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Designing Regulation for Conservation and Biosecurity

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Designing regulation for conservation and biosecurity

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Abstract

Much Australian law for the protection of ecological assets has inherited a focus on species and their habitats, reflected in a reliance on taxonomic lists as triggers for action. We argue that an over-reliance on lists may compromise the effectiveness of conservation actions because it overlooks the potential value of managing complete ecological systems. We consider three aspects of environmental law: the control of new threats, particularly invasive plants; the protection of native species and their habitats; and the rehabilitation of damaged ecosystems. We focus principally on federal weed and quarantine legislation, and biodiversity conservation law.

Australian federal threatened species legislation largely reflects international obligations, which focus on the protection of particular species. In quarantine and invasive control law, lists of species are a legacy of this historical focus. The law has struggled to keep pace with the recent emergence of the discipline of conservation biology, which itself has not been effective in communicating uncertainties. We argue that increasing threats from invasive pests, diseases and pathogens, salinity, changed climate and disturbance regimes require new legal responses which should embrace a more cohesive legal framework together with ecosystem thinking that supplements list-based, species-focused legislation.

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Contents

I INTRODUCTION

Taxonomy and population ecology focus on identifying, describing and understanding the biological elements of the natural world. Systems ecology focuses on the dynamic interactions between these elements and the physical world, and the characteristics of those interactions. These approaches are complementary. Between the mid-1800s and the 1900s, ecology evolved from static, taxonomic descriptions of species and ecological communities to an increased understanding of the evolution, integration and dynamics of ecological systems, and grew in prominence with society's concern with the state of the environment.[1]

Legal institutions have partly mirrored these developments. Initially, environmental legislation focused on the protection of places within which natural elements were found (for example conservation parks and reserves). The first reserves in Australia were proclaimed to protect resources such as timber and water, provide recreation opportunities, and protect and allow for the observation of spectacular natural features. Most were acquired opportunistically.[2] More recently, legislation focused on the protection of species. In contemporary times, environmental protection legislation has begun to encompass concern for ecological systems and processes.

A recent review of Australia's environment legislation[3] highlighted limits to the effectiveness of laws for habitat protection and control of invasive species, as well as significant transaction costs and the potential for inequities in complex systems of regulation. It explored the difference in the design and implementation of the national

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1 C S Holling, 'Resilience and stability of ecological systems' (1973) 4 *Annual Review of Ecology and Systematics* 1; Robert P McIntosh, *The background of ecology: concept and theory*. (1985); Anthony Trewavas, '"A brief history of systems biology" Francois Jacob (1974)' (2006) 18 *The Plant Cell* 2420.

2 H F Recher and L Lim, 'A review of current ideas of the extinction, conservation and management of Australia's terrestrial vertebrate fauna' in D A Saunders, A J M Hopkins and R A How (eds), *Australian ecosystems: 200 years of utilisation, degradation and reconstruction* vol 16 (Surrey Beatty, Chipping-Norton, 1990) 287; Resource Assessment Commission, *Forest and Timber Inquiry, final report.* vols 1 and 2 (Australian Government Publishing Service, Canberra, 1992).

3 Paul Martin, Robyn Bartel, Jack Sinden, Neil Gunningham and Ian Hannam, *Developing a Good Regulatory Practice Model for Environmental Regulations Impacting on Farmers*, July 2007 (Australian Farm Institute and Land & Water Australia, 2007).

Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act*) that partly reflects a philosophy of ecosystem protection, and the list-based federal and state legislation for the control of invasive plants and the protection of specific habitats. That paper suggested the need for a reduction of the jurisdictional and functional fragmentation of the law and its administration by various agencies.[4]

This article considers a second aspect of the redesign of environmental laws, motivated by the systemic and diffuse harm caused by the chronic, cumulative and interactive impact of multiple threatening processes. We suggest changes which aim to reduce the risks of over-reliance on list-specific protection by increasing a complementary focus on ecological systems.[5]

II LEGISLATIVE FRAMEWORKS

In practice, the targets of conservation efforts, such as protected areas, serve multiple goals. They prevent harm to nominated species at particular sites. They also serve broader goals, such as providing protection for unspecified species and ecological communities against broader classes of threat (such as climate change or land use change). Biosecurity and quarantine legislation aims to prevent the introduction and limit the dispersal of harmful species. In general, rehabilitation protects and encourages the recovery of desirable flora and fauna, discourages undesirable taxa and restores the ecological contexts within which they exist.

Such practical realities suggest that protection and rehabilitation involve a mixture of specific (exclusion of hazardous species, protection of threatened species and habitats) and more general strategies. Thus, conservation legislation and regulation have begun to encompass broader strategies including management of biophysical processes, ecosystem services, social values and market instruments[6].

There are literally hundreds of laws across Australia concerned with different aspects of conservation and rehabilitation.[7] Most focus on individual species or ecosystem types without a complementary focus on systems, which (we argue) may compromise their effectiveness. We highlight several significant Acts that illustrate these patterns of regulation.[8]

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4 It also highlighted the need for simultaneous reduction of the transaction costs of regulation, and improved attention to the social justice impacts of the allocation of costs of protecting our environment.

5 In making this case we do not intend to diminish the importance of also addressing the issues of efficiency and equity raised in Martin et al, above n 3.

6 Sarah A Bekessy and Brendan A Wintle, 'Using Carbon Investment to Grow the Biodiversity Bank' (2008) 22 *Conservation Biology* 510.

7 P Martin and M Verbeek, *A Cartography for Natural Resource Law: Finding new paths to effective resource regulation* (Land and Water Australia, 2000), re-published as *Using Environmental Law for Effective Regulation* Research project number TPF1 of the Social and Institutional in *Land & Water Australia Natural Resource Management – People and Policy II*, Research Program of Land & Water Australia (2002).

8 Martin et al, above n 3. See detailed discussion of appendix 2, dealing specifically with state and national biodiversity, invasive plants and quarantine laws: 47–8.

1. national quarantine legislation (mirrored in state species movement controls) which proscribe listed species from importation,[9]
2. state invasive species legislation, based on species lists to which are attached prescribed controls to be implemented by landowners and resource managers,[10] and
3. the national *EPBC Act* which is partly reflected in state law.[11] This law uses a combination of species listing and broader habitat protection.

These laws reflect different constitutional and historical settings, levels of scientific understanding, regulatory philosophies, administrative and implementation arrangements. Change in the law may be slow, as courts and legislatures gradually incorporate new knowledge. During times of rapid scientific change, the legislative process inevitably struggles to cope. We argue that legal and regulatory systems have struggled to keep pace with the recent emergence of the discipline of conservation biology,[12] which itself has not developed effective systems for communicating the uncertainties inherent in its assessments of risk.

The circumscription of species is relatively precise, so that weed, quarantine and threatened species lists provide technically reliable identification of regulated flora and fauna. This facilitates drafting, and makes policing and administrative actions effective, as many evidentiary issues are reduced to species taxonomy. Scientific and regulatory conservatism ensures that the addition of new items to the lists occurs after careful evaluation, creating a 'conservative' bias that we explore further below.

In contrast, ecosystem conservation (illustrated by the *EPBC Act* emphasis on designated threatened habitats and threatening processes) involves greater scientific and legal ambiguity because ecosystem-types are less precisely designated than species.[13] Examples include the apparently precise designations of ecosystems such as 'white box woodland' or 'hanging peat swamp'. The subjectivity in identifying whether a habitat fits a description becomes obvious when applied in the field or in court. This leads to some ambiguity in applying the law, with resultant uncertainty and the potential for delay.[14] These issues need to be resolved with legal and scientific instruments, if ecosystem conservation is to progress.

III LISTS OF THREATENED AND INVASIVE SPECIES

9 Ibid 48–50.

10 Ibid 50–2.

11 Ibid 53–9, 60–3.

12 Curt Meine, Michael Soulé and Reed F Noss, '"A Mission-Driven Discipline": the Growth of Conservation Biology' (2006) 20 *Conservation Biology* 631.

13 Brian J Preston and Paul Adam, 'Describing and listing threatened ecological communities under the Threatened Species Conservation Act 1995 (NSW): Part 1 – the assemblage of species and the particular area' (2004) 21 *Environmental and Planning Law Journal* 250: David A Keith, *The interpretation, assessment and conservation of ecological communities. Ecological Management and Restoration* (in press).

14 Demonstrated with NSW native vegetation clearing approvals, and in responses to the *EPBC Act* requirement for developers to self-assess and notify potentially high impact developments.

Threatened species legislation is intended to stave off the loss of species.[15] Protection is afforded to listed species and ecological communities. State and federal authorities specify particular noxious pests, weeds and pathogens as a basis for setting management priorities. Additional legal and social policy mechanisms — including native vegetation protection, catchment management investments, fire and weed control programs, and salinity control programs — are used to protect ecosystem condition and threatened species indirectly,[16]

Nationally, and in all states (using different approaches), legislation exists to protect rare and threatened habitats.[17] For instance, the *EPBC Act* protects Ramsar wetlands, World Heritage areas and listed threatened species. The Australian federal government maintains a list of threatened Australian plants based broadly on the IUCN Red List system.[18]

Some jurisdictions use lists of threatened species to allocate recovery resources, design reserve systems, constrain development, report on the state of the environment, or otherwise support decisions about conservation priorities.[19] However, if threatened species lists are used in isolation from a consideration of the ecosystems and broader contexts within which these species exist, the lists may result in poor decisions.[20] The lists are uncertain, largely a consequence of a lack of knowledge regarding the conservation status of species.[21] The lists do not reflect many of the real threats to

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15 Pat Hutchings, Daniel Lunney and Chris Dickman (eds), *Threatened species legislation: is it just an act?* (Royal Zoological Society of New South Wales, Mosman, NSW 2004); Michelle Jenkins and Alex Gardner, 'Conservation of Biodiversity Through the Listing of Threatened Species and Ecological Communities – A Comparative Review. (2005) 10 *Australasian Journal of Natural Resources Law and Policy* 1.

16 *Quarantine Act 1908* (Cth); R J S (Bob) Beeton, Kristal I Buckley, Gary J Jones, Denise Morgan, Russell E Reichelt and Dennis Trewin, *Australia State of the Environment 2006. Independent report to the Australian Government Minister for the Environment and Heritage*, (Department of the Environment and Heritage, Canberra, 2006); Jenkins and Gardner, above n 15.

17 Note that these broad legislative protections exist alongside development-specific requirements for environmental impact assessments based on State law and upon delegated decision-making at a state or local government level.

18 IUCN, *Red List Categories Version 3.1* (Gland, Switzerland, 2001) avail <http://www.iucnredlist.org/static/categories_criteria_3_1> at 15 February 2008.

19 John Lamoreux, H Resit Akçakaya, Leon Bennun, Nigel J Collar and Luigi Boitani et al, 'Value of the IUCN Red List' (2003) 18 *Trends in Ecology and Evolution* 214.

20 Hugh P Possingham, Sandy J Andelman, Mark A Burgman, Rodrigo A Medellín, Larry L Master and David A Keith, 'Limits to the use of threatened species lists' (2002) 17 *Trends in Ecology and Evolution* 503 ('Limits to TS lists').

21 Burgman (2002) and Keith and Burgman (2004) established that the majority of species listed as extinct in Australia in the past are no longer considered to be so: Mark A Burgman, 'Are listed threatened plant species [TPS] actually at risk?' (2002) 50 *Australian Journal of Botany* 1; and David A Keith and Mark A Burgman, 'The Lazarus effect: can the dynamics of extinct species lists tell us anything about the status of biodiversity?' (2004) 117 *Biological Conservation* 41. While many were rediscovered (representing a change in knowledge about distribution and abundance), most changed status as a consequence of taxonomic revision (representing changes in knowledge about the circumscription of species). The rules governing classification of species as endangered or vulnerable are vaguer and more ambiguous than those determining the status 'extinct' and a lack of knowledge will be even more prevalent than it is for putatively extinct species.

biota, leaving non-descript taxa relatively poorly protected,[22] and the risk of extinction does not account for varying difficulty in how species may be conserved or rehabilitated.[23] Uncertainty leads to entities going unprotected until information can be gathered,[24] creating a conservative bias in the composition of lists.

Weed control relies on legislation to restrict new introductions and to control potentially damaging established species. Quarantine laws and state weed legislation specify species for control but do not focus on the ecosystems upon which they might impact or the broader context (such as climate or land use) which will shape that impact. There are many gaps, inconsistencies and complexities in this list-based approach, the most striking of which is inconsistency between plants classified as serious weeds across jurisdictions.[25]

Many opportunities to improve weeds law were identified by the Australian Senate References Committee, which stated that: ‘It is self-evident that, to improve their effectiveness, legislation and strategies for managing invasive species need to be better harmonised’.[26] Calls for reform of list-oriented environmental regulation include:[27]

1. broadening the range of listed entities to better represent micro-organisms, invertebrates and non-vascular plants,
2. developing a system for protection and recovery that avoids giving resource priority only to listed entities in the highest risk category,
3. mapping threatened species and ecological communities, monitoring changes over time and incorporating the results into the lists,
4. moving from a ‘prohibited if listed’ approach to weeds to a ‘permitted if listed’ approach,
5. rationalisation of the state and federal agency lists and better coordination of legal and administrative processes,[28] and
6. the use of duties (such as an environmental duty of care) to provide an over-arching framework of environmental responsibility.

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22 Susan McIntyre, ‘Risks associated with the setting of conservation priorities from rare plant species lists’ (1992) 60 *Biological Conservation* 31.

23 Possingham et al, Limits to TS Lists, above n 20; Jenkins and Gardner, above n 15.

24 Ibid.

25 Andreas Glanznig, Kristi McLachlan and Ouerdia Kessal, *Garden Plants that are Invasive Plants of National Importance: an overview of their legal status and commercial availability* (WWF Australia Sydney, 2004).

26 Australian Senate Environment, Communications, Information Technology and the Arts References Committee, *Turning back the tide - the invasive species challenge.* Report on the regulation, control and management of invasive species and the Environment Protection and Biodiversity Conservation Amendment (Invasive Species) Bill 2002 (2004) 51.

27 Jenkins and Gardner , above n 15; Glanznig et al, above n 25; Martin et al, above n 3.

28 Uniformity in the listing process in various legislative regimes would require a national approach and mirror legislation — we anticipate it will be difficult to achieve the necessary consensus among states and the Commonwealth.

To this group we add our recommendation to supplement species list-based approaches with regulation that is more deliberately focused on broader ecological systems, processes and services.

IV WHAT IS AT RISK WITH LIST-BASED REGULATION?

Effective conservation involves identifying and addressing the causes of environmental impact.[29] Management may be more efficient if it were to focus more on the mitigation of threatening processes and rehabilitation of ecosystem processes. Threatening processes are those processes that threaten 'or may threaten the survival, abundance or evolutionary development of a native species or ecological community'.[30] Threatening processes listed under the *EPBC Act* include the impacts of feral goats and rabbits, dieback caused by the root-rot fungus *Phytophthora cinnamomi*, and loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.[31] In most Australian regions, land clearing, invasive species, salinity, disease and urban development are prominent threats to biodiversity.[32] Most are systemic, rather than species- or location-specific. To date, regulation has not been sufficiently effective in stemming the tide of environmental loss due to such systemic changes.[33]

The Australian federal Department of Environment and Heritage routinely publishes lists of critically endangered and endangered plants.[34] Relevant threats fall into four broad classes: demographic factors (inherent risks confronted by rare and restricted species), agriculture (largely land clearing) and grazing, other human activities and landscape factors.[35] Within each broad class, there are several threatening processes. Figure 1 shows the processes grouped under the heading of Landscape Factors.

Many of the threats noted in Figure 1 are increasing because of the growing demands of the human population. Many of these were not significant in the past, or affected comparatively few species. It will be difficult to deal with them on a species-by-

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29 Graeme C Caughley and Anne Gunn, *Conservation biology in theory and practice* (1996).

30 *EPBCA Act* s 188(3). Environment Protection and Biodiversity Conservation Act 1999. Reprinted on 1 March 2007. Reprint 3. Commonwealth of Australia, Canberra.

31 Department of Environment, Water, Heritage and the Arts (Cth) (DEWHA), 'Listed Key Threatening Processes' (undated) <http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl> at 18 February 2009. Compare Department of Environment and Climate Change (NSW), 'List of key threatening processes' (3 June 2008) <http://www.environment.nsw.gov.au/threatenedspecies/KeyThreateningProcessesByDoctype.htm> at 18 February 2009.

32 Eg, Colin J Yates and Richard J Hobbs, 'Temperate Eucalypt Woodlands: a Review of Their Status, Processes Threatening Their Persistence and Techniques for Restoration' (1997) 45 *Australian Journal of Botany* 949; John Woinarski, 'A review of changes in status and threatening processes' in Peter Whitehead, John Woinarski, Alaric Fisher, Rod Fensham and Kerry Beggs (eds), *Developing an analytical framework for monitoring biodiversity in Australia's rangelands* (Tropical Savannas Management Cooperative Research Centre, Darwin, 2001) 71.

33 See Beeton et al, above n 16; and Martin et al, above n 3.

34 DEH, above n 30.

35 M A Burgman, D A Keith, S D Hopper, D Widyatmoko and C Drill, 'Threat syndromes and conservation of the Australian flora' (2007) 134 *Biological Conservation* 73.

species basis because remediation requires intervention in landscape-scale processes. Heavy reliance on individual species or unique habitats in legislation inadvertently delays a shift in management emphasis towards landscape-scale, systemic interventions. Resources and management attention remain focused on the specific and the rare, rather than the more fundamental and pervasive aspects of conservation and rehabilitation. Many species are affected by more than one process, at least to some extent, creating an imperative for the simultaneous treatment of multiple threats.

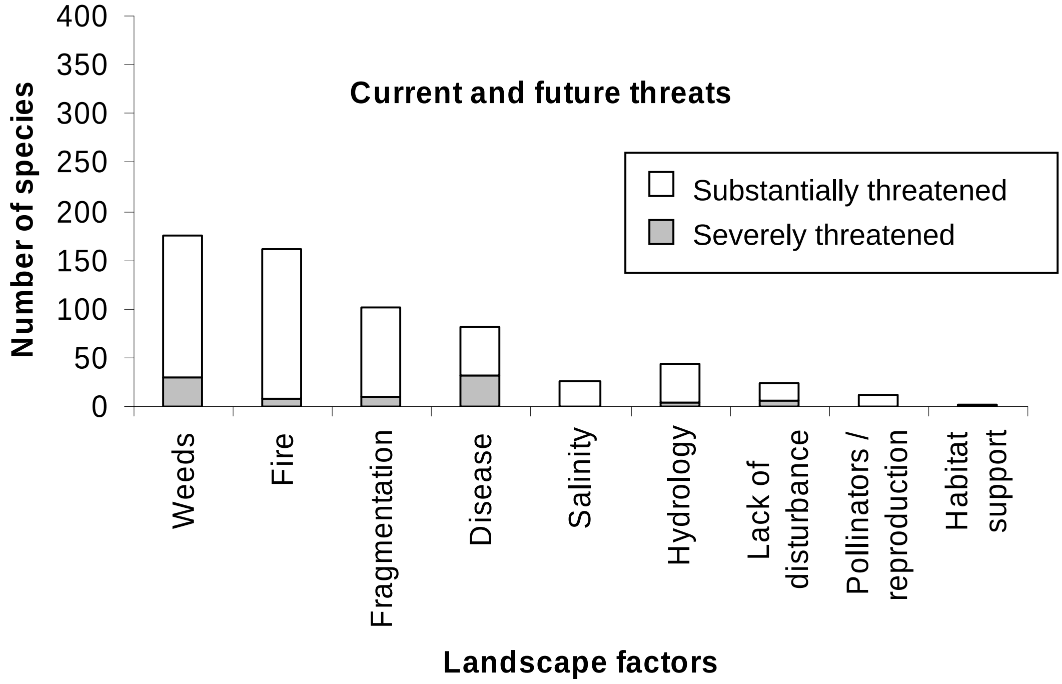

Figure 1. The number of species severely and substantially threatened by landscape factors including weeds, fire, fragmentation, disease, salinity, altered hydrology, lack of disturbance, pollinator or other reproductive disruption, and lack of habitat support.[36]

To illustrate, many species are at risk simply because they are rare — there are few individuals (tens or hundreds) in very restricted ranges (a few tens or hundreds of square metres: Figure 2). Some species are naturally rare and may persist indefinitely in small isolated populations, such as many species on the ancient southwest Australian landscape.[37]

Most restricted and rare species acquire this rarity as the result of land clearance and other changes, a legacy of past human activities that no longer threaten them directly.

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[36] After Burgman et al, Threat Syndromes, above n 35.

[37] Stephen D Hopper and Paul Gioia, 'The Southwest Australian Floristic Region: Evolution and Conservation of a Global Hot Spot of Biodiversity' (2004) 35 *Annual Review of Ecology, Evolution and Systematics* 623.

Many of these species persist in fragmented patches in a small part of their former range in conservation reserves, road and railway verges, isolated in non-arable land and other vegetation fragments that remain after land clearing activities have slowed. Species are added to lists only when we are reasonably sure they are at risk (or in the case of lists of invasive species, that they are a proven risk). Some become icons, deserving special attention (for example, Helmeted Honeyeaters, *Lichenostomus melanops cassidix,* in Victoria, and Matchstick Banksias, *Banksia cuneata*, in Western Australia). This focus on proven rarity or threat rather than upon causes of rarity carries the risk of distorting resource allocation, resulting in avoidable loss of species.

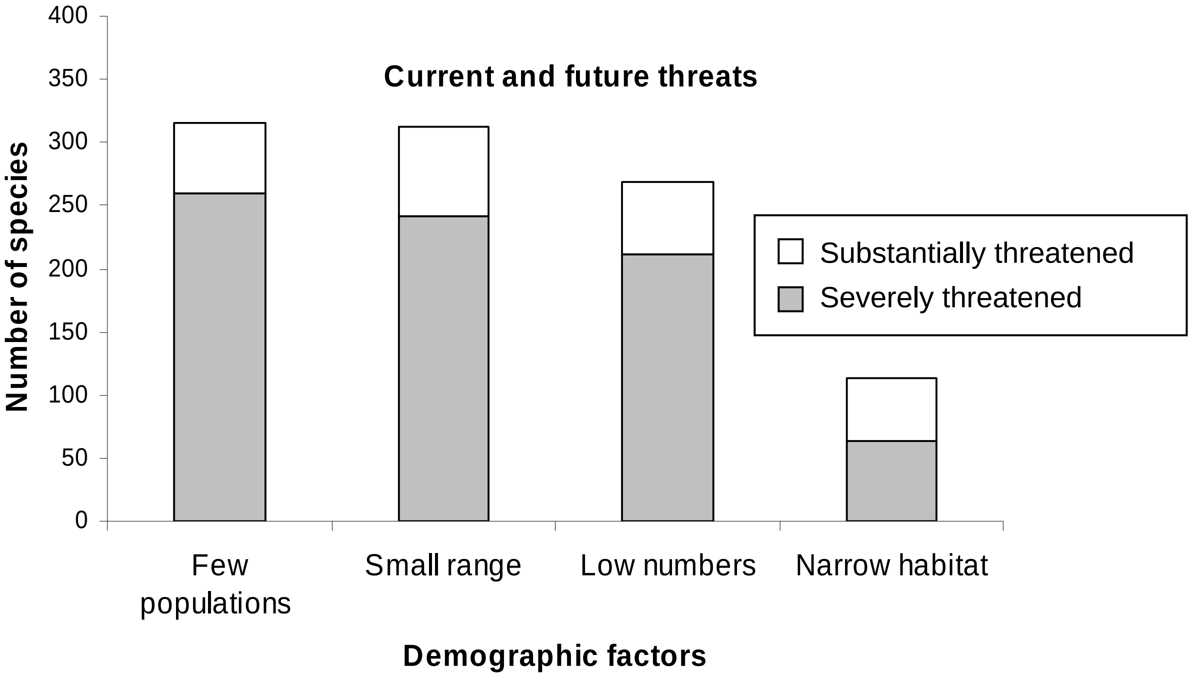

Figure 2. The number of species severely and substantially threatened by demographic factors including few populations, small range, low numbers and narrow habitat.[38]

Unfortunately, rarity is also an unreliable guide to setting priorities. For example, there are many hundreds of species of vascular plants in Western Australia that have not been listed because there are insufficient resources to survey them adequately. Many will turn out to be critically endangered but are afforded little protection while they await assessment. The likely consequence is a pattern of continually playing ‘catch up’ with an increasing list of rare and threatened habitats and species, many of which are the victims of landscape-scale, systemic trends. Such strategies are likely to result in a conservation landscape made up of iconic patches of increasing rarity.

The reluctance of scientists and regulators to list species for which there is little information reflects the methodological conservatism of conventional science, coupled with a management aversion to allocating resources to species that may not

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[38] After Burgman et al Threat Syndromes, above n 35.

need them. However such concerns about misallocation do not extend to management priorities among listed species which have qualified for iconic status. Managers tend to allocate finite resources preferentially to the most critically endangered species.[39] The politics of iconic status also contribute, with the media attention given to species 'going extinct' creating imperatives for resource allocation. Attempts to salvage species that are difficult to conserve may consume scarce conservation resources disproportionately.[40]

We do not advocate dispensing with the protection of listed threatened or with the prohibition or control of listed invasive species. Rather, an approach that weighs system health together with icon protection may result in a more effective use of limited funds. A greater number of less threatened taxa might be secured for relatively little cost, and more extensive protection may be achieved by increasing system resilience or reducing system threats. Given insufficient funding and increasing threats, ecological triage may require admitting that some species are simply too expensive to save.[41]

This view does not argue for rejection of social and cultural values in conservation decisions, nor does it advocate setting priorities solely on the basis of cost per species saved. It does emphasize the importance of thinking about cost and budget limitations, and of the opportunity costs involved when setting priorities.

V INVASIVE SPECIES

Invasive species, including weeds, pests and pathogens, are a major threatening process. Their influence will increase over the coming decades (Figure 1). Many naturalised species (species that have established reproducing populations) have yet to reach their full geographic extent. Even if there were no new invasions, environmental damage from pests and diseases will increase due to normal patterns of dispersal and responses to climate change.

The importance of priorities that consider ecosystem-level context is illustrated by a potential interaction between land use, climate change and invasive species management. Land retirement from farming may increase as a consequence of climate change making production less economically viable in some areas. Financial pressures may intensify if trade continues to be liberalised and the profitability of some conventional farming practices declines. Land retirement may lead to abdication of responsibility for weed control, exacerbating weed establishment and spread. Weed threats will increase,[42] but a species-focused, scientifically conservative approach to

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[39] For example, recovery plans for critically endangered, endangered and vulnerable listed species.

[40] Possingham et al, Limits to TS lists, above n 20.

[41] S McIntyre, G W Barrett, R L Kitching and H F Rechner, 'Species Triage – Seeing Beyond Wounded Rhinos' (1992) 6 *Conservation Biology* 604; Madeleine C Bottrill, Liana N Joseph, Josie Carwardine, Michael Bode, Edward T Game, Hedley Grantham, Salit Kirk, Eve McDonald-Madden, Robert L Pressey, Susan Walker, Kerrie A Wilson and Hugh Possingham, 'Is conservation triage just smart decision making?' (2008) 23 *Trends in Ecology and Evolution* 649.

[42] See R D Van Klinken, V A Osten, F D Panetta and J C Scanlan (eds), *16th Australian Weeds Conference Proceedings: Weed management 2008 Hot topics in the tropics*, Cairns 18–22 May 2008 (Queensland Weeds Society, 2008). See particularly Rachael V Gallagher, Linda Beaumont, Paul O Downey, Lesley Hughes and Michelle R Leishman, 'Weeds in a warmer climate: a tool for

listing invasive species for control or exclusion is unlikely to be the most effective regulatory strategy.

Unlike threatened species strategies, weed management strategies usually consider 'feasibility' and control costs explicitly when setting priorities.[43] Hundreds of new species establish in Australia every year (Figure 3), be it through trade in ornamental plants, or to improve agricultural practices, or simply as a collateral of burgeoning international trade.[44]

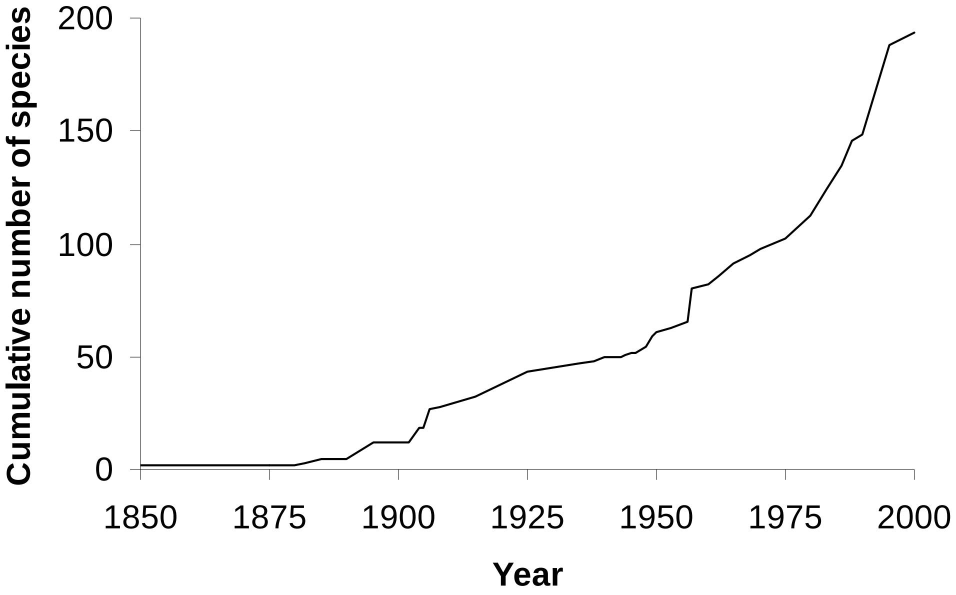

Figure 3. The cumulative number of vascular plants that have become naturalised in South Australia since 1850.[45]

Most serious weeds were introduced to Australia deliberately, as ornamental plants for urban gardens, industrial landscaping and to improve agricultural pasture.[46] Many, such as serrated tussock *(Nassella trichotoma*) and blackberry (*Rubus fructicosus aggregate*), have achieved their own (notorious) iconic status. Once introduced, the

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assessing tolerance to changing temperatures' 42 et seq; Kate E Stokes, Steve I Barry, R Hickson and Saul A Cunningham, 'Future spread of lippia in the Murray-Darling Basin under climate change': 44 et seq; John K Scott, Kathryn L Batchelor and Paul B Yeoh, 'Modelling climatic change impacts on sleeper and alert weeds' 143 et seq; and Karina J B Potter, Darren J Kriticos and Agathe Leriche, 'Climate change impacts on Scotch broom in Australia' 523 et seq.

43 Eg, Food and Agriculture Organisation (FAO), *Procedures for post-border weed risk management* [prepared by (John Virtue] (Plant Production and Protection Division, FAO, United Nations, Rome, 2006).

44 Alexander Y Karatayev, Dianna K Padilla, Dan Minchin, Demetrio Boltovskoy and Lyubov E Burlakova, 'Changes in Global Economies and Trade: the Potential Spread of Exotic Freshwater Bivalves' (2007) 9 *Biological Invasions* 161.

45 After Peter Caley, Richard H Groves and Robyn Barker, 'Estimating the invasion success of introduced plants' (2008) 14 *Diversity and Distributions* 196.

46 R H Groves, *Recent incursions of weeds to Australia 1971–1995,* CRC for Weed Management Systems Technical Series No. 3 (CRC for Weed Management Systems, Adelaide, 1998).

degree of invasion of Australian ecosystems depends on the ecology of the species and its interactions with climate, vegetation structure, natural and artificial disturbance and the proximity and multitude of pathways for spread.[47]

Changes in attitude to invasive species usually lag behind their environmental effects, illustrated by one of the most damaging invasive species in Australia, Cinnamon or root rot fungus (*Phytophthora cinnamomi*). It is lethal to many plant families and is spread in soil water and by root-to-root contact. Presently, more than 10 per cent of the Western Australian Jarrah Forest is infected, and the disease is spreading in Tasmania and Victoria. It is listed under the *EPBC Act* as a threatening process. It was probably first established in Western Australia from a tropical source in the early 1900s.[48] It did not spread substantially until the 1940s and coordinated measures to control it were not implemented until the 1970s. The Cinnamon fungus exemplifies the inefficiencies of a control approach that is reactive to a proven threat, rather than defensive of ecosystems.[49]

Recently the *Quarantine Act* has shifted towards listing based on prediction of invasive potential (for example, species that are aggressive invaders elsewhere, that produce abundant easily dispersed seed are ranked as high risks).[50] Whilst this is an improvement, the fundamental predisposition of the law remains to act only once there is strong scientific proof of the hazard (albeit now predictive).

Multi-species management must confront the prospect that intervention that protects a threatened species or remediates a pest may be detrimental to other species or policy objectives. For example, efforts aimed at biological control of an agricultural pest may threaten the survival of endemic species,[51] or the prevention of the introduction of a potentially hazardous plant species may impact on the economic capacity of some farmers to fund other weed-control activities. A focus on managing at the level of particular species or designated habitats without commensurate attention to system effects does not address such considerations.

This is particularly so when listing decisions are made at administrative levels, where the trade-offs among competing values are submerged or ignored in agency-specific bureaucratic procedures. Transparent and deliberate debate can highlight tradeoffs and systemic effects. Without this kind of debate, it can be difficult for decision-makers to understand complex interactions of impacts.[52]

VI SCIENTIFIC BIAS

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47 W M Lonsdale, 'Global patterns of plant invasions and the concept of invisibility' (1999) 80 *Ecology* 1522.

48 G Weste and G C Marks, 'The biology of *Phytophthora cinnamomi* in Australasian forests' (1987) 25 *Annual Review of Phytopathology* 207.

49 Reuben P Keller, David M Lodge and David C Finnoff, 'Risk assessment for invasive species produces net bioeconomic benefits' *Proceedings of the National Academy of Sciences* (*of the United States*) (*PNAH*) 104 (2007) 203.

50 Ibid.

51 Daniel Simberloff and Peter Stiling, 'How risky is biological control?' (1996) 77 *Ecology* 1965.

52 See Martin et al, above n 3. for a discussion of regulatory process aspects

Scientific information such as is summarised in Figures 1 and 2 may be misleading because of hidden biases in the underlying data. The lists of threatened and invasive Australian plants focus on large, spectacular or otherwise high profile species, and on geographically restricted and specialised species.[53] Sampling effort is biased among taxa. The data in Figures 1 and 2 come from far fewer non-vascular plants than vascular plants (Table 1), not because there are fewer non-vascular plants at risk, rather, they have been historically a less appealing group for most biologists and, as a result of this history, have tended to arouse much less attention among regulatory agencies and the public.[54] The iconic value of a slug is probably less than that of a raptor. Birds and mammals are much better studied than other animals, and have far greater proportional representation on listed threatened species as a result.[55]

Even given this disproportionate attention, threatened species lists are unreliable even for vascular plants. Species turnover on the lists is high, reflecting uncertainties including taxonomic changes, changes in attitude to uncertainty, and improvements in knowledge about distribution.[56]

The Cinnamon fungus again serves to illustrate the potential for far reaching consequences of the lack of regulatory control concerning under-researched potential invaders (mirrored in the under-protection of under-researched indigenous species). Little is known even about the taxonomy of fungi in Australia, with far less about 10 per cent of species scientifically documented (Table 1). Many non-vascular plants and fungi arrive each year. It may be many years before their effects are felt in Australian ecosystems. As a consequence, lists of potentially damaging invaders rarely make reference to fungi. Almost all listed 'noxious', potentially environmentally damaging species are vascular plants, those in which scientists have historically been most interested. For example, the Commonwealth Government listed 20 'Weeds of National Significance' in Australia[57] and a further 28 potentially invasive species on the 'National Environmental Alert List' — all vascular plants.[58] The list of diseases, fungi and parasites lists just four species, all established in Australia and known to be damaging.[59]

Most species are effectively ignored in most threat assessments, compounding the problem of the lack of attention to the interaction between species and their

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53 Burgman, Are listed TPS actually at risk?, above n 21.

54 M J Brown, S J Jarman and G Kantvilas, 'Conservation of non-vascular plants in Tasmania, with particular reference to lichens' (1994) 3 *Biodiversity and Conservation* 263.

55 Robert M May, John H Lawton and Nigel E Stork, 'Assessing extinction rates' in John H Lawton and Robert M May (eds), *Extinction rates*, (1995) 1.

56 Keith and Burgman, above n 21.

57 DEWHA, 'Weeds of National Significance' (WONS) (last updated 5 February 2009) <http://www.weeds.gov.au/weeds/lists/wons.html> at 18 February 2009.

58 DEWHA, 'The National Environmental Alert List' (last updated 14 September 2007) <http://www.weeds.gov.au/weeds/lists/alert.html> at 18 February 2009.

59 DEWHA, 'Diseases, fungi and parasites in Australia' (last updated 16 February 2009) <http://www.environment.gov.au/biodiversity/invasive/diseases/index.html> at 18 February 2009. List comprises root-rot fungus (*Phytophthora cinnamomi* or cinnamon fungus), Mundulla Yellows (a fatal dieback disease of eucalypts and other native trees and shrubs), *Chytridiomycosis* or amphibian chytrid fungal disease caused by the fungus *Batrachochytrium dendrobatidis*), and psittacine cicroviral, or 'beak and feather', disease.

ecosystems. The majority, including the balance of the vascular plants, non-vascular plants and fungi are hidden by the veil of historical scientific bias, as illustrated by the shaded taxa in Table 1. Data for threatened species reflect mostly vascular plants. Other taxa of ecological interest (shaded) are substantially under-represented or ignored entirely. We know nothing about their habitats, distributions, population sizes, interactions, dependencies or tolerances to environmental change. Unfortunately, existing environmental laws for protection of native ecosystems do not recognise this uncertainty.[60] The implicit, incorrect, assumption is that only those taxa which have been listed are significant enough to deserve attention. The bias is clear, and the resultant risks are substantial.

This bias is translated into government policy (and thence resource allocation) because priorities are tied to lists whose composition depends on the historical interests of scientists.[61] The problem is compounded by the intrinsic conservatism of the legal system and the long lead time in the creation of new laws.

Table 1. Australian rare or threatened plant species.[62]

Group	Estimated total no. of species in Australia[1]	Total no. of native species known in Australia[2]	New Australian species yet to be named and described[3]	Listed rare or threatened species in Australia
Vascular plants				
Flowering plants	22,000	15,600	4,000	1,167
Cycads, conifers	110	60	10	1
Fern, fern allies	450	410	30	0
Total	*22,560*	*15,970*	*4,040*	*1,168*
Non-vascular plants				
Mosses	2,000	1,200	500	0
Liverworts	1,400	800	500	0
Algae	11,000	3,000	1,500	1
Fungi	250,000	20,000	180,000	0
Lichens	5,000	3,000	500	0
Total	*269,400*	*28,000*	*183,000*	*1*
Bacteria	?	?	?	0
Viruses	?	?	?	0

[1]. includes undescribed, native and naturalised species

[2]. excludes naturalised species

[3]. undescribed native species

60 Other than at the most abstract, with the requirement for 'precaution' in many administrative determinations.

61 Brown et al., above n 54; G A M Scott, TJ Entwisle, T W May and G N Stevens, *A Conservation Overview of Australian Non-marine Lichens, Bryophytes, Algae and fungi*. Report to Wildlife Australia (Environment Australia, Canberra, 1997); Burgman, Are listed TSP actually at risk?, above n 21.

62 Burgman, Are listed TPS actually at risk?, above n 21.

A feedback loop reinforces this bias. Laws for single species and habitats impact on the forms of scientific evidence that are used in legal disputes and administrative decisions, in turn driving (to some extent) the nature of research. Species and habitat-specific issues, especially for charismatic species, transcend broader system considerations. The imperative to collect knowledge of poorly understood taxa is diminished, and the costs of ignorance are magnified. This feedback loop entrenches a bias towards the issues that were of most importance to past scientists, bureaucrats and regulators.

VII Responses to the challenge

Australia faces significant challenges in balancing its needs for economic growth with the maintenance of biodiversity. This article has argued that current legal instruments are not well-designed to meet these challenges. The narrow focus of their design and the resultant reliance on protection or exclusion lists does not reflect the nature of the challenges. This article argues that the list-based translation of conventional science into regulation creates a tendency towards 'patches' of protection of scientific icons, within a landscape of continuing degradation. This trajectory is not likely to result in the type of resilient landscapes that are needed to achieve national policy goals. We have to alter the legal instruments to place greater emphasis on the protection and enhancement of substantial ecosystems, their processes and services.

There is a serious lack of integration between laws and across jurisdictions, such as those relating to invasive species control and managing other threatening processes.[63] Significant redesign is needed to remediate regulatory coordination problems, including their excessive number, confusing jurisdictional structures and poor institutional architecture.[64]

Future risks for many species may be mitigated by changes in policy. While these solutions may not be enough to protect many threatened species where several interacting processes underpin the decline towards extinction,[65] substantial benefits could be anticipated from more effective controls over land clearance and more supportive arrangements for habitat restoration, more effective surveillance of travel and trade that provide entry pathways for potentially damaging plants, pests and diseases, and more effective fire management strategies.[66] This will require a mixture of strong controls and effective positive incentives.

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63 For instance, lists of Weeds of National Significance are not a major consideration in policies promoting native vegetation retention, such as the Net Gain policy in Victoria, in which the only mention of specific weeds is under the duty of care of landowners to eradicate 'regionally prohibited weeds': see Victorian Department of Natural Resources and Environment, 'Victoria's Native Vegetation Management; a Framework for Action', 31.

64 Martin Bartel et al, above n 3.

65 Richard J Hobbs, 'Synergisms among Habitat Fragmentation, Livestock Grazing and Biotic Invasions in Southwestern Australia' (2001) 15 *Conservation Biology* 1522.

66 Hugh Possingham, Sarah Ryan, Jenny Baxter and Steve Morton, 'Setting Biodiversity Priorities. Paper prepared as part of the activities of the working group producing the report *Sustaining our Natural Systems and Biodiversity* for the Prime Minister's Science, Engineering and Innovation Council in 2002 (2002); Keller et al, above n 49.

Whether new policy instruments seek to curb negative behaviour or encourage positive behaviour, any change implies a shift in costs and benefits.[67] Decision-makers and stakeholders vary in their perceptions of the effectiveness of alternative policies and the moral legitimacy of the distribution of costs and benefits. Perceptions of effectiveness will be conditioned by values.[68] The priorities of stakeholders holding predominantly economic utilitarian perspectives may be substantially different to those of stakeholders having different biocentric or social justice priorities. Issues of fairness, as well as effectiveness, will be vitally important.[69]

The law sets the framework for much of the action taken to conserve nature. It creates enforceable obligations, and the legal settings for administrative action. Even within the existing regulatory architecture there are opportunities for improving weed control and habitat protection and rehabilitation. Many methods exist for structuring objectives, weighing alternatives, and setting priorities that account for alternative and conflicting values, generally termed structured decision analysis.[70] These methods are rarely applied to setting priorities for threatened or invasive species.[71] Such tools could contribute to a redesign of ecosystem conservation legislation to better achieve public goals.

Within the current framework, a broader set of entities than vertebrates and vascular plants should be considered routinely for listing[72] in order to address the taxonomic biases within threatened species lists. The concept of 'umbrella' species is widely acknowledged in conservation biology.[73] Protecting these widespread, iconic species has been motivated in part by the protection that their habitat affords to non-target species and processes. While species and communities are poor predictors of the distributions of other species,[74] management of landscapes, threatening processes and

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67 David J Pannell, 'Heathens in the chapel? Application of economics to biodiversity (2004) 10 *Pacific Conservation Biology* 88; James Boyd and R David Simpson, 'Economics and biodiversity conservation options: an argument for continued experimentation and measured expectations' (1999) 240 *The Science of the Total Environment* 91.

68 Yung En Chee, 'An ecological perspective on the valuation of ecosystem services' (2004) 120 *Biological Conservation* 549; Ken J Wallace, 'Classification of ecosystem services: Problems and solutions' (2007) 139 *Biological Conservation* 235.

69 Martin Bartel et al, above n 3; G Bates, *A duty of care for the protection of biodiversity on land* Consultancy Report to the Productivity Commission, AusInfo, Canberra 2001).

70 Robin Gregory, Tim McDaniels and Daryl Fields, 'Decision Aiding, Not Dispute Resolution: Creating Insights through Structured Environmental Decisions' (2001) 20 *Journal of Policy Analysis and Management* 415; Daniel T Maxwell and Dennis M Buede, 'Composing and constructing value focused influence diagrams: a specification for decision model formulation' (2003) 12 *Journal of Multi-Criteria Decision Analysis* 225.

71 Lynne A Maguire, 'What Can Decision Analysis Do for Invasive Species Management?' (2004) 24 *Risk Analysis* 859; Helen M Regan, Frank W Davis, Sandy J Andelman, Astrid Widyanata and Mariah Freese, 'Comprehensive criteria for biodiversity evaluation in conservation planning' (2007) 16 *Biodiversity and Conservation* 2715.

72 Burgman, Are listed TPS actually at risk?, above n 21; Jenkins and Gardner, above n 15.

73 Reed F Noss, 'Indicators for monitoring biodiversity: A hierarchical approach' (1990) 4 *Conservation Biology* 355.

74 Simon Ferrier, 'Mapping spatial pattern in biodiversity for regional conservation planning: Where to from here?' (2002) 51 *Systematic Biology* 331.

ecological communities provide a degree of inclusiveness and protect at least some hidden taxa.

Many emerging technical tools, such as reserve design algorithms, surrogate biodiversity measures, and species dissimilarity models, may make ecosystem conservation strategies more efficient and less biased.[75] Policy and law makers need to encourage such systematic directions of scientific inquiry to increase the reliability and comprehensiveness of protection. Competitive research funding and agency priorities could be stratified to focus on taxa that reflect their diversity, their importance in supporting ecosystem processes, and other socially important and ecologically defensible criteria, any of which would be better for biodiversity conservation than the whims and historical prejudices of research scientists.

It will remain the case for some time that priorities for management actions will be affected strongly by formal species lists, despite the arguments explored here.[76] It is, however, time for both science and the law to begin a process of significant reform, in the communication of bias and uncertainty by the nation's scientists and improvement in legal instruments by its legislators.

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[75] M A Burgman, D B Lindenmayer and J Elith, 'Managing landscapes for conservation under uncertainty' (2005) 86 *Ecology* 2007.

[76] Possingham et al, Limits to TS lists, above n 20.