece !'* Euripides, *Medea* <sup>1</sup>

In 2013 the Yarra Ranges Council in Melbourne's outer east felled two stands of mature Radiata Pine trees (*Pinus radiata* D. Don), comprising 500 trees, in the Richards Reserve in Montrose, replacing them with indigenous species. How was the decision to cut down the pines justified? The Council claimed that *P. radiata* is one of the five most widespread 'environmental weeds' in the Yarra Ranges. The pines were seen as 'Invasive Alien Species' (IAS), threatening nature conservation values. However, the Council's public statements did not refer to any assessment of the particular risks posed by these historical stands (Yarra Ranges Council, 2013).

The Richards Reserve, at its closest, is about 1 km from the Dandenong Ranges National Park and is surrounded by houses. Did the pines pose any threat to that national park? What was the basis for the judgment that the pines were environmental weeds? The felling raises questions about how we should deal

with the legacy of the 19<sup>th</sup> -Century introduction of *P. radiata* to Australia – and other introduced plants, generally.

Although many environmental weed lists compiled in recent years have included *P. radiata*, a list of the most significant weeds published by the Yarra Ranges Council in 2014 did not include *P. radiata* but did include 'blackberry (*Rubus fruticosus* L. sp. agg.), pittosporum (*Pittosporum* Banks ex Sol. spp.), English ivy (*Hedera helix* L.), spear thistle [*Cirsium vulgare* (Savi) Ten.], montbretia (*Crocsmia* Planch. spp.), creeping buttercup (*Ranunculus repens* L.), wandering trad (*Tradescantia* Ruppert ex L. spp.), Japanese honeysuckle (*Lonicera japonica* Thunb.), nightshade (*Solanum nigrum* L.) and cotoneaster (*Cotoneaster* Medik. spp.)' (Yarra Ranges Council, 2014).

A local field guide, published by the Friends of Sherbrooke Forest and the Department of Conservation, Forests and Lands, listed *P. radiata* among introduced plants present in the Sherbrooke Forest (part of the Dandenong Ranges National Park), but not among the major threats posed to the natural vegetation (Friends of Sherbrooke Forest Victoria and Department of Conservation, 1989).

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<sup>1</sup> The quote appears in Euripides' *Medea and Other Plays* (2000), Translated by Phillip Vellacott,

We know little of the local residents' reaction to this alteration to their cultural landscape, but we may infer that at least some people would miss the trees. The removal was timed to avoid the seasonal feeding on the pines by Yellow-tailed Black Cockatoos (*Zanda furnera*, Shaw, 1794; syn. *Calyptorhynchus funereus*)<sup>2</sup>, an indigenous species, which apparently knew and enjoyed the pines but would now need to look elsewhere.

The Radiata or Monterey Pine was widely planted in Australia and other countries following its discovery by Europeans in the mid-19<sup>th</sup> Century in California. Introduced from California to England by David Douglas in the 1830s under the earlier name *Pinus insignis* Douglas ex Loudon (meaning 'Remarkable pine') (Nisbet, 2009, p. 252), it is a large, handsome, quick-growing tree up to 50 m in height, with thick, dark-brown bark, which on old trees is divided by deep ridges.

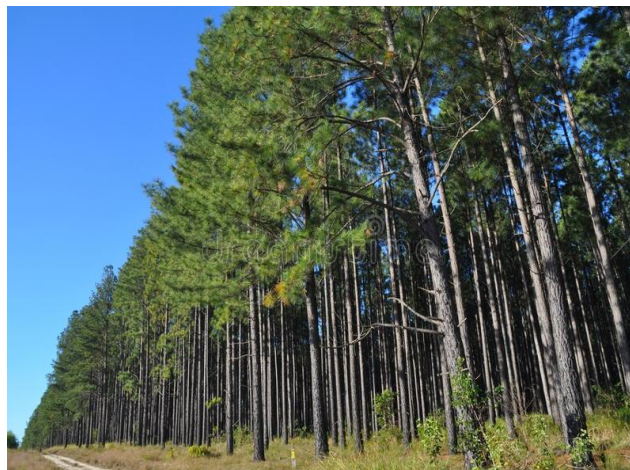
The dark-green, thin leaves or needles are in three groups, 8 to 15 cm long, in dense clusters. The female cones may be solitary or in clusters, on short stalks, and are asymmetrically egg-shaped, up to 15 cm long, with scales rounded on their exposed portion. Each scale contains two winged seeds adapted to wind dispersal (Richardson, Richardson, and Shepherd, 2011, p. 9; Spencer, 1995, p. 263; Walsh and Entwisle, 1994, p. 119; The Jepson Herbarium - Jepson eFlora<sup>3</sup>).

Restricted in the wild to a few square miles of hilly terrain near the sea around Monterey in southern California and two small Mexican islands off Baja California, where it is now rare and endangered (Spencer, 1995, p. 264; 2002), Monterey or Californian Pine has been amazingly successful in many countries to which it has been introduced. It has also been planted in various parts of the Californian coast, where it has become naturalised. Given a fresh start in Australia, New Zealand, Italy, and South Africa, this almost extinct pine delighted foresters with its rapid growth and good form (Duffield and Stockwell, 1949).

The species is now one of the most widely cultivated timber plants in the world, in plantations covering some 3.7 million ha in all, including New Zealand (1.2 million ha), Chile (1.3 million), Australia (740,000 to 1 million) (New South Wales Department of Primary Industries, 2008) and Spain (260,000) (Wu et al., 2007). *Pinus radiata* is by far the most important

tree in New Zealand (Webb, Sykes, and Garnock-Jones, 1988). *Pinus* has been popular as a plantation species because it grows rapidly under a range of climatic conditions, producing a most useful softwood timber (Figure 1).

It is suggested that plantation areas in the world are likely to increase. The tree has also been much planted in south-western Britain, near coastal resorts in particular, where mature trees serve as landmarks and give a distinctive character to the landscapes (Mabey, 1997, p. 25).



**Figure 1** A pine plantation in New South Wales, Australia, grown for commercial timber harvest

It is noted that other species of pines, such as twisted pine (*Pinus contorta* Dougl.), Aleppo pine (*P. halepensis* Mill.), black pine (*P. nigra* Arnold), Mexican weeping pine (*P. patula* Schiede and Deppe), cluster pine (*P. pinaster* Ait.), western yellow pine (*P. ponderosa* Laws), Turkish pine (*P. brutia* Ten.), and Scotch pine (*P. sylvestris* L.), have also been widely introduced in the southern hemisphere and have established populations over considerably

<sup>2</sup> Yellow-tailed black cockatoo  
(<https://avibase.bsc-eoc.org/species.jsp?avibaseid=E6DFA7077084129A>).

<sup>3</sup> The Jepson eFlora, Vascular Plants of California, University of California, Berkeley ([https://ucjeps.berkeley.edu/eflora/search\\_eflora.php?name=](https://ucjeps.berkeley.edu/eflora/search_eflora.php?name=)).

large areas (Richardson, Williams and Hobbs, 1994; Hill, 1998). However, this essay is confined to *P. radiata* because it has been the species most used in plantations in Australia, Chile, New Zealand, and South Africa.

How have *Pinus* trees come to fall from grace as trees introduced and cultivated for their beauty and utility for more than 150 years, since around the 1850s and come to be felled in 2013 as an invasive alien species that threatened indigenous vegetation?

Peters (1983) gave a warning referring especially to the *Radiata* pine that, "despite the commercial benefits and attractive appearance of the pines grown in Australia, it is a pity that they have been allowed to invade natural vegetation to the extent they have".

## Taxonomy

The taxonomy of *P. radiata* (Figure 2) has been more complicated than the above account suggests. Ian Tyrrell, in his study of the exchange of plants between California and Australia, *True Gardens of the Gods* (1999), prefers the common name 'Remarkable Pine', a name given by Australian foresters. 'Remarkable' is simply a translation of *insignis*, the name given to pines originally by David Douglas.

Tyrell suggests that *P. radiata* and *P. insignis* were distinguished as different species, although 'later botanists' identified the different characteristics as 'minor variations of the same species'. Support for the suggestion that *P. radiata* and *P. insignis* were seen as separate but closely related species is provided by John Ednie Brown's *A Practical Treatise on Tree Culture in South Australia* (1883).

Brown, who was somewhat a controversial figure, did make a significant contribution to the cultivation and promotion of pines across Australian States and Territories. It seems that *P. insignis* Douglas ex Loudon, was for a time, the accepted designation but has been replaced by the more accepted name *P. radiata* D. Don<sup>4</sup>.

Later fieldwork by Ken Eldridge and his colleagues from the CSIRO Division of Forest Research in 1978 recognised three varieties of *Pinus radiata*: viz. *P. radiata* var. *radiata* from California, *P.*

*radiata* var. *binata* Englem. (Lemmon) from Guadalupe Island, and *P. radiata* var. *cedrosensis* (Howell) Silba from Cedros Island. The varietal name *binata* was first used by Engelmann (1880) and the name *cedrosensis* by Howell (1941), who gave a useful account of its history.



**Figure 2** Female (A) and male (B) cones of *Pinus radiata*

<sup>4</sup> Don, D. (1836). Descriptions of Five new Species of the Genus *Pinus*, discovered by Dr. Coulter in California. *Transactions of the Linnean Society*. London, 17 (3): 439-444. (Available at: [https://www.biodiversitylibrary.org/page/137872\\_94#page/504/mode/1up](https://www.biodiversitylibrary.org/page/137872_94#page/504/mode/1up)); David Don (1799-1841), who named *Pinus radiata*, was a Scottish botanist

who specialized in conifers. He was Professor of Botany at King's College, London (1836-1841), and Librarian at the Linnean Society (1822-1841); also see: Kewscience, *Plants of the World On-line* (<http://powo.science.kew.org/taxon/30020085-2>).

These two island varieties are now considered to be synonymous (Gymnosperm Database <sup>5</sup>). However, they are not recognised in the latest revision of *Pinus* at the Kew Herbarium<sup>6</sup>

Similarly, these varietal names have not been recognised in California (The Jepson Herbarium: Jepson eFlora, 2021); nor in Australia (Hill, 1998). Notwithstanding the falling out of favour, these island varieties are still under cultivation in the Westbourne Arboreta in the Australian Capital Territory (ACT), and they have long been used to widen the genetic base of *P. radiata* in Australia. These two island varieties can, however, be distinguished from the type variety by their leaves being generally in twos rather than threes. Other features align them most closely to *Pinus radiata*.

The full citation of *Pinus radiata* is *Pinus radiata* D. Don, *Trans. Linn. Soc. London* 17: 442 (1837). syn. *Pinus insignis* Douglas ex Loudon, *Arbor. Frutic. Brit.* 4: 2265 (1838).

*Pinus radiata* has many different common names, some of which are used in this paper. The most popular names are Monterey Pine and Radiata Pine.

### Conservation Status – Global

*Pinus radiata* has been listed as 'Endangered' in the global scene by the International Union for Conservation of Nature (IUCN) Red Lists. The main threats for the extant populations are excessive logging and wood harvesting, pests, diseases and impacts of other weedy species <sup>7</sup>.

## Introduction to Australia

The species was possibly introduced by gold miners coming from the Californian gold rushes to the Australian goldfields in the early 1850s (New South Wales Department of Primary Industries, 2008), but other accounts say that Victoria's first government botanist, Ferdinand Mueller, introduced the Monterey Pine to Australia (Willis and Cohn, 1993, p. 67).

The earliest introduction record to Australia is of a consignment of seed for the Melbourne and Sydney Botanic Gardens in December 1857 (Spencer, 1995, p. 264). There may have been other introductions, as Adcock's Nursery of Geelong listed *P. insignis* for sale in 1857 (Brookes and Barley, 2009, p. 135). In 1857, it was listed in the catalogue of the Royal Society's *Garden* in Tasmania.

By 1858, the species was under cultivation in the Melbourne botanic gardens. In 1860 it was offered in *Rule's Nursery Catalogue* in Victoria and more widely in nurseries after that (Brookes and Barley, 2009, p. 135).

Mueller (1825–1896), government botanist 1853–96 and Director of the Melbourne Botanic Gardens 1857–73, was a strong advocate of the acclimatisation of useful plants and animals (von Mueller, 1858, 1885). He suggested, as early as 1859, that *P. insignis* would be a good plantation species.

An enthusiast for all conifers, he later described *P. radiata* as 'a splendid dark-green pine, fully to 100 feet high, with a straight stem, occasionally 8 feet in diameter' and 'the quickest growing of all pines' (von Mueller, 1885, p. 283). He propagated a large number among the tens of thousands of plants he distributed each year (Maroske, 1993).

In the 1860s, Monterey Pines were distributed from the Melbourne Botanic Gardens to other botanic gardens, cemeteries, churchyards, landowners and state reserves in Victoria and South Australia and Tasmania (Fox, 2004, p. 193; Spencer, 1995, pp. 264–265). Mueller wrote of Radiata Pine:

'...Most extensively distributed through the colony of Victoria and also some other parts of Australia since 1859 by the author of this work, not so much as a timber tree, but to impart quickly and interruptedly a magnificent verdure to towns and landscapes, and to afford early shelter...' (Friends of ACT Arboreta, p. 23).

Rural Victoria was the main beneficiary of the hundreds of thousands of seedlings, many of them conifers including *P. radiata*, distributed by Mueller: 'it was only by determined indifference that any town or

<sup>5</sup> The Gymnosperm Database. *Pinus*: (<https://www.conifers.org/pi/Pinus.php>).

<sup>6</sup> (1) Kewscience, *Plants of the World On-line – Pinus radiata* (<http://www.plantsoftheworldonline.org/taxon/urn:lsid:ipni.org:names:30020085-2>); (2) The Plant List ([http://www.theplantlist.org/tpl/search?q=Pinus+radiata&\\_csv=on](http://www.theplantlist.org/tpl/search?q=Pinus+radiata&_csv=on)).

<sup>7</sup> (1) Farjon, A. (2013). *Pinus radiata*. *The IUCN*

*Red List of Threatened Species* 2013: e.T42408A2977955. (<https://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T42408A2977955.en>); (2) Farjon, A. (2001). *World Checklist and Bibliography of Conifers*. 2nd edition. The Royal Botanic Gardens, Kew; (3) IUCN. 2013. *IUCN Red List of Threatened Species* (ver. 2013.1) (Available at: <http://www.iucnredlist.org>).

*hamlet did not get plants (especially conifers) free of charge for the ornamentation of their public spaces'* (Maroske, 2002, p. 424).

Between 1861 and 1866, some 7,000 Radiata Pine seedlings were distributed by Mueller in Victoria and to South Australia for ornamental plantings and windbreaks (Wu et al., 2007, p. 216). The planting of conifers, in particular *P. radiata* and Monterey cypress (*Cupressus lambertiana* Camière; syn. *Hesperocyparis macrocarpa* Hatw.), in Tasmania in the late 19<sup>th</sup> Century was so widespread that today:

"...Conifers are integral to the older settled Tasmanian landscapes, especially its rural landscapes ... There is a national wealth attached to this living heritage, which can occur as boundaries of internal lines of properties, in arboreta of old homesteads, as single trees, along driveways, isolated in paddocks, along roadways, almost it seems, anywhere...."

Sheridan (2011, p. 12)

Monterey Pines were also widely used in Victoria and South Australia for windbreaks around agricultural properties and ornamental planting. This use was especially popular in 1850–70 when their dark-green foliage and strong architectural form made a distinctive contribution to the landscape (Spencer, 2002, p. 265). The trees are now important components of many cultural landscapes. For example, there are 13 *P. radiata* in Walhalla cemetery, estimated in 1995 to be about 120 years old (Spencer, 1995, p. 265).

Walhalla, near the Mt Baw Baw National Park, was a gold-mining town in the 1860s and is today a historic township standing as a fascinating reminder of what was once a very rich goldfield (Blake, 1977, p. 270). Another example is at the heritage-registered Smeaton House, built for the overlander and pastoralist Captain John Hepburn in 1849–50, and one of the earliest substantial homesteads in Victoria (Heritage Council Victoria, 1974b). The perimeter of the family cemetery is planted with Monterey Pines and cypresses (Heritage Council Victoria, 1974a).

Pines, planted by German settlers in the 1860s, in what was known as Waldau and has become suburban Doncaster East, can still be found in many parts of this Melbourne suburb, particularly around George (formerly, 'German Lane') and Victoria Street (formerly, Bismarck Street), and to the south-east. They were planted as windbreaks or boundary markers for agricultural properties, orchards in particular, and serve as an indicator of historical property boundaries. There is an outstanding tree at 16 Roderick Street, Doncaster East, on the National

Trust's Register of Significant Trees (National Trust of Australia (Victoria), 2001). 'The Pines' still appears as a destination on public transport serving the area.

Monterey Pines were used in 1933 for the Avenue of Honour at Moyston, in central Victoria, the only known example of a commemorative avenue to use the species. Each tree bears an inscribed plaque to commemorate men from the area who served in World War I. The avenue is also on the National Trust's Register of Significant Trees (National Trust of Australia (Victoria), 1989).

Pines planted by early settlers can generate strong emotional ties. The writer Don Watson, who grew up on a small dairy farm in Gippsland, has written about the big *P. radiata* at the front of his family's old house as recurring in his dreams, calling it 'the primary symbol in my subconscious' (Watson, 2014, p. 71).

## Establishing Victorian plantations

Years of sustained endeavour were required to establish the *P. radiata* plantations of Victoria. William Ferguson (c. 1827–1887) began work establishing the State Forest Nursery at Mt Macedon in 1872. Ferguson, when employed as the gardener at Flemington House (since demolished), had developed by 1865 one of the most complete collections of *Coniferae* in the colony. His 1868 list of trees growing at Flemington included the Californian *Pinus insignis*, *P. ponderosa*, *P. radiata* and *Cupressus macrocarpa*, among other conifers.

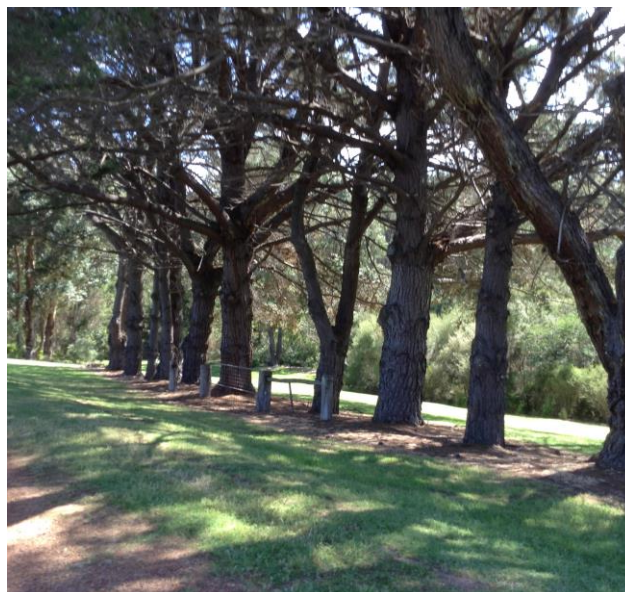


Figure 3 Pines along a fence line in South Australia

A board of inquiry in 1867 had recommended the extensive introduction of coniferous trees into Victoria's state forests. The *Land Act 1869* provided for the reservation of land specifically for timber production. Ferguson was appointed inspector of forests and was instructed to establish the nursery at Mt Macedon. His application to the task of clearing the site and planting thousands of trees, including *P. radiata*, meant that from September 1873, all plants distributed to the many reserves managed by the Lands Department came from this nursery (Wright, 2002). By June 1873, Ferguson had successfully planted more than 10,000 of the choicest and best kinds of Himalayan and Californian timber trees, including 1,500 conifers, *P. insignis* among them (Fox, 2004, p. 207).

By the end of the 1860s, more than 276,000 ha had been set aside as state forests and timber reserves. The Ballarat and Creswick State Forest, proclaimed in 1872, was used for cutting timber until 1882, when it was closed, and John La Gerche (1845–1914) was appointed bailiff and forester to supervise the forest and take proceedings against all persons found cutting or removing timber.

In 1886 La Gerche began an experimental nursery on denuded diggings at Sawpit Gully, enclosing a 2-acre (0.8 ha) plot and transplanting more than 700 seedlings of *P. insignis* (A. Taylor, 1998, pp. 168–171). This old gold-mining site had diggings perforating the slopes and a water race traversing the spurs – a mass of weeds and eroded gullies, some completely denuded by timber splitters. La Gerche considered such disturbed slopes 'the very thing for growing pines' (A. Taylor, 1998, p. 139).

From this small beginning, the plantation was extended to 12 ha in 1888, with more than 8,500 trees planted. The 2,000 trees obtained from Ferguson's Macedon nursery included *Pinus*. The plantation reached its final size of 121 ha with 246,000 trees in 1899 (Heritage Council Victoria, 2015). Angela Taylor characterised La Gerche's achievement:

"...The conifers and deciduous trees La Gerche planted were ornamental as well as valuable commercial species. Since the early 1860s, they had been planted by botanists, gardeners and nurserymen in the shaping of 'a common landscape of taste'... across the colony. La Gerche's mixed plantings at Sawpit Gully have created – more than one hundred years later – a picturesque forest..." (A. Taylor, 1998, p. 139).

The historic plantation, including areas designated as *P. radiata* breeding arboreta, is now on

the Victorian Heritage Register and the Register of the National Estate. The *P. radiata* tree in the Creswick Regional Park, known as The Mother Tree, grows on the site originally used by La Gerche to raise seedlings and is seen as a significant living monument to La Gerche and his work (National Trust of Australia (Victoria), 2007).

In 1909 a State Pine Forest was established on a government reserve north of Frankston, in the 6 km<sup>2</sup> set aside for the 'preservation and growth of timber' under the *Land Act 1860*. More than one million trees were planted, the most successful being *P. radiata*. In 1955 wildfire destroyed a large part of the plantation, and in 1956 1.2 km<sup>2</sup> was excised for public housing. The resulting estate became known as 'The Pines', a name that some still prefer to 'Frankston North'.

## School plantations

In the 1920s, the Victorian Education Department established a School Forestry Scheme. Schools were to lead the community, arousing interest in forestry by establishing plantations as a teaching resource and a source of revenue. By 1925 there were school plantations in Ballarat, Castlemaine, Creswick, Chiltern, and Porepunkah (Gay, 1925). However, the plantations included eucalyptus species and other conifers such as Western Yellow Pine (*P. ponderosa*), *P. insignis* was regarded as '*the most profitable to grow in school plantations*' and '*the most easily raised in seed beds*' (Gay, 1925).

By 1936, 348 plantations had been established, totalling 1,436 ha. The number of trees supplied annually-averaged 80,000–90,000 – more than a million in all (Gay, 1938, p. 68). The former State School No. 46 at Bulla, its adjacent pine plantation and suspension footbridge are on Victoria's Heritage Register, and 'The survival of mature pine trees from this plantation provides a strong visual coherence to the precinct' (Heritage Council Victoria, 1982).

By 1972, there were 638 plantations involving 702 schools, the net return from the sale of trees totalling \$377,784 (Heritage Council Victoria, 1982). Nevertheless, in the 1980s, the project's value began to be questioned. Some plantations were deemed unsuccessful. The Land Conservation Council and government policy called for a reassessment of all school plantations on crown land and decided that new plantations should only be established for educational purposes where the establishment would allow rehabilitation or reforestation of cleared or eroded areas.

## Remedial uses of *Pinus radiata*

Lessons learned from Sawpit Gully in using *P. radiata* to rehabilitate land degraded by mining were later applied in the Ovens Valley in north-east Victoria. Professor Alfred Ewart (1872–1937), Victorian government botanist and foundation professor of botany at the University of Melbourne, advised in 1910 that plantations should be established on land around Bright that had been degraded by mining and colonised by St. John's Wort (*Hypericum perforatum* L.). His words were: 'The only profitable use to which the dredged flats could be put would be to use them for forestry purposes, and the Bright district is admirably suited for the growth of coniferous wood' (Ewart, 1910).

The Forestry Commission planted *P. radiata* on the weed-infested former racecourse at Bright and large areas in the Ovens Valley in 1916, resulting in 'splendid growth' by 1932 (Currie and Garthside, 1932, p. 11). Ewart's *Handbook of Forest Trees for Victorian Foresters* (1925) included *P. radiata*, as did his *Flora of Victoria* (1930).

## South Australia

Radiata pines were introduced to the Adelaide Botanic Gardens as early as 1866 when Mueller provided the director with seeds for an avenue (Payne, 2007, pp. 89, 114). A Forest Board was established under the *Forest Board Act (SA) 1875*, chaired by surveyor-general GW Goyder. Australia's first commercial pine plantation was established the next year at Bundaleer (Wu et al., 2007, p. 215), where 8,000 *P. insignis* seedlings were planted (Sheldrick, 2013, p. 302).

One account of the use of *P. radiata* in forestry in Australia centres on South Australia and the work of a young Scot, John Ednie Brown (1848–1899), who had visited North America and written reports for the Scottish Arboricultural Society on the trees he found there (Tyrrell, 1999). Brown was appointed conservator of forests in South Australia at the age of 30 and was responsible for plantings of *P. insignis* in 1878–80. His *Practical Treatise on Tree Culture in South Australia* (1881) went to three editions by 1886.

Brown was Director-General of forests in New South Wales 1890–93 when the position was abolished due to economic depression. He has been called 'the father of economic and scientific forestry in Australia' (Aitken and Looker, 2002), but was a controversial figure, in part due to his belief that forests influenced climate by – among other things – increasing rainfall (Brown, 1883, p. 7). Goyder

strongly opposed Brown's attempts to push planting into arid areas.

Sir David Hutchins (1850–1920), who had trained in forestry at the *Ecole Nationale des Eaux et Forêts*, Nancy, came to Australia in 1914 after a long career in forestry in India, South Africa, and other parts of the British Empire. In 1916 he was highly derogatory of Brown, alleging that his plantings were badly organised and injudicious, that he was not a trained forester, and ignorant of current trends in scientific forestry (Hutchins, 1916, p. 253). However, others concluded that Brown made a 'considerable arboricultural contribution' (Carron, 1985, p. 219), and Brown's obituary said that he had long been recognised as 'one of the best experts south of the line' and had retained the position of conservator of forests' with great credit to himself and satisfaction to the department' (West Australian, 1899).

In his *Practical Treatise on Tree Culture*, Brown wrote of the early success of *P. insignis*: 'this is one of the few introductions of pines to the colony which have succeeded to the best of expectations' (Brown, 1883, p. 93). When he left South Australia to take up his New South Wales post in 1890, Walter Gill (1851–1929), described as 'the doyen of Australian forestry', became conservator (Aitken and Looker, 2002, p. 261). Some 10,672,000 trees were planted during his term of office, and he was 'the first in South Australia to utilise successfully the Remarkable pine (*Pinus insignis*) for commercial purposes' (*The Advertiser*, 1929). During Gill's 33-year tenure, *P. radiata* became the dominant species in forest planting in South Australia (Tyrrell, 1999, p. 93).

## Western Australia

In 1895, Brown was engaged by the government of Western Australia and produced a *Report on the Forests of Western Australia* (1896). The Department of Woods and Forests was created, with Brown as its first conservator, a post he held 'to the great satisfaction of the government' (Refshauge, 1969). Brown established a state nursery about 75 km south of Perth in 1897. By 1899 some 200,000 plants were under cultivation, with *P. insignis* among 50 kinds of introduced trees (Brown, 1899, pp. 55–56).

This nursery was still functioning in 2007 when it was included in the Register of Heritage Places. In 1897 plantings to that date totalled 'Poplars of sorts, 10,000; osiers, 5000; planes, 3000; elms, 10,000; tamarisks, 7000; oaks, 500; ash, 500; New Zealand flax, 500'. The addition of 15,000 pine seedlings was planned, some of which would have been *P. insignis* (Heritage Council of Western Australia, 2007, p. 7).

## Nutrition and site requirements

Early advocates for *P. radiata* frequently claimed that it would do well in difficult conditions, such as degraded agricultural land and even gold diggings (Ewart, 1910, pp. 505–506). Nevertheless, it appears that 'early extensive plantings were made with scant empirical information on growth, little knowledge of diseases, and no understanding of nutritional problems associated with the species' (Turner and Lambert, 1986, p. 325).

In hindsight, it might have been anticipated that the species would have particular nutritional needs and require favourable soil and climatic conditions to do well. An early indication of nutritional problems occurred in 1939, when extensive dieback in South Australian plantations was due to zinc deficiency (ForestrySA, 2021). The remedy was to spray a zinc sulphate solution onto the foliage early in the trees' development (Carron, 1985, p. 220).

It is now recognised that although '*Radiata Pine has proved to be a very adaptable species in its main adopted countries ... its history of successes and failures shows that there are places where it should not be planted and other sites where it is ideal*' (Mead, 2013, p. 15). It prefers:

- Winter rain and relatively dry summers;
- Rainfall greater than 600 mm per year;
- A lack of hot, humid conditions;
- Long-term minimum temperatures above minus 10 degrees Celsius;
- Deep, well-drained soil. Dislikes 'wet feet';
- Fertile, acid soils – higher nutrient demand than many other pine species;
- Available ectomycorrhizae, crucial for nutrient uptake;
- Moderate tolerance of salt spray; and
- A latitude zone of about 34–44 degrees (Mead, 2013, pp. 32–33).

## Threats to Radiata Pines

Many thousands of *P. radiata* trees have been killed in Australia by the Sirex woodwasp (*Sirex noctilio* Fabricius), native to Europe, Asia, and northern Africa. The insect kills healthy trees by introducing a wood-rotting fungus and toxic mucous when depositing eggs (oviposition) (K. Taylor, 1981, p. 231; University of Maryland, 2008). The seriousness of the threat to *P. radiata* plantations is shown by a 1987 outbreak in South Australia, where

50,000 ha of plantations were infected, and almost five million trees died (CSIRO, 2011).

Although there were probably repeated accidental introductions before the wasp became established in Australian pine plantations, the first mainland infestation occurred near Melbourne in 1961. When a program of expanding the pine plantations began in Victoria, from that time, aiming at an additional 80,000 ha over the next 40 years, there were alarming reports of infestations by *Sirex* wasps in scattered trees and shelterbelts on private property.

An extensive eradication program involved searching out affected trees and destroying the trees and wasps. Nearly 10,000 trees were felled on more than 500 properties. This program was expensive and only moderately successful as the spread of wasps continued.

By 1962 it had been confirmed that the wasp had been in Victoria for at least eleven years (that is, since 1951) and possibly sixteen (since 1946). Encouragement was derived from the fact that, despite no attempt at control until 1962, *Sirex* had occupied relatively little country during such a long period (Forests Commission Victoria, 1963).

*Sirex* was first detected in New South Wales in 1980 at Albury. It slowly spread north, eventually reaching Queensland in the early 21st Century (Carnegie, Eldridge, and Waterson, 2005). Western Australia has 70,000 ha of pine plantations. As of 1992, *Sirex* had not established itself in that State, although there have been regular discoveries of its larvae in wood imports (Shea, 1992, p. 2).

Research from the mid-1960s onwards demonstrated the potential of nematode parasites to control *Sirex* by sterilising the female wasps (CSIRO, 2011). Biological control replaced eradication by destruction in Victoria from 1972 (Carron, 1985, p. 200), since when the *Sirex* control program has been very successful (Eldridge and Taylor, 1989, p. 5).

Other pests of *P. radiata* include the Western Gall Rust (*Peridermium harknessii*), first noted on Monterey Pines in California in 1880 and thought to have been associated with pines for millions of years as obligate parasites. Control is not easy. Mature fruiting galls can be removed but must be carefully handled to prevent spore dissemination (Adams, 1977, p. 2).

There have been recent warnings that the Giant Pine Scale, an insect that feeds on the sap of conifers, has been found in and around Melbourne. It is regarded as a serious threat to *P. radiata* plantations. Arborists have been trained in identifying and treating



it, and a website established to receive reports of suspected sightings (Hyde and Ryles, 2015).

## Reports of spreading pines

From the point of view of the pines and the communities that cultivated them, most of this is a success story. However, there was to be a dark side. In New Zealand, a warning was sounded by George Thomson in 1922 that *P. radiata* was spreading naturally and becoming common. Thomson went on to refer to other reports of the plant spreading (Thomson, 1922). In Australia, Ewart in 1930 noted *P. radiata* as '*spreading freely by seed, native to America and recorded as naturalised in SW, S. and E. Victoria. Creswick 1909; Beaconsfield to Emerald, 1913 (already reported in Ewart (1915)); Cheltenham and Mentone, 1915*' (Ewart, 1930, p. 65). Ewart had not referred to *P. radiata*'s tendency to spread freely in his *Handbook of Forest Trees for Victorian Foresters* (Ewart, 1925, pp. 476–477), nor listed it in *The Weeds, Poison Plants and Naturalised Aliens* (Ewart and Tovey, 1909), but the 1925 supplement to that work included the following:

"...*Pinus radiata*, Don, 'Remarkable or Monterey Pine' (Coniferae): This American tree was originally extensively cultivated in this State for shelter, shade and ornamental purposes, but of recent years its value for timber has been recognised. In some districts the seeds from cultivated trees have been carried by the wind to the adjoining scrub land, where they have germinated, and the young plants have established themselves among the native flora..." (Audas and Morris, 1925, p. 13).

I infer that the spreading of pines into bushland was not apparent in 1909, but at some point, between that date and 1925, the situation changed. In any event, despite the observed spreading into adjoining scrubland, the plant was not seen as a troublesome weed.

In 1953, the New South Wales Department of Agriculture published *Weeds*, self-described as 'the most comprehensive book yet published on Australian weeds – native and introduced' (Whittet, 1962). *Pinus radiata* was not included. Nor was it among the 283 weeds in Lamp and Collet's *Weeds in Australia* (1974), or in Auld and Medd's more comprehensive *Weeds: An Illustrated Botanical Guide to the Weeds of Australia* (1987).

## Pines as controllers of other weeds

Despite *P. radiata*'s known propensity to spread, some parties continued to advocate its use to control weeds, such as St. John's Wort (referred to above) and, in New Zealand, blackberry (*Rubus fruticosus* sp agg) and Canadian or Californian Thistle (*Cirsium arvense* Scop), by planting fast-growing trees such as *P. radiata* over the patches (Hilgendorf and Calder, 1952, pp. 105, 205). The plant itself was not listed as a weed.

## The environmental turn

From around the 1970s, attitudes began to change. The environment movement gathered strength, and remnant native vegetation ceased to be regarded as 'mere' scrubland, but rather as indigenous species in natural vegetation communities that should be conserved. Exotic plants invading such communities were called 'environmental weeds' (as distinct from agricultural, horticultural and ruderal weeds) in Australia (Amor and Stevens, 1976).

The expression is something of a misnomer, as every weed is in an environment. However, my observations tell me that the environmental movement is not concerned with the 'whole environment'. Instead, it appears to value only the remnant indigenous species. Introduced or exotic species are seen as undesirable or worse. The term 'invasive species' is used more generally in the USA especially, to include introduced species that spread widely without the help of humans. Some regard any naturalised, exotic species as 'invasive'.

An early voice expressing concern was Winty Calder in 1975. In discussing the vegetation of the Mornington Peninsula, south-east of Melbourne, she listed *P. radiata* as a weed, noting that it had been planted there for softwood timber, but its main use had been as windbreaks around orchards and improved pastures: it had 'naturalised, and is spreading into clumps of indigenous trees, many of which it could eventually dominate unless continually removed by hand weeding of the seedlings and young saplings' (Calder, 1986, p. 117).

## How serious is the threat?

While it is clear that *P. radiata* has often spread, the question remains how serious a threat it poses for native plant communities in Australia. In 1982 the Victorian Forests Commission published a study that measured its spread into eucalypt forests at 30 sites near Myrtleford, Bright, Beechworth, Tallangatta and

Chiltern. Four Myrtleford sites were groups of mature pines planted as shelter trees, surrounded by intensively grazed farming properties. At the four Chiltern sites, the open eucalypt forest surrounding the pine plantation was mainly Blakely's Red Gum (*Eucalyptus blakelyi* Maiden).

The study found no invasion of the *E. blakelyi* forest and concluded that this forest type appeared to be unfavourable for establishing *P. radiata*. No seedlings were found in any of the shelter tree sites at Chiltern, the authors concluding that seedlings were effectively controlled by intensive grazing and might struggle in open pasture. It was noted that, in undisturbed eucalypt forest, pines could not establish among Tall Bracken (*Pteridium esculentum* Forst f. Nakai) in the riparian zone of streams or among clumps of blackberries (*Rubus fruticosus* agg) (Minko and Aeberli, 1982).

On sites carrying short native grasses, however, pines were commonly found, even when there was 100% ground cover. In eucalypt forests where Narrow-leaf Peppermint (*Eucalyptus radiata* Sieber ex DC) and Broad-leaved Peppermint (*E. dives* Schauer) predominated, the spread of *P. radiata* was found to vary according to the topography of the plantation boundary and its exposure to prevailing winds and to depend on the absence of fire and grazing.

Although the winged seeds of *P. radiata* are adapted for dispersal by wind, other factors, such as receptiveness of the ground, the type and density of ground vegetation, and general climate and seasonal conditions, may affect spread into surrounding native forest. Study results indicated that one pine per hectare could be expected in peppermint-type forests at a distance up to 2.7 km to the South of exposed plantation boundaries and 0.8 km to the east. To the north and west, the distance was 0.4 km (Minko and Aeberli, 1982). A survey published in 2007 found:

"...Little is known about the total area invaded by pines, the population biology of *Pinus* species outside of plantations or their impacts on native communities in Australia ... Records of pine spread in Australia are scarce. Observations of infestations remain largely anecdotal, and quantification of wildling densities and distributions are mostly restricted to a handful of studies..." (Williams and Wardle, 2007, p. 722).

Anecdotal observations are provided by publications such as *Environmental Weeds in Victoria* (Carr, Robinson, and Yugovic, 1992), cited as authority for Williams and Wardle's statement that

'*Pinus radiata* has been listed as a very serious threat to one or more vegetation formations in Victoria and has been observed spreading into a range of environments including heathland, lowland grasslands and grassy woodland, dry and damp sclerophyll forest and riparian vegetation' (2007, p. 727). However, the 1992 publication cited gives no details such as the exact place and date of the observations, nor any other material by which the anecdotal evidence could be verified. As is so often the case in the weeds literature, it is, in essence, simply a list of 584 plants said to be environmental weeds, defined as 'exotic plants that invade native vegetation, usually adversely affecting the survival of the indigenous flora'. There is no citation of studies of invasions or the effects on indigenous flora.

Similarly, *The Flora of Victoria* (1993) included a chapter by G.W. Carr on 'Exotic flora of Victoria and its impact on indigenous biota'. This concludes with a list titled 'Environmental weed species in Victoria rated as very seriously invasive in indigenous vegetation', which includes *P. radiata*, but again without any supporting material (Walsh and Entwisle, 1994, p. 293). The bibliography lacks any studies of *P. radiata*, not even Minko and Aeberli's of 1982, described by Williams and Wardle as the only 'quantitative work in Victoria' (Williams and Wardle, 2007, p. 727).

Mechanisms of *P. radiata* spread are little understood, apart from the recognition of wind and possible bird dispersal. Some see *P. radiata* as a serious threat, and others classify it as a threat of a lower order. It was not included among the 65 most serious environmental weeds published by the Australian National Parks and Wildlife Service in 1991 (Humphries, 1991). Nor was it included in the comprehensive *Geographical Atlas of World Weeds* (1979), although 21 other *Pinus* species were listed as present in the USA as weeds (Holm et al., 1979, pp. 280–281). On the other hand, *P. radiata* was included in Randall's comprehensive *Global Compendium of Weeds* (2002).

Measured studies of the spread of *P. radiata* into eucalypt forest adjacent to a large plantation in the Australian Capital Territory began in 1974, reported by Burdon and Chilvers in 1977 when the pine plantation was clear-felled. In 1981 the original 160 x 20 m transect in the eucalypt forest was carefully remapped, as described by Chilvers and Burdon in 1983. It appeared that substantial numbers of young pines were being generated from the wildling pines that had established in the transect, but also that many of the first-year seedlings did not survive.

The tree population was approximately stable, with just a small replacement of eucalypts by pines. However, the pines were growing at a much faster rate than the eucalypts, altering the general appearance of the tree community. Acknowledging that exotic plants rarely establish themselves in stable plant communities without prior disturbance and modification of the environment, the authors considered that the scale of pine establishment seemed out of proportion to the level of disturbance.

They observed that the density of invading pines varied greatly between different sites, with the densest invasions at dry sites with poor, shallow soils. 'Where pine plantations are grown at moister sites with deeper soil levels, and the adjacent eucalypt forest tends to be the "wet sclerophyll" type, invasion is minimal or absent' (Chilvers and Burdon, 1983, p. 244). These observations should be followed up by a detailed investigation of the reasons for the differences.

A later measured study in New South Wales, in 2003, observed similar levels of invasion by *P. radiata* in two different types of dry sclerophyll eucalypt woodlands with differing dominant tree species (Kennedy, et al., 2013, p. 137). There was little evidence that different canopy species influenced susceptibility to invasion. Pine numbers generally diminished with distance from the plantations. Large reproductive pine trees were found up to 4 km from the seed source. Though the wind was an important factor in the spread of *P. radiata*, the presence of isolated trees suggested that dispersal mechanisms in addition to wind may be operating. Yellow-tailed Black Cockatoos observed feeding on plantation trees at both study sites may have been seed-dispersal vectors. Large numbers of young pines were thought to have been sourced from wildlings rather than from the plantation.

Yellow-tailed Black Cockatoos feeding on Monterey Pines may be understood as an example of indigenous fauna adapting to novel ecosystems, of which the pines are part. Kennedy et al. argued in 2013 that 'novel ecosystems are now critical for maintenance of faunal diversity at the genetic, species and ecosystem level, and restoration goals to eliminate novelty might not always benefit faunal conservation' (p. 137). It is hoped that the Yarra Ranges Council considered the alternative food available for the cockatoos when removing the pines on which they were known to feed.

The suggestion that *P. radiata* is not always invasive is confirmed by the experience in Chile. There are more than one million hectares of *P. radiata*

plantations there, but the species, although introduced, is not considered invasive (Kruger, Breytenbach, Macdonald, and Richardson, 1989; Williams and Wardle, 2007, p. 722). The interiors of undisturbed native forests are resistant to invasion. Similarly, no invasions by *Pinus* species have been recorded for Colombia or Kenya, despite their large pine plantations. As Williams and Wardle correctly concluded: 'A sound approach to wildling management will not require the removal of all trees, rather an assessment of the risks posed by each stand' (Williams and Wardle, 2007, p. 722).

## Pines and landscapes

The spread of *P. radiata* into treeless grasslands and shrublands can alter the character of the Australian landscape. The tall, dark trees contrast strongly with the native vegetation and transform the shape and colour of the countryside. Many local inhabitants have, however, developed an affinity for them (Williams and Wardle, 2007, p. 722). Cultural landscapes with pines as a component may well have heritage significance such that they should be conserved.

Victorian landscapes have been markedly altered by windbreak plantings and amenity plantings in towns (Figure 4). The use of pines and cypresses as windbreaks around orchards and crops, around pastoral homesteads, and along driveways and roads has been widespread in Victoria. Nineteenth-century settlers cleared the land of native vegetation and then realised that they needed to protect their crops, orchards, and gardens from strong winds. Their choice was often to plant pines and cypresses as windrows.



**Figure 4** Pines at sunset on the clifftop at Mt Eliza, on the Mornington Peninsula, Victoria.

Today, lines of pines and cypresses planted in the 19<sup>th</sup> Century are often the only remains of orchards long gone. The association of such plantings with the orchard industry has left many stands of conifers, which now characterise the landscape of regions, such as Templestowe and the Mornington Peninsula. The roadside avenues of pines tell us of the previous land use and have been recognised as landscape elements of cultural heritage significance (for example, Gilfedder, 2001).

In coastal settings, pines were used as windbreaks protecting gardens and as markers of seaside resorts. As specimen trees in parks, gardens, and reserves, they are widely distributed – from coast to mountain – and form components of significant landscapes, where their importance has led to clashes between values of cultural heritage conservation and environmentalism.

A good example is provided by a stand of some 250 pines at the seaside resort Shoreham on the Mornington Peninsula, most dating from the early 20<sup>th</sup> Century (Figure 5). The place known as The Pines was included in the Victorian Heritage Register in 2002. I was a member of the committee that decided to include *The Pines* in the register.



**Figure 5 Heritage-listed pines at Shoreham, Victoria**

Registration was supported by members of the local community, who felt a strong attachment to the trees and their place in the landscape, and by Heritage Victoria. Registration was opposed by the committee of management for the Shoreham foreshore and others who contended that *P. radiata* is an environmental weed, and as such, could not be of cultural significance. That argument was rejected.

It was accepted that The Pines was the best surviving example of the planting of pines at a seaside resort in Victoria. It was registered as a place of cultural heritage significance at the State level, as a representative surviving example of pine trees

marking a beach resort. The Pines are of aesthetic significance as 'a unique element in a significant landscape' and 'important for their landmark quality on the Western Port littoral of the Mornington Peninsula', giving 'the Shoreham foreshore its distinctive character'. The Pines are also of historical significance (Heritage Council Victoria, 2002).

## Competing values

Two Monterey Pines, standing on school grounds on a rocky point by a beach in Tarooma, Tasmania, were the subject of lively community debate. The trees (Figure 6), rooted into a midden associated with occupation by the Mouheneener people dating back 6,000 to 8,000 years, are described as 'living relics of a colonial aesthetic that preferred imported flora and fauna' (Lien and Davison, 2010).



**Figure 6 Pines at Tarooma, Tasmania. Photograph by Damien Ramon**

The Tarooma Environment Network (TEN), one of an estimated 60,000 community coast care groups in Australia, has been 'restoring' the foreshore and nearby bushland by removing what they see as invasive species. TEN proposes removing the pines, apparently because they are introduced and do not belong in Australia.

TEN sees its proposal as the straightforward application of environmental science, but its approach is strongly opposed by many local residents, who value the trees and the landscape to which they contribute, both for their beauty and as relics of 20<sup>th</sup> Century culture in a multi-layered landscape. So there is a clash between these competing values, obscured perhaps by the invocation of science. Properly understood, science is confined to factual explanations of what the case is and not concerned

with values, but in environmental science, this distinction has, I believe, often been forgotten.

The conservation of the midden adds to the complexity of the dispute. TEN seeks to conserve Aboriginal heritage, but its removal of introduced Boxthorn (*Lycium ferocissimum* Miers) and Bramble (*Rubus fruticosus* agg.) has exposed the midden to the risk of erosion. To avoid damage to the midden, TEN had fenced off the midden (and the pines). Some argued that to conserve the midden, the pines should be removed. Others said that the pines helped to bind the midden against erosion. Questions arise as to how Aboriginal heritage values relate to European culture and nature conservation.

The environment that Europeans encountered when they arrived in Australia in the late 18th Century onwards had been significantly modified by thousands of years of Aboriginal land management, but there is a tendency for environmentalists to regard as 'natural' the environments that have been created by the Aboriginal people (S. Taylor, 1990, p. 411). There is no clear answer as to which cultural values should prevail, nor any mechanism for resolving the question.

Social anthropologist Marianne Lien, one of the authors of the 2010 paper on the Tarooma pines, has described the Australian environmentalists as recreating a 'timeless' Tasmanian landscape, as it was before the arrival of Europeans; establishing their 'sense of place' by literally uprooting the remnants of European plants. However, there was no 'timeless' landscape when the Europeans arrived. The Aboriginal people had deliberately fashioned the landscape. In an insightful essay, Lien compares the environmentalists' sense of landscape to the paintings of John Glover (1767–1849) and suggests that the environmentalists are, like Glover, 'working within the framework of the picturesque'.

Glover depicted the lost landscape of the Tasmanian Aboriginal people that would never be restored. The environmentalists, like Glover, 'work to harmonise the less than perfect present and an imaginary past':

*"...Glover and contemporary environmentalists both exemplify reflexive interventions in which the making of place involves a transformation that seeks to highlight background potentiality at the expense of foreground actuality. In both cases the imaginary past is a timeless landscape that is seen as capturing an essential dimension of the island's identity, while the presence that is silenced by various interventions (artistic omission or botanical*

*eradication) bears the mark of mobility and historical rupture..."*

*"...Narrating Tasmania within the framework of the picturesque thus implies producing a landscape in which traces of biomigration, human and non-human, are silenced. In this sense, one could argue that both cases concern an active denial of process, yet this denial is in itself the result of conscious human intervention, and in the contemporary case, a consistent and prolonged effort of hard work. To the extent that the landscapes appear in the end as timeless, it is timelessness of a temporary kind, one which serves first and foremost to conceal the transportations and transformations that have, in fact, taken place...." (Lien, 2007, p. 115).*

To regard Australia's landscape as it was at the time of European arrival as the 'timeless work of nature' is to perpetuate the myth that the cultural landscapes made by the Aboriginal people were untamed wilderness.

The error in imagining the pre-1788 landscapes of Australia as wilderness has been exposed often, most recently by Bill Gammage in *The Biggest Estate on Earth: How Aborigines Made Australia* (2011) and Bruce Pascoe's *Dark Emu* (2014).

The European colonisers fundamentally altered the landscapes and continue to shape Australia and its people. Their cultural heritage includes the plants that they introduced. The pines at Tarooma, at Shoreham, and elsewhere in Australia, are in many places, significant markers in landscapes and part of Australia's heritage.

## Conclusion

The moral to be drawn from the parable of *Pinus radiata* in Australia is ambiguous. Have the benefits of pines outweighed the risks posed by its potential spread? Was all the work conducted over more than a Century to establish plantations misguided?

Valued as a timber resource and as a distinctive feature of significant cultural landscapes, Monterey Pines, some populations of which are considered as globally 'endangered', have come to be regarded by some people as *Invasive Alien Species* that should be felled and removed in Australia. Nevertheless, I believe that we should not rush to fell the large populations of pines still in Australia without knowing just what is happening in the novel ecosystems of which they are part, and what the consequences might be for the environment as a whole.

As Don Watson concluded, 'we need to love it [the bush] as it is and can be, not the way it was and will never be again' (Watson, 2014, p. 372). Perhaps the overall lesson is that, while it is often difficult to foresee the consequences of human interventions in the natural world, we should do what we can to conserve the whole environment, including introduced trees in our heritage landscapes, *Pinus radiata* among them.

Since the preparation of this paper, attention has been drawn to a State government report from South Australia by Virtue and Melland (2003) in which the State conducted a Weed Risk Assessment (WRA) of radiata pine, Aleppo pine and Turkish pine.

Both Aleppo pine and Turkish pine were introduced to Australia after the First World War to commemorate the 'Lone Pine of Gallipoli'<sup>8</sup>. The South Australian report includes some additional, helpful information about the introduction and spread of radiata pine in that State (Virtue and Melland, 2003, pp. 59-64). However, the report does not refer to much of the material covered in this paper.

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<sup>8</sup> "The Lone Pine" battlefield was named for a solitary Turkish pine that stood at a battleground at the start of the fighting between Australia-New Zealand (ANZAC) troops and the Ottoman Turks, in 1915. The tree was also known by the Anzac soldiers as the "Lonesome Pine". The battlefield

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