Weeds or wild nature: a permaculture perspective

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Summary

Land design and management informed by permaculture principles tends to regard naturalized species of plants as assets that should be managed to stabilize water and soil, build biomass, fix nutrients, ameliorate microclimate and provide habitat, fodder, fuel and food in the early stages of system development. While naturalized species may be given a lower value in permaculture design than species regarded as indigenous to the site and region, the typical designation of naturalized species as 'invasive species' or 'environmental weeds' is typically rejected as anti-ecological thinking.

The background and basis for this positive view of naturalized plants is not well understood, and has led to strong and persistent criticism of permaculture by those promoting the orthodox view of naturalized species as invasives. This has itself influenced the practices and teaching of many permaculturists to moderate or compromise the permaculture approach to naturalized species. Consequently the 'weeds or wild nature' controversy is alive and well within the permaculture movement.

As one of the co-originators of the permaculture concept I am in a position to provide a unique perspective on the evolution of this debate and its connection to wider debate on this issue in conservation and land management networks. Inevitably this story is partly an historical and personal one rather than a review of scientific literature on the subject.

Introduction

Permaculture is a design system for sustainable living and land use. Its conceptual origins in Australia in the 1970s coincided with the first wave of modern environmentalism stimulated by the oil crises of 1973 and 1979. For more than three decades, permaculture designers, teachers and activists have spread the ideas around the world to an extent that permaculture activism in Australia is now only a small part of the global activity. In Australia, permaculture has been a conceptual influence on many of today's mainstream environmental solutions from Landcare to school gardens, from passive solar design to compost toilets, and from ethical investment to farmers markets.

Some of the strategies and techniques used by permaculture designers have been controversial within more mainstream environmentalism. The use of plant species capable of naturalizing has been a consistent issue, especially in Australia and affluent English speaking countries. That critique has come from environmental activists focused on indigenous biodiversity conservation and revegetation, even though permaculture was itself a major contributor in the greater awareness of the value and utility of indigenous species (see Mollison and Holmgren 1978)[1].

While the application and influence of permaculture has expanded greatly since the 1970s, over the same period indigenous biodiversity conservation and revegetation captured a large slice of the environmental agenda backed by government policies and funding. Of all the issues that were part of the first wave environmental agenda in the 1970s, this valuing of indigenous biodiversity has been most successful. Other 'solutions' to the environmental dilemma such as reducing consumption, localized economies, intentional communities, organic agriculture, energy efficiency and renewable energy have, by comparison, been ignored or only adopted by the wider society to a very limited extent. I believe the difference in outcome is that indigenous biodiversity conservation did not require a fundamental redesign of society. Furthermore, this positive agenda was massively amplified by a simultaneous negative campaign against all naturalizing plants (and animals) as 'environmental weeds' and vermin. Compared with other active campaigns of the environmental movement against nuclear power, genetic engineering, coal mining or even native forest logging, the demonizing of naturalized species was not up against established powerful interests, and found a psycho-social resonance in the general population that could relate to the idea of pest plants and animals. A war against 'environmental weeds' or simply invasive species was a natural extension of the war against agricultural weeds that had its origins with the beginnings of agriculture and civilization. An island nation founded on the fear of foreigners and the guilt of dispossession of the indigenous people may have further intensified this rise of 'nativist' demonizing of naturalized species in Australia.

These psycho-social factors, combined with the prevailing view within the biological science community, led to the belief that so called invasive species were a major threat to Australian and global biodiversity. As the concept of indigeneity gained status as a way to evaluate biodiversity, naturalized species were increasingly characterized as invasives, aliens or environmental weeds. This perspective has consolidated as a new scientific orthodoxy that treats naturalized species as forms of biological pollution or a negative measure of biodiversity. Consequently, it is common that sites where naturalized species predominate are treated as having very low biodiversity value even though the total number of species may be very high.

Terminology

I avoid using the term 'weed' because it simply means 'a plant out of place', and is therefore a description of human preferences and has no validity as a scientific descriptor of plant species. The term 'environmental weed' used to describe species that can invade natural or near natural environments simply builds a superficially ecological concept on a foundation that has no ecological basis. I prefer the term 'naturalized species' to describe all plants that have developed self reproducing populations outside of their supposed natural range where they are 'indigenous'.[2] The term 'naturalized' has long been in use by botanists, and recognizes species that have achieved the first level of ecological functionality in establishing a self-maintaining population.

The term 'invasive species' is also problematic because of the strong negative emotions associated with it.[3] I prefer the term 'migrant species' to indicate this capacity to shift in the same way that invasive is used to prejudge species with the potential for movement. Most, if not all, so-called invasive species should be

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1 The Food Forest at Gawler, South Australia (http://www.foodforest.com.au/) includes indigenous revegetation, bush tucker and the productive use of threatened marsupials as integrated aspects of permaculture design.

2 Even though the concept of indigeneity is inherently problematic when viewed from a paleo-ecological perspective, and without the blinkers created by the *terra nullius* doctrine, that assumed indigenous people did not modify or manage their environment.

3 See Wikipedia entry on invasive species for acknowledgement of the problematic nature of the term. http://en.wikipedia.org/wiki/Invasive_species

described by the classic ecological term 'pioneer species' for which a typical list of characteristics can be enumerated. Pioneer species respond to disturbance, and almost all 'weed invasions' occur in a context of human disturbance to a greater or lesser degree.

Within the broad church of environmentalism one of the few groups to recognize and articulate the value of naturalizing species was permaculturists. This began with the valuing and use of pioneer species to quickly stabilize soil and water resources, build organic matter, fix nutrients, ameliorate microclimate and quickly provide habitat and resources while more delicate, longer lived climax species become established. Bill Mollison and I have been of like mind on the use of species capable of naturalizing. American permaculture practitioners and authors Jono Neiger and Dave Jacke provide a overview in Questioning the Invasive Species Paradigm (Neiger and Jacke 2008), with extensive references to the scientific literature. However, this positive view of naturalizing plants remains controversial amongst permaculture teachers, designers and practitioners.

Over many years I have strongly articulated these values of naturalized species (Neiger and Jacke 2008), and in publicly debating the 'weeds' issue[4]. During the 1990s I undertook research for a book[5] on the subject, but was diverted by a focus on a more fundamental development of permaculture theory and design principles (Holmgren 2002).

In that work I articulate permaculture design principles in the context of an energy descent future for humanity. My more recent work has focused on furthering the creative grass roots responses to the unfolding global crisis that may see the 'weeds' debate forgotten as more urgent issues and crises driven by peaking resources and climatic chaos capture our collective attention.

The invitation by the Weeds Society of Victoria to contribute to this Seminar is an opportunity to clarify the origins, rationale and future of the positive view of naturalizing plants that characterizes my work specifically, and permaculture more generally, as a global grass roots environmental movement.

Origins of the positive view of naturalized species in Permaculture

The favourable view of naturalizing plants (weeds)[6] in my own work and permaculture more generally has been influenced by five primary sources.

1. Indigenous hunter-gatherer culture.
2. Economic botany researchers of the 19th century.
3. Organic farming pioneers.
4. 'The Limits to Growth' work of systems modellers led by Jay Forester.
5. The ecological energetics of Howard Odum.

Indigenous hunter gatherers

Australian and other indigenous cultures were a primary source in the development of permaculture concepts and thinking. We saw agriculture as embodying fundamental design flaws that were major contributors to global unsustainability and, like many other environmental thinkers, saw indigenous hunter gather cultures as being a source of wisdom, if not as specific ways of living that could influence the creation of future sustainable cultures.

More specifically, the focus of hunter-gatherer cultures on the naturally generated surpluses of abundant plants and animals in their environment avoided the weed problem created by agriculture's disturbance of the soil. Although hunter gathers clearly favour species with their intervention, they seem to recognize and accommodate all species as part of the natural order. For example, the Arran'da people of the central desert have a word that means 'of the land'. All things 'of the land' have moral status and can be appropriately used but not abused. Naturalized species of animals such as rabbits and donkeys are 'of the land'. Consequently programs to waste and even exterminate feral animals are not supported by traditional people. Of course modern, especially educated aboriginal people, will sometimes express a disdain for 'white fella' weeds and vermin, but I think this should be recognized as primarily using certain aspects of the dominant culture to advance a cause.

Economic botany of trees and perennial species

In late 19th century there was a huge scientific interest in the potential of underutilized wild plants, especially trees that could provide timber, fuel, chemicals, foods and pharmaceuticals. The botanical explorers of Europe, and especially Britain, recognized that wider use of previously little cultivated and wild perennial species could be as significant to economic and environmental improvement as the 'discovery' of highly cultivated annual plants from the Americas had already proved. The facsimile edition of Maiden's *Useful Plants of Australia* (Maiden 1975), originally published a century before, was emblematic of the period, and a major reference in Permaculture One. Although the focus of permaculture may have been on small-scale cultivated systems, we recognized that naturalization was an important pathway to more sustainable systems that should not be ignored. Naturalized timber, fodder and food trees could be used to create new sustainable resources that required few inputs once established, in the same way that naturalization of Mediterranean pasture legumes has improved the productivity and sustainability of broad acre pastoral farming in Australia.[7]

Organic agriculture

Organic agriculture simultaneously emerged in Britain, Germany, USA and Japan in the 1930s as a response to first generation industrialized agriculture. The increasing capacity of modern agriculture to win the war against weeds led some of the organic pioneers to a more positive view of weeds as soil repairers, herbal remedies and biodiversity that supported beneficial insects and birds. While acknowledging the need for weed management, organic farmers recognized the importance of balance. Ironically, it was the widespread use of modern herbicides in the 1970s that dramatically highlighted the distinctive nature of organic agriculture that was reliant on traditional methods of weed control. This view of agricultural weeds within organics was influential in the permaculture concept of 'pioneer plants'. In particular, fast growing leguminous shrubs and trees were recognized for their capacity to build biomass, stabilize and improve soils and ameliorate microclimate for the establishment of long lived 'food forests'. In the same way that the organic pioneers recognized the value of herbaceous agricultural weeds, we recognized the value of woody pioneer species, many of which were being identified in the new category of 'environmental weeds' considered to be a threat to natural ecosystems.

Limits to growth

The Limits to Growth report (Meadows *et al*. 1972) commissioned by the Club of Rome was arguably the most widely read and debated public scientific report in history. As expressed in the report, the essence of the environmental dilemma is summed up in the notion that depletion of non-renewable resources, combined with the earth's limited capacity to absorb human-generated waste, would create non-negotiable limits to population and economic growth.

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4 Public debate with John Robin 1990 University of Tasmania, Geoff Carr 1996 Creswick Landcare Information Centre.

5 Unpublished manuscript: Migrant Plants and Animals.

6 I avoid using the term 'weed' because it simply means a plant out of place, and is therefore a description of human preferences.

7 Without the ability to 'persist' (i.e. naturalize) these legumes would have been of little value.

We see permaculture as providing the eco-technic design solutions able to cushion the decline of non-renewable resources and accelerate the healing processes of nature by use of a broader range of species from similar climates around the world. We recognize that with less power to control nature, humanity in the future would be forced to work with what was wild, and that a diversity of wild food and other useful species has been the necessary precursor to previous cycles of agricultural evolution. Further, we recognize that during past periods of economic decline, war and social stress, that wild foods and plants provided essential fall-back resources to sustain local communities.

I see the ecological, economic and cultural implications of these four influences on the positive view of naturalized species as coming together through the ecological energetics of Howard Odum. His book Environment, Power and Society (Odum 1971) was the first reference in the bibliography of Permaculture One, and his ongoing work is the single most important influence on my own evolution and articulation of Permaculture, including the dedication of *Permaculture: Principles and Pathways Beyond Sustainability* to his memory. Odum's ecological energetics provides a rational scientific framework for evaluating the contribution of naturalizing vegetation in stabilizing the environmental resources of soil and water, building biomass, fixing nutrients, providing for increased floristic and faunal diversity and new renewable resources.

Concurrent with the influence of Odum's writings, I worked with Haikai Tane[8], a watershed resource ecologist in New Zealand who shared my positive view of naturalized species. In 1984 we coined the term 'ecosynthesis' to describe the rapid evolution of new ecosystems we saw occurring on degraded land where human intervention had lapsed. Haikai Tane inspired a lifelong passion for the development of skills in reading landscapes as a critical tool to fast track our understanding of this ecosynthesis process.

As the new orthodoxy of what Tane called 'Nativism' influenced resource conservation and land management during the 1980s and 1990s, permaculture was increasingly painted by some as ecologically naïve, focused on narrow human utilitarian values, or worse, a vandalistic spreading of invasive species[9]. In the mid 1990s I made an indirect contribution to the formal scientific study of ecosynthesis when I introduced Michael Wilson to the Spring Creek Community Forest site[10], and suggested this riparian system dominated by willows might be a candidate for his PhD thesis (Wilson 2001). Since then Wilson has become a leading expert on willow ecology in Australia, supervising several PhD projects that have gradually built a body of evidence on the positive effects of willows.

Spring Creek Community Forest

Our own informal observations and conclusions at the Spring Creek Community Forest over 25 years, combined with observations from many other sites where the ecosynthesis process has been able to proceed without regular reset by human intervention, are in keeping with a growing body of peer reviewed science that suggests the ecological outcome of novel ecosystems is complex, productive and diverse. We believe that novel ecosystems provide better models for the design of humanly productive ecosystems. This is exactly what we have been doing in modest ways at the Spring Creek Community Forest. For two decades we have been using the site in Permaculture Design Courses and tours to teach skills in reading landscape and to engage people with the empowering concept that humans can contribute to ecosystem evolution in ways that support ecological processes and improve resource values without the use of toxins or massive disruptive interventions.

Parallel thinking

During the 1990s, the internet made possible a greater awareness of similar views of naturalized species that countered the increasing feeling in Australia that permaculture might be the last bastion of a positive view of species naturalization. Since then, a wider range of scientists, land managers and commentators have begun to question the orthodoxy.

Fringe practitioners and authors

Natural Sequence Farming[11], the term coined by Peter Andrews to describe his landscape restoration work over the last 30 years, has received praise from leading Australian resource and watershed ecologists. However, his positive view of agricultural weeds has retarded the acceptance of his ideas in farming communities. More significantly, his use of willows has been the focus of controversy, given that Catchment Management Authorities across South Eastern Australia have used taxpayers money to establish a new rural 'industry' removing willows from riparian landscapes.

In North America, those who questioned the orthodoxy also tended to come from the fringe. For example, David Theodoropoulos is a self taught naturalist and economic botanist who runs a small business selling seed of useful species in California. In his well argued and referenced book *Invasion Biology: Critique of a Pseudoscience* (Theodoropoulos 2003) critiques the psycho-social origins of nativism, and lays out the case that the naturalization of species is a hedge against climate change and other human impacts. My review (Holmgren 2003) of his book included a rhetorical question about whether this book would stimulate more peer reviewed science that questioned the nativist orthodoxy.

Mainstream science

Since then I have become aware of a flood of theoretical and applied scientific work that undermines the nativist orthodoxy in the biological sciences.

Most notable for its concurrence with our concept of ecosynthesis, Jansen's concept of 'ecological fitting'[12] proposed in the mid 1980s, questioned the assumption that most close relationships between species were created by co-evolution. Jansen used well credentialed research in the tropical rainforests of Costa Rica to suggest that even in these most stable and complex climax rainforests, many of the inter-species relationships were generalist 'lock and key' relationships that did not require long evolutionary time. In essence, while species evolution may take a long time, functional ecosystems can evolve rapidly.

More recently the term 'novel ecosystems' was coined to describe the rapid evolution that is occurring around the world as a result of human disturbance and species introductions. In 2006 ecologist Richard Hobbs and 17 colleagues (Hobbs *et al*. 2006) argued that novel ecosystems have value in promoting biodiversity and also help with services such as providing flowers for pollinators or the cycling of nutrients, and thus they should be studied scientifically. In another paper Hobbs (2007) questions whether restoration work in fragmented ecologies within urban and rural landscapes is simply an expensive form of gardening that has limited conservation value, and is unsustainable in the longer term. These are the same questions that I was asking 20 years ago,

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[8] See website http://www.cyberport.net.nz/

[9] Perhaps the most well known Australian critic of permaculture in this regard is Tim Low. See Feral Future 1999 for the flavour of his comments on permaculture and specifically on my own work.

[10] See Spring Creek Community Forest web-page http://www.holmgren.com.au/html/SpringCk/SpringCk.html

[11] See website of the Natural Sequence Association http://www.naturalsequenceassociation.org.au/

[12] See Wikipedia article for summary and sources of the concept http://en.wikipedia.org/wiki/Ecological_fitting

as urban and rural Landcare projects that attempted to tackle environmental weeds started sucking up the limited available environmental dollars.

One of the most strongly held beliefs of nativism is that naturalizing species result in species extinctions and a general loss of biodiversity. Sax and Gaines (2008) review evidence for species naturalizations and extinctions on oceanic islands, considered to be most vulnerable to the adverse effects of naturalization. Their collected evidence confirms the impact of animal introductions, but refutes the idea that plant introductions have coincided with major loss of native species. In all islands studied, total species richness had increased, most showing a doubling. This work adds to considerable evidence collected by these authors on continental biodiversity enrichment through plant naturalizations.

In an extensively referenced discussion paper on conciliation biology Scott Carroll (2011) defines conciliation biology as:

> 'that part of invasion biology that focuses not on prevention or eradication of invasive species, but instead predicts and manages outcomes of longer-term native–non native interactions at the levels of individual, population, species, community, and ecosystem. Conciliation biology recognizes that many non native species are permanent, that outcomes of native–non native interactions will vary depending on the scale of assessment and the values assigned to the biotic system, and that many non native species will perform positive functions in one or more contexts. Managing such mixed and novel systems will require integrated schemes responsive to change. Compared to invader-free communities, invader-perturbed communities are more likely to require monitoring and management of evolutionary processes. Indeed, these same communities may also be more susceptible to proactive eco-evolutionary manipulation than in the more integrated and redundant structures of deeply coevolved native communities.'

This quotation could be a description of the permaculture thinking that has informed our modest Spring Creek Community Forest project.

Within the world of mainstream science journalism, the study of novel ecosystems is finally getting a long overdue airing. For examples of the flavour of that discussion see Marris (2009) and Vince (2011). These articles report on how acrimonious the debate over novel ecosystems has been, especially when applied to management of high value biodiversity reserves. They also show how more pragmatic land managers are turning away from the orthodoxy because of its failure to offer workable management strategies for dealing with naturalizing species that do not involve huge budgets and collateral damage to environmental assets. These reports remind me of how, on permaculture design courses, we generally have one or more disillusioned bush regenerators who have come to permaculture as providing a more balanced and holistic approach to naturalized species.

Climate change and peak oil as context for valuing naturalized species

Most of the debate about naturalized species occurs in isolation from awareness and discussion of the global civilization crisis precipitated by the emerging limits to growth. My own articulation of permaculture as design for the energy descent future (Holmgren 2002)[13] driven by climate change and peak oil makes this awareness and discussion central to any realistic evaluation of naturalizing species.

Globalized trade

Firstly, it should be acknowledged that the spread of biological organisms to their global ecological limits is primarily a by-product of economic globalization sustained by cheap oil. If globalized trade and movement of people were to continue on their current trajectory for another 50 years, then we should expect everything to go everywhere. The spread of invasives by corporate and government driven globalization gets minimal attention, perhaps because it is seen as an accidental outcome rather than through malicious intent or perhaps because it is accepted as inevitable. On the other hand, permaculturists spreading potential invasive species have been strongly criticized by some prominent environmentalists such as Tim Low.[14] Perhaps it is the articulation of the ecologically positive aspects of naturalized species that stimulates such outrage, or maybe it's just that permaculture seems like a soft target compared with economic globalization.

Climate driven species migration

Climate change has been widely predicted to lead to mass movement of species. Evidence of these adaptive behaviour movements is already accumulating, but native species that have been successful in moving in response to human induced environmental change are commonly labelled as undesirable invasives by some biologists and land managers. How can these views be reconciled? I often joke with tour visitors to Melliodora[15] that the sulphur crested cockatoos that cause us so much grief by their demolition of our fruit and nut crops are indigenous (because they arrived in Hepburn three years before we did!). Perhaps the most dramatic of these migrations is the endangered rainforest fruit bats from North Queensland that now are established right down the East Coast, including the controversial colony at the Melbourne Botanic Gardens.[16]

However, latitudinal movement of species is arguably a minor outcome of climate change. With the increase in extreme weather events already being experienced, disturbance of natural, agricultural and settled landscapes will guarantee increased opportunities for naturalization. Within the invasion biology field this is typically discussed as an ecological disaster that is best prevented by ensuring no seed sources of potential invasive species, leaving the field open to indigenous species. This perspective ignores the evidence that many exotic species have greater potential to better stabilize soil and water resources than locally indigenous species[17]. Novel ecosystems are the laboratories where we can study how native and migrant species might combine in this future of disruptive climate change.

Peak oil and naturalizing species

The current peak in production of the world's dominant source of transport fuel, with no alternatives able to sustain current levels of consumption let alone growth, promises to change both the rate and extent of naturalized species as well as our attitudes to and use of these species as resources.

Firstly, peak oil is likely to fragment the global supply system and stimulate relocalized economies. Reduced global trade is likely to reduce accidental naturalizations especially of insects, diseases and other microorganisms.

Higher energy costs are already flowing through to food and all other resources, both renewable and non-renewable.

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[13] See also Future scenarios: mapping the cultural implications of peak oil and climate change (2008) http://www.futurescenarios.org/.

[14] Tim Low recently declined an invitation to publically debate the 'weeds' issue with me.

[15] See Melliodora page of HDS website http://www.holmgren.com.au/.

[16] See Tim Low's *The New Nature* (2002) for an excellent overview of this and other species migrations and naturalizations of Australian species outside their pre-European ranges.

[17] For example, the capture of sediment and phosphorus by willow root mats being larger than that by eucalypts (40 and 10 times respectively) recorded by Wilson (2001) in central Victorian streams.

Resulting economic contraction[18] will see less money for weed control, while the high embodied energy cost of herbicides will reduce options for weed control.

Higher commodity and food costs will drive a greater use of marginal and waste land close to population centres for food production. As a result, novel ecosystems that have spread in an era of cheap energy and food may be converted to intensive use. On the other hand, economic and geopolitical shocks could see a collapse in the capacity to manage land using machines and herbicides, such as occurred in Cuba during the 1990s. In this scenario, novel ecosystems could spread rapidly.

The low level of interest in economic botany of trees and long-lived perennials in the 20th century can be attributed to abundant cheap oil that undercuts the value of renewable resources. I see permaculture as prefiguring a revival of interest in both native and migrant species as valuable resources in the energy descent future. In less intensively managed landscapes the renewed value from naturalized species, e.g. willow for animal fodder, could see more people actively spreading potentially useful species.

Caveats

In highlighting the positive aspects of naturalized and migrant plants to balance what I believe is an anti-ecological and damaging orthodoxy, I don't want to give the impression that I believe caution is not required in the introduction of new species. In my teaching of permaculture I have always emphasized the distinction between animals (especially vertebrates including fish) and plants when considering the potentially problematic introduction of these organisms to new environments: clearly top predators are the most problematic of all introductions. That being said, prohibitions on culture of (for example) Redfin perch in central Victoria is meaningless when this species has been naturalized in all streams and most dams for at least a century.

I also distinguish between radically modified environments and relatively pristine environments when considering the introduction of species. Overlaid with this I use a watershed framework where introductions low down in most watersheds are less likely to be problematic than introductions at, or near, headwaters.

Similarly, the potential impacts (positive and negative) of introductions are proportional to the geospatial scale of introduction. Introductions to islands are more significant than those to new bioregions within continents, which are in turn more significant than introductions to new sites within a bioregion.

Finally, in permaculture, introductions of new species to a site generally follow the zoning principle where the plant is nursery raised and tested in 'zones one or two'[19] before deciding if it is suitable for wider naturalization in the outer zones where control or removal is more difficult.

In Trees On the Treeless Plains: a revegetation manual for the volcanic plains of central Victoria (Holmgren 1994), I used a hierarchy for species selection in broad acre farm revegetation and tree planting: 'Use a local indigenous species in preference to an Australian native species, in preference to an exotic species'. However, the multifunction nature of species selection in permaculture often means locally indigenous or even Australian native species will not do the job. For example, in many environments, shelterbelt designs may require deciduous species to avoid long winter shadows over crops. Additionally, a need for fire retardant and animal fodder species would lead to well proven exotics, such as elms and oaks, while no Australian species can match these criteria (in central Victoria).

Conclusion

These well thought out criteria for considering plant species introduction show that the practical difference between permaculture and more conventional approaches to land management is not so great. The gulf widens when nativist ideology takes hold.

The nativist ideology that has largely captured public policy, resource allocation and instigated increasing regulation, as well as influenced the personal decisions of farmers and land managers, makes the following assumptions that I believe are all ill founded:

1. All species naturalizations at all scales represent ecological degradation, and should be avoided.
2. Ecosystem services provided by naturalized species are insignificant or trivial.
3. New resource opportunities from naturalized species are insignificant or trivial.
4. Control and/or extermination of already naturalized species is a high priority in land management.
5. Collateral damage to soil and water resources, and to other life forms from use of toxins and machinery is minor.
6. That the war against weeds can be won.

While these pernicious ideas continue to hold sway, it is incumbent on those with a more balanced and holistic (ecological) perspective to articulate the positive aspects of plant naturalizations. The greatest good than might flow from this articulation is the protection and study of advanced examples of novel ecosystems.

Whatever the dynamics of the unfolding global crisis driven by climatic chaos and peaking resources, the process of ecosynthesis of novel ecosystems based on past changes to global system seems set to accelerate, while capacity to pour resources down the drain of nativist illusions will collapse, if only because of the embodied energy cost of herbicides and diesel powered machinery. While most thinking about the energy descent future is negative, one of the positive possibilities is that novel ecosystems may cushion humanity's descent, and reinvigorate biodiversity in an increasingly relocalized bioregional world. While the basis for this speculation is beyond the scope of this paper, it is one that I believe is better supported by evidence than the negative view of a MacDonaldized world of weeds that sustain neither nature nor people.

An important role for researchers and organizations (such as the Weed Society of Victoria) that focus on naturalizing species is to help convince policy makers that the evolution of novel ecosystems through better understanding and management is central rather than peripheral to the future well being of humanity.

[18] Australia's status as an energy and resource superpower may allow Australia to avoid some of these impacts for a few decades but the globally connected nature of the current system provides no certainty.

[19] In permaculture design terminology 'zones one and two' are the intensively managed areas of garden agriculture around a house or homestead.

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Agricultural bioenergy cropping in Victoria – balancing the issues

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Abstract
There has been considerable interest in biofuels and bioenergy production (the generation of energy from biomass), as alternative agricultural industries for the future. High oil prices, diminishing total oil supply, the energy security debate, growing environmental awareness and the need to develop sustainable regional agricultural industries under climate change, are issues that are driving this interest. The Victorian Government, through its Agriculture and Fisheries Four Year Strategy, recognizes the benefits of developing a sustainable bioenergy industry, particularly using second generation biofuels. The development of a sustainable biofuel industry in Victoria may have a major impact on the Victorian economy by potentially: lessening the dependence on fossil fuels; enabling new markets and alternative income streams for farmers to be developed; developing new industries for regional Victoria; assisting in the reduction of greenhouse gas emissions; developing land management systems which provide efficient, low emissions energy sources, while reducing greenhouse gas (GHG) emissions. However, while bioenergy offers potential for significant benefits, it is critical that the economic, environmental (including weed risk, lifecycle GHG emissions and energy balance) and social values of any potential biofuel crop be fully assessed before its introduction and promotion.

Keywords: bioenergy, biofuel, biomass, bioenergy crops, sustainable, weed risk.

Introduction
Bioenergy is a form of renewable energy derived from conversion of biomass to electricity, heat and/or liquid fuels (biofuels) for transport via processes of combustion, fermentation or digestion. Bioenergy represents around 10 per cent of the world's primary energy consumption, although bioenergy has been less widely adopted in Australia, accounting for only 4% of Australia's primary energy consumption in 2007–2008 (but 78% of renewable energy use; Australian Government 2010). As a consequence of Government targets for renewable energy use, emissions reduction and other policies such as pricing carbon, bioenergy use in Australia is projected to increase by 2.2% per year to 340 petajoules in 2029–2030 (Australian Government 2010). Bioenergy in Australia is currently derived almost entirely from waste biomass with heat and electricity from bagasse, wood waste and gas capture from landfill and sewerage (anaerobic digestion), ethanol from sugar by products, waste starch and grain, and biodiesel from tallow, used cooking oil and oilseeds (e.g. dryland mustard). However, to meet the future demand for biomass, additional purpose grown sources will be required.

Discussion
The availability of reliable, consistent and sustainable biomass supply is critical to the development and expansion of the bioenergy sector (and indeed for the developing bioeconomy). First generation biofuel crops are those crops that contain either plant oil that may readily be extracted and converted into biodiesel, or starch or sugar that can easily be converted into ethanol by fermentation (e.g. maize, wheat, palm oil). Emergent 2nd generation (or later) technologies will be able to utilize a range of carbon sources, including lignocellulosic material found in the fibrous or woody material of plant crops, for conversion into liquid fuels (and as an alternative to combustion for heat and/or power). This creates new opportunities for both the use of the non-edible portion of food crops (including food processing waste) in addition to cultivation of non-food energy specific crops. Another aspect of biomass for bioenergy is the production of by-products and co-products. By-products can include precursors for the manufacture of industrial chemicals or products, or fermented product for animal