

Cross pollination or cross-contamination? Directions for informing the management of invasives with market-economy concepts

Paul Martin

Australian Centre for Agriculture and Law, University of New England, Armidale,
New South Wales 2350, Australia and CRC Irrigation Futures: System Harmonisation Program
Email: paul.martin@une.edu.au

Summary At the 15th Weeds Conference (Preston *et al.* 2006), my audience and I came up with some interesting potential innovations to tackle weed invasion, without reliance on government funds. That discussion serves as the seed for this keynote. In this paper I want explore radical possibilities, in the hope that they might blossom into exotic, but hopefully beneficial maturity.

Our understanding of plants, epidemiology and natural systems is expanding quite fast. Our understanding of how to adjust behaviour to advance sustainability is doing so more slowly. Many experiments are occurring in the weeds arena that could inform behavioural strategy, if only we had a paradigm to work within.

The paper presents some aspects of that possible paradigm, which includes:

1. A coupled systems concept of behaviour and behavioural strategy;
2. Adopting a multi-attribute, multi-instrument approach to the design of interventions;
3. Using transaction costs as a policy lens; and
4. The adoption of disciplined, continuous learning approaches to the quality of our intervention strategies.

Keywords Economics, market instruments, law, risk, strategy.

The choice is an exercise of judgment under extreme uncertainty (Ohmae 1982).

Un-stated paradigms and ‘conventional wisdom’ influence resource allocation, and the outcomes of strategy (Kuhn 1974). Nowhere is this more obvious than in weed programs.

The strategy that harnesses the most resource has the greatest probability of success. Darwin demonstrated this for the animal kingdom in his theory of evolution. Some disciplines and cultures are more economically successful than others, as some paradigms are better adapted to resource winning.

Alternative paradigms for thinking about weed strategy may allocate or secure resources more effectively. My knowledge of weed science is limited. Whilst I will put forward design concepts, I will provide ‘how to do it’ guidance and an example so that weed professionals can create their own better informed solutions¹.

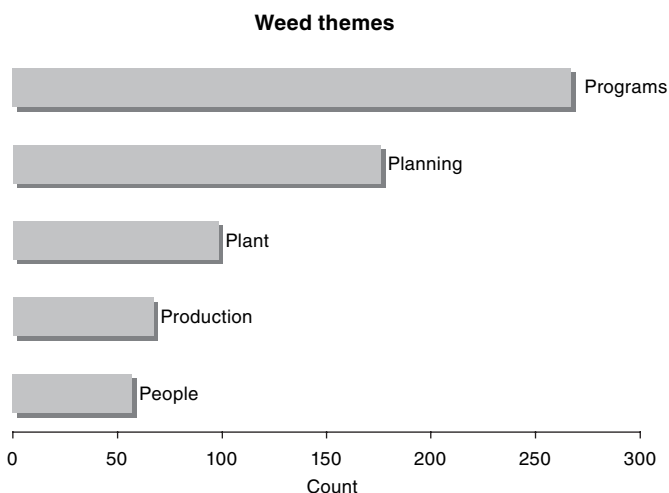
HOW WEED MANAGERS THINK

From the abstracts for this conference, it is possible to hypothesise the collective wisdom of the major gathering of Australian weeds experts each year. Theme analysis of the abstracts highlights the documented preoccupations.

INTRODUCTION

This paper is about sustainability strategy (Martin and Verbeek 2006). Strategy is the formula, the ‘diamond hard logic’, for allocation of scarce resources to achieve a desired goal. The most limited resource is human energy and ingenuity.

The more inadequate the resources, the more critical is an innovative, tough-minded strategy. Missing resources have to be replaced by innovation. The strategist has to eschew diversionary investment to avoid fragmenting the limited resource. How scarce skills will be focused is a fundamental issue in weeds management.



The wisdom within the conference program supports the following weed program emphases.

1. The understanding of natural systems (biology, epidemiology genetics) and their interaction with mechanical, chemical and biological control is the priority for knowledge investment. By default other potential knowledge investments such as understanding of social systems are discounted.
2. Government is the main actor in the social system. Private markets are principally sellers of inputs (chemicals, consulting, machinery or services) or 'customers' of science outputs. The market is a context to be managed or a problem to be solved.
3. Community is principally a target for communication or for recruitment as volunteers.
4. Risk is allocated to government; the environment and those whose land uses are harmed by weed invasion. Those who make the decisions that allow or stimulate weed invasion do not own in this risk.

The investment priorities indicated by the abstracts, (rather than empirical investment patterns), are certain aspects of science, coordinative approaches to harness government, and to recruit the community. The tactical tools for addressing behaviour are regulation, selective approaches to voluntarism, and a focus on government resources and incentives.

Economics, law and the social sciences are subordinate. Economics is principally viewed as a mechanism for cost-benefit justification of programs, regulation is background 'noise', and the social sciences transmute into tactical communication and marketing.

My conversations with weed program managers suggest other challenges that seem to be no less important to them:

1. Securing sufficient resources on a sustained basis (economics/management);
2. Overcoming institutional inefficiencies (economic, managerial and legal); and
3. The behaviour of communities, including farmers, road authorities, local government officers and the nursery sector (social systems/marketing).

INVERTING THE WISDOM

Contemporary literature (Eliadis *et al.* 2005, Martin *et al.* 2007) on natural resource management indicates that key considerations in designing an effective natural resource management program include:

1. A behaviours-focused strategy using a cocktail of regulation, market instruments, subsidy and volunteerism;
2. Managing the total resource consumption (social) system (Parsons 1952, Kuhn 1974, Luhmann

1984, Martin and Verbeek 2002, Weber and Hemmelskamp 2005) rather than 'spots' within that system;

3. Ensuring that the supporting institutional structure (Fiorino 1995, Martin and Verbeek 2002, Wentworth 2003) creates minimal transaction cost 'drag' on the strategy;
4. Understanding and managing risk issues (Anderson 2001, Shapiro and Glicksman 2003, Botterill and Mazur 2004, Hutter 2005); and
5. A design process that ensures precise goals and generates a robust contest about the efficiency of the instruments selected (Gunningham and Grabosky 1998, Business Council Of Australia 2005, Martin *et al.* 2007).

Within this framework, economics, law and the social sciences are strategic and the physical sciences, bureaucracy and community education are tactical.

An economist may view the problem of weeds as a matter of incentives and utility, whereas a soil scientist will see it as a manifestation of disturbance, structure and nutrients. A geneticist will see a weed as a mass of DNA, whereas an ecologist will see it as a system problem. Each will, by virtue of the paradigm they choose, arrive at a different strategy. All have value, but some will be more effective than others in particular situations.

WEED MANAGEMENT INSANITY?

Albert Einstein reportedly defined insanity as *doing the same thing over and over again and expecting different results*². The frustration of weed program managers with the results of their own programs may cause one to wonder whether, notwithstanding all of the excellent work that is done, weed program managers may not see this statement as a description of some programs. An alternative strategy would be sane if it resulted in a more powerful impetus and greater resources, even if it meant painful re-prioritisation and reallocation of resources.

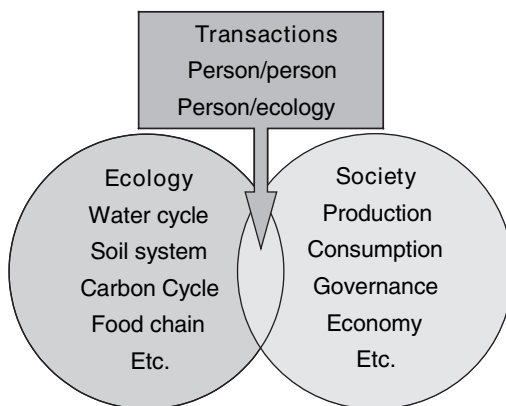
The approach I wish to explore reflects the literature on institutional frameworks for natural resource management (NRM) (Natural Resource Management Ministerial Council 2002, Australian Government 2003a). This literature would suggest that the pivotal goal of a NRM program is adjusting the patterns of transacting within the social system that consumes the resource. Managing behaviour is the focus of attention.

Our research suggests that NRM strategists have only two levers to work with: the flow of resources (including money) and the flow of information (variously signals or data) (Martin and Verbeek 2002, Martin and Verbeek 2006). These flows occur

through many transactions, shaped by both pre-established conditions (culture and attitude, power relationships, rules and organisations) and by the dynamics of the system itself. This social system interacts with the ecological system in a complex dance.

Some central concepts should be explained before we proceed.

1. A resource consumption system (RCS) (Martin and Verbeek 2006) is a social system comprised of the actors and interactions between them that shapes the pattern of resource use. It includes the directly involved participants (government agencies, community, and commercial resource users), and indirect actors (financiers, insurers, litigators, political actors).
2. The RCS is coupled to the biophysical system (Gill 1999, Brunner *et al.* 2005). The linkage between this system and the environment is through transactions. Transactions exist when a decision is made by an actor which impacts on a flow of resources or information within the biophysical system. It is also at the transacting point that various private and government interventions are triggered.
3. The flows of information and resources that constitute transactions are impeded by three sets of variables. The first set impede (or 'tax') the flow of information, for example an actor's failure to use available information because it does not fit with preferred analytic techniques. The second set taxes the flow of financial or other resources, such as through administration or contractual complexity. The third set is made up of the lags and leads, such as the time required for actors to make and implement decisions. These three sets are loosely characterised as 'transaction costs' (Maser and Heckathorn 1987, Colby 1995, Boerner and Macher 2006, The Allen Consulting Group 2006).
4. 'Institutions' are the rules and organisations that underpin and which in part govern transactions (Dovers 2001, Stavins 2001, Hannam and Boer 2002, EarthTrends 2003, Middle 2004, Eliadis *et al.* 2005). These include government regulation or investment. Typically at the point of transacting various regulatory or financial implications arise, such as taxation obligations, the potential for prosecution, or qualification for economic support. Private buyers, financiers, insurers and industry organisations also affect the flows of resources and information, again acting through transactions. Their rules and actions are no less important (and in many cases more important) than government.



This leads to some design principles for a NRM program. The first is to focus on the coupled human/environment systems that lead to excessive demands on the environment. A coupled systems approach will typically cause the strategist to address many different transactions, using a range of instrumental approaches.

The second emphasis is on the incentives and disincentives influencing the transactions (Baldwin and Cave 1999, Anderson 2001, Biodiversity Convention 2002, Australian Government 2003b, Driessen 2003, Shine 2004, Gunningham 2007). This focus on incentives reflects the evolutionary fact that man for all of his sophistication is still an animal. What has changed with evolution is the sophistication of the drive, not its essence. Economic theorists such as Adam Smith or Maynard Keynes were dealing with essentially the same behavioural fundamentals as the contingency theorist BF Skinner or Charles Darwin in his work on evolution. Economics has a particular emphasis on incentive frameworks, but all behavioural disciplines (including marketing or the law) require consideration of incentives and disincentives.

An emerging emphasis is the need to manage the transaction costs that impact on the dynamic of the system. Whether one is introducing a new market instrument like pollution trading, or a regulatory control over native vegetation clearing, or a government subsidy, transaction costs impact on the outcomes (Maser and Heckathorn 1987, Bromley 1991, Colby 1995, Bromley 1997, Dragan 1999, Williamson 1999, Boerner and Macher 2006, The Allen Consulting Group 2006).

The pragmatic issue of resourcing must also be a key part of the deliberations. A strategy that cannot be sufficiently resourced is a delusion. Sadly, the experience with many otherwise creative NRM programs suggests that resource inadequacy is the

accepted norm, along with the consequent experience of limited success.

The instruments that are available to the strategist are characterised by how they operate.

Overlaid on instrument choice are implementation and design considerations, notably the allocation (and management of) risk of instrumental failure (Bromley 1991, Segerson 1995) and the control and allocation of transaction cost. Government regulation, incentives and education are generally funded from taxes, but this is not unavoidably the case. Regulation can be private, or cost-neutral, as can incentives and education, through good design.

EXPLORING ALTERNATIVES

Rather than continue to describe the alternatives in abstract terms, a concrete example of the conceptual design of privately resourced weed control program is set out.

The following diagram is a high level ‘map’ of transactions that link weed pathways with the network of actors and interactions that drives use of the biophysical system. The map only highlights some actors (government, domestic sector, services sector) but is sufficient for this discussion. Some accountability concerns that a weed program might typically address are highlighted as targets for intervention.

Just as there are many transactions, there are many potential points for intervention across the government and private sector. There are sub-transactions, and behind each there are flows of information and resources. The more precisely the coupled system and the transactions that provide that coupling are evaluated, the more opportunities that will be identified.

I have highlighted seven aspects, labelled as accountability issues, where I think over-reliance on government could be reduced by innovation to engage the market. This in turn ought to ensure a larger flow of resources into solving the accountability challenges. This illustrative program demonstrates the use of risk, changes to information flows, and economic incentives and disincentives. Its principal goals are to strengthen private accountability, transfer risk towards those in the best position to control it, to markedly increase the flow of resources into prevention and remediation, and to minimise the transaction costs for industry and government.

I will first address risk. Under current weed strategies, risk management cost is principally borne by government, and substantive risk borne by farmers and others who suffer from weed invasion. Is it possible to adjust this so that risk is transferred through the private market to those in a position to control the harm?

Table 1. Instrument characteristics.

Instrument type	How does the instrument work?	What behaviours are promoted?	Institutional concerns
Markets	Through market transactions the price of scarce resources increases; consumption is therefore curtailed by choice or inability to pay.	Market entrepreneurship, trading or improved resource access or value.	Creating artificial scarcity by regulation, which generates trading. Ensuring integrity in the transactions Enforcement of property rights
Private Regulation	Through private litigation, harmful effects are compensated for. Harm to third parties is therefore curtailed by the choice to avoid risk.	Avoidance of third party harm and ‘neighbourly’ negotiation of interests	Specifying the extent of private rights and responsibilities Providing/ restricting standing to sue Enforcement of judgements
Public Regulation	Through penalisation: Specified behaviours are made expensive. Consumption is therefore curtailed by choice to avoid risk.	Compliance, focused on least cost to avoid the risk.	Defining legal obligations Specifying evidence requirements Policing powers Enforcement of orders
Incentives	Through contract: Desired behaviours are rewarded; Conserving behaviour is thereby promoted.	Administrative entrepreneurship to win grants satisfy requirements	Defining the contractual relationships Administrative integrity and independence
Education	Through communication: Attitude or knowledge change leading to conserving behaviour.	Civic responsibility	Liability for content

Insurers are a remarkably powerful, if often invisible, market force (Mallin 1987, Abraham 1991, Segerson 1995). They attach a price to risky behaviours through premiums and force risk-reduction through insurance contracts. Mandatory insurance creates a form of hidden co-regulation with government but with the costs borne privately.

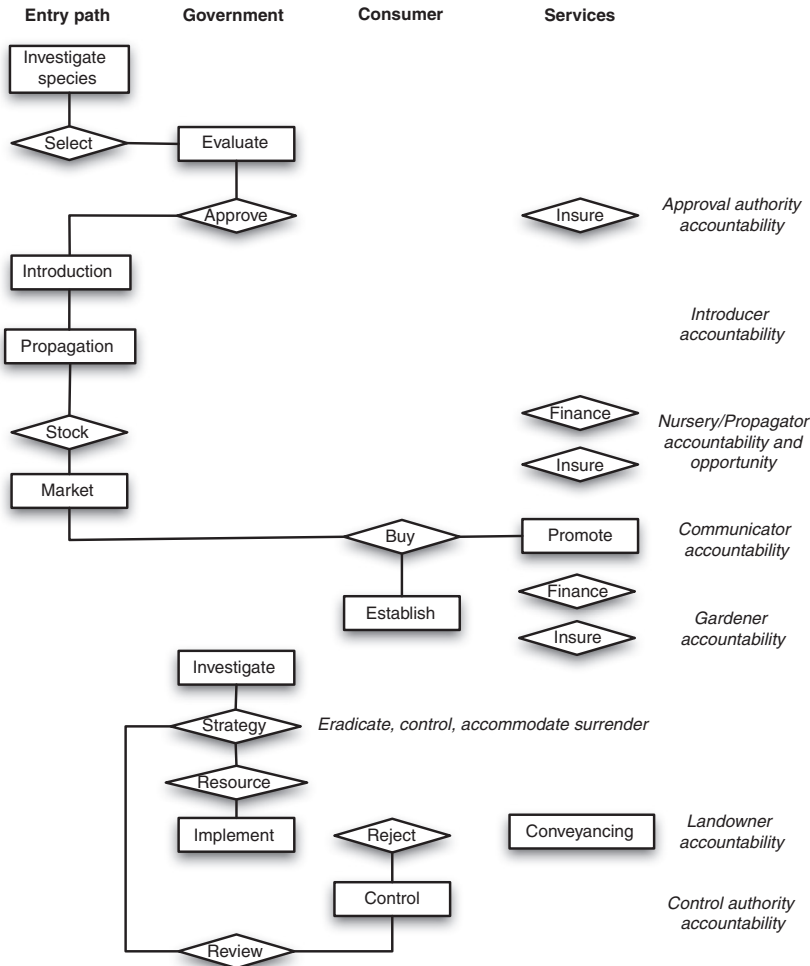
The trigger for insurer involvement is civil liability including class actions or legal obligations upon transactors to compensate for specified harms.

The Oil Spill Disaster Recovery Fund is an international fund through which international shippers pay an insurance premium that is collectively sufficient to cover the costs of clean up of shipping oil spills (Segerson 1995). Risk management has led to the creation of a specialist clean up team and investment in new technologies. A powerful private regulatory and remediation structure has replaced a traditional public regulatory arrangement.

It is possible to envisage a system under which the introducer of a risky plant would be required to take out 'weed remediation' insurance as a condition of introduction. This would result in extensive risk evaluation by private insurers, and risk-based control conditions. In turn this would alter the dynamics of introduction with the costs being substantially met outside government.

A further theoretical possibility would be to move from government conducted and funded inspection towards private certifiers for import approval or propagation of plants. Under such a program the certifier might be required to insure to provide funds for remediation of harms that arise from certifier error. Private certifiers are widely used in the construction sector, though the approach is not without its critics.

An industry pooling approach, much like the oil spill disaster recovery example, is possible as a way of reducing problems of proving causation.



These private market interventions focus on introduction into the weeds pathway. A weeds strategist might equally consider new approaches to the later control and remediation stages of the pathway, with interventions that alter the flows of information and resources, and provide strong private incentives to act in the interest of the environment and other landowners.

At the last conference we ‘brainstormed’ a concept to close the accountability loop for property owners by altering information flows, to generate private sector incentives for weed control. Under this concept, owners who wished to convey property would be required to provide an environmental condition report, addressing weed status of the property. No other intervention may be required. Once information flow is adjusted in this manner environmental quality would become an element in private market property price negotiation. This could be expected to at least partly price in the negative externalities of allowing weeds to propagate on private lands, and provide some economic gain for those who provide effective control or removal. Once weed control has a clear economic incentive for the landowner, one might expect them to become much more mindful of weed issues, and to look for plants and plant suppliers who are less risky to their economic interests.

This could lead the strategist to consider the economic opportunity of strong accountability in the nursery sector. A powerful market participant who is the champion of sustainability will strengthen any private market sustainability programme. Perhaps surprisingly to some, I have suggested that this ethical and commercial leadership can and ought to be the private nursery sector (Martin *et al.* 2005). Other retail sectors (for example pharmacy with its Responsible Use of Medicines and Home Medication Reviews programmes³) have demonstrated that a strong ethical stance can provide both risk reduction and economic incentives for individual businesses. A nursery sector which identified ‘de-weeding’ and retrofitting established gardens, positioned in the mind of the community as the ethical and safe source of supply, which secured that positioning aggressively through tight self-regulation and a strong position on control of other weed pathways, may find itself with a significant competitive benefit.

Within such a commercial incentives approach, tighter regulation of weed spread transactions (including labelling, and non-nursery spread) would be led by the sector as the key to improved profit (as well as ameliorating their already present risk from the Trade Practices and Sale of Goods Acts) (Martin *et al.* 2005).

The extent of this economic opportunity is principally dependent on the ingenuity and cohesiveness of

the industry concerned. A series of studies, seminars and strategy development exercises for the industry may be sufficient to open their eyes to a pathway that they cannot currently see.

The conceptual program outlined is illustrative of a coupled-systems approach. It combines an understanding of the interaction between the ecological system and the resource consumption system, and targets the transactions that link these systems. It concentrates first on the operation of private markets and citizens, and sees the government as a facilitator and provider of institutional structures for free markets. Using light-handed regulation, private incentives, and the manipulation of risk, new sources of resource and energy can be harvested.

NO FREE LUNCHES

For every complex problem, there is a solution that is simple, neat, and wrong⁴. (Henry Louis Mencken)

Any discussion of innovative private market approaches to the design of weed control programs would be misleading if it did not acknowledge that every such form of intervention carries with it both risks and cost. In sustainability policy, there are no free lunches.

Private markets tend to exploit incentives to unexpected and sometimes dysfunctional extremes. Careful design is needed to minimise these risks. Further, capitalist systems transfer assets to those most competent to exploit them, and this can result in inequities that will not solve themselves. Finally, when shifting from one thinking model to another there is the likelihood that naïve mistakes will be made as learning occurs (Teece 1986, Driessen 2003, Eliadis *et al.* 2005, Pannell *et al.* 2006).

Creating economic incentives for one aspect of natural systems also has the potential to distort investment towards the priced good, and this can create other ecological and social problems. This risk has been again demonstrated with the taxation incentives for forestry (Lacey *et al.* 2006, Dutton 2007).

These risks associated with the use of market instruments should be evaluated against the risks and the failures arising from the current paradigm. Regulation carries with it costs and inefficiencies (Baldwin and Cave 1999, Davidson *et al.* 2006), and of course failures of weed control programs also involve both substantial costs and inequitable distributions of both costs and benefits. There is no strategy for reducing the load of weeds on the environment and economy that does not carry some risk. There is a natural tendency to prefer the devil you know, and to see the dangers of the devil you do not. This tendency, rather than any particular dangers with using the market, is the most likely source of resistance to innovation.

So I return to the title of this paper. Will the use of market-focused approaches to weed control strategy be cross-pollination or cross-contamination? The desired outcome is that combining market-focused approaches with more traditional concepts will result in a productive non-sterile hybrid, rather than a plant out of place. The key to this will be the creativity and energy of weed program strategists, managers and workers rather than the intrinsic character of the instruments that are available.

REFERENCES

- Abraham, K.S. (1991). 'Environmental liability insurance law: an analysis of toxic tort and hazardous waste insurance coverage issues'. (Prentice Hall Law and Business, Englewood Cliffs, NJ, USA).
- Anderson, R.C. (2001). The United States experience with economic incentives for protecting the environment. Washington DC, National Center for Environmental Economics, 254.
- Australian Government (2003a). Report of the natural resource management community forum Brisbane. Commonwealth of Australia, Canberra.
- Australian Government (2003b). Arrangements to enhance the effective use of incentive mechanisms in natural resource management. Land and Water Australia.
- Baldwin, R. and Cave, M. (1999). 'Understanding regulation: theory, strategy and practice.' (Oxford University Press, Oxford).
- Biodiversity Convention (2002). Incentive measures: examples of case studies, guidelines and best practices. UN Environment Program, <http://www.biodiv.org/doc/case-studies/inc/cs-inc-ca-01-en.pdf>.
- Boerner, C.S. and Macher, J.T. (2006). Transaction cost economics: an assessment of empirical research in the social sciences. <http://faculty.msb.edu/jtm4/Papers/MR.JEL.2006.pdf>.
- Botterill, L. and Mazur, N. (2004). Risk and risk perception: a literature review. RIRDC Publication No. BRR-8A. Rural Industries Research and Development Corporation, Canberra.
- Bromley, D.W. (1991). 'Environment and economy.' (Blackwell, Oxford).
- Bromley, D.W. (1997). Rethinking markets. *American Journal of Agricultural Economics* 79 (Proceedings Issue No. 5), 1383.
- Brunner, R.D., Coe-Juell, L., Cromley, C., Edwards, C. and Steelman, T.A. (2005). 'Adaptive governance: integrating science, policy and decision making'. (Columbia University Press, New York).
- Business Council of Australia. (2005). Business regulation action plan: for future prosperity. Business Council of Australia.
- Colby, B.G. (1995). Regulation, Imperfect markets and transaction costs: the elusive quest for efficiency in water allocation. In 'Handbook of environmental economics', ed. D. Bromley, pp. 475-502. (Blackwell Publishers, Oxford).
- Davidson, A., Beare, S., Gooday, P., Kobic, P., Lawson, K. and Elliston, L. (2006). Native vegetation: public conservation on private land: cost of foregone rangelands development in southern and western Queensland. ABARE Research Report. 06.13 ABARE, Canberra.
- Dovers, S. (2001). Institutions for sustainability. TELA: environment, economy and society. Issue 7, April. Australian National University, Canberra.
- Dragun, A. (1999). Environmental institutional design: can property rights theory help? Brisbane, Department of Economics, University of Queensland.
- Driessen, D.M. (2003). The economic dynamics of environmental law. (MIT Press, USA).
- Dutton, P. (2007). Non-forestry managed investment schemes, Australian Treasury. Media Release No. 007. Australian Government, Canberra.
- EarthTrends (2003). Environmental institutions and governance – Australia. http://earthtrends.wri.org/pdf_library/country_profiles/env_cou_036.pdf.
- Eliadis, P., Hill, M.M. and Howlett, M. (2005). 'Designing government: from instruments to governance.' (McGill-Queen's University Press, Montreal and Kingston).
- Fiorino, D.J. (1995). 'Making environmental policy.' (University of California Press, Los Angeles).
- Gill, R. (1999). Planning for sustainable agro-ecosystems: a systems approach. <http://www.une.edu.au/cwpr/Papers/Agriculture.PDF>.
- Gunningham, N. (2007). Incentives to improve farm management; EMS, supply-chains and civil society. *Journal of Environmental Management* 82, 302-10.
- Gunningham, N. and Grabosky, P.N. (1998). 'Smart regulation: designing environmental policy'. (Clarendon, Oxford).
- Hannam, I. and Boer, B. (2002). Legal and institutional frameworks for sustainable soils: a preliminary report. IUCN Gland, Switzerland.
- Hutter, B.M. (2005). The attractions of risk-based regulation: accounting for the emergence of risk ideas in regulation. London, ESRC Centre for Analysis of Risk and Regulation. Discussion Paper No. 33. London School of Economics and Political Science, London.
- Kuhn, A. (1974). The logic of social systems: a unified, deductive, system-based approach to social science. (Jossey-Bass, San Francisco).

- Lacey, R., Watson, A. and Crase, J. (2006). Economic effects of income-tax law on investments in Australian agriculture: with particular regard to new and emerging industries. RIRDC Publication No. 05/078. Rural Industries Research and Development Corporation, Canberra.
- Luhmann, N. (1984). 'Social systems.' (Stanford University Press, Stanford).
- Mallin, T.W. (1987). Pollution and contamination: how will property insurers respond. Chicago, Tort and Insurance Practice Section: American Bar Association, 16.
- Martin, P. (2006). Weeds: new strategies for an old problem. Proceedings of the 15th Australian Weeds Conference, pp. 118-21. (Weed Management Society of South Australia, Adelaide).
- Martin, P., Bartel, R., Sinden, J., Gunningham, N. and Hannam, I. (2007). Developing a good regulatory practice model for environmental regulations impacting on farmers. Australian Farm Institute, and Land and Water Australia.
- Martin, P. and Verbeek, M. (2002). 50,000,000 Australians? Is sustainability possible? Land and Water Australia, Canberra.
- Martin, P. and Verbeek, M. (2006). 'Sustainability strategy'. (Federation Press, Sydney).
- Martin, P., Verbeek, M., Thompson, S. and Martin, J. (2005). The costs and benefits of a proposed mandatory invasive species labelling scheme: a discussion paper. <http://wwf.org.au/publications/InvasivesMandatoryLabelling/>.
- Maser, S.M. and Heckathorn, D.D. (1987). Bargaining and the sources of transaction costs: the case of government regulation. *Journal of Law, Economics and Organisation* 3, 69
- Middle, G. (2004). Institutional arrangements, incentives and governance. Unlocking the barriers to successful coastal policy making. A report from Coast to Coast 2002 National Conference. (CRC for Coastal Zone Estuary and Waterway Management, Indooroopilly).
- Natural Resource Management Ministerial Council. (2002). National framework for natural resource management standards and targets. Australian Government, Canberra.
- Ohmae, K. (1982). 'The mind of the strategist.' (McGraw Hill, New York).
- Pannell, D.J., Marshall, G.R., Barr, N., Curtis, A., Vanclay, F. and Wilkinson, R. (2006). Understanding and promoting adoption of conservation technologies by rural landholders. *Australian Journal of Experimental Agriculture* 46, 1407-24.
- Parsons, T. (1952). 'The social system.' (Tavistock, London).
- Preston, C., Watts, J.H. and Crossman, N.D. (eds) (2006). Proceedings of the 15th Australian Weeds Conference. Managing Weeds in a Changing Climate. (Weed Management Society of South Australia, Adelaide).
- Segerson, K. (1995). Liability and penalty structures in policy design. In 'Handbook of environmental economics'. ed W. Bromley. pp 272-94 (Blackwell, Massachusetts).
- Shapiro, S.A. and R.L. Glicksman (2003). 'Risk regulation at risk: restoring a pragmatic approach.' (Stanford University Press, Stanford, California).
- Shine, C. (2004). Using tax incentives to conserve and enhance biological and landscape diversity in Europe. STRA-REP. United Nations Environment Program, Strasbourg.
- Stavins, R.N. (2001). Experience with market-based environmental policy instruments. Resources for the Future, Washington.
- Teece, D.J. (1986). Profiting from technological innovation: implications for integration, collaboration, licensing and public policy. *Research Policy* 15, 285-305.
- The Allen Consulting Group. (2006). Transaction costs of water markets and environmental policy instruments: final report. Productivity Commission, Melbourne.
- Weber, M. and Hemmelskamp, J. (2005). 'Towards environmental innovation systems.' (Springer, Berlin).
- Wentworth Group. (2003). A new model for landscape conservation in New South Wales – The Wentworth Group of Concerned Scientists report to Premier Carr. (WWF, Australia).
- Williamson, O.E. (1999). Public and private bureaucracies: a transaction cost economics perspective. *The Journal of Law, Economics and Organization* 15, 306-42.

(Endnotes)

- ¹ These concepts reflect the publications noted, and the emerging approaches to System Harmonisation from the CRC Irrigation Futures Social, Cultural and Institutional program. See www.irrigationfutures.org.au/projects.asp?ID=35
- ² More accurately attributed to John Dryden in his play *Spanish Friar* (act II, st. 1), 1681
- ³ This program operates in close collaboration with the medical profession and government. For a description see www.guild.org.au/mmr/content.asp?id=421
- ⁴ Anecdotal but widely attributed: reference details not found.