Title: Conserving biodiversity through private land managers: integrating adaptive management, economic design and field experience**.**

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Summary

In this paper we present an economic design approach to integrate the biophysical and management implementation aspects of the adaptive management cycle. The economic design cycle contains four steps which can be loosely summarised as: problem definition; policy mechanism selection; solution implementation; and monitoring, evaluation and assembly of lessons for the future. The economic design process aids in identifying when a policy intervention is warranted, what market and regulatory failures any intervention would need to overcome, which policy mechanisms are available and the type of refinements required for effective application, and to guide what should be monitored and assessed for future interventions. The theoretical framework presented through the economic design construct is complemented by lessons from the field through case studies of mechanisms implemented in various Australian jurisdictions. Case study results emphasise the benefits from synergies with existing organisational capacities but also suggest the possibility of improved biodiversity conservation measures from an economic design approach.

Key words: incentives, regulations, institutions, adaptive management, economic design

1. Introduction

Adaptive management incorporates well developed processes for experimenting, learning and choosing management actions to achieve a biophysical objective under conditions of uncertainty (McLain and Lee 1996). The approach emphasises the use of flexible institutions and a process of monitoring, evaluating and taking corrective actions as a result of the new information (Jacobson et al. 2006). Adaptive management approaches are much less developed for considering the uncertainties around policy mechanism effectiveness and user responses to management (Brugnach et al. 2007; Johnson 1999; Gunderson 1999).

The relatively new field of economic design integrates economic theory about policy design from an economic perspective including selection, design and implementation of biodiversity conservation measures. The economic design approach can inform the poorly described policy mechanism element of the adaptive management cycle. The approach induces increased rigour in mechanism selection decisions with consequent implications for the likelihood of delivering the desired outcomes. In particular economic design can contribute to a more complete framework for the application of adaptive management approaches. In this paper we describe how economic design theory based mechanism selection, design and implementation can contribute to mechanism selection and implementation and therefore the adaptive management cycle. We complement the theoretical analysis with a set of case study analyses identifying lessons from the field that complement the theory based approach.

The paper is structured as follows. In section 2 we set out the aims of this paper via a discussion of adaptive management and the role of economic design theory (also known as mechanism design). The process of economic design within an adaptive management decision making framework is discussed in section 3. In section four we incorporate the lessons identified from a set of case studies of field experience and their role in economic design. Conclusions and discussion are provided in section five.

2. Adaptive management and economic design

2.1 What is adaptive management?

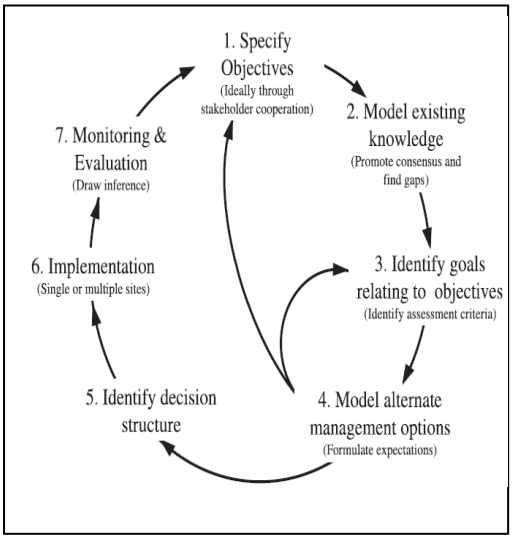
Decisions about when, where and which policy mechanisms to employ to deliver conservation objectives require a sound framework that incorporates available

ecological knowledge. Adaptive management provides that framework via the systematic acquisition and application of reliable information to improve management over time (Wilhere 2002). Adaptive management is grounded in the admission that human knowledge of ecosystems is incomplete, but rather than postpone action until enough information is known, management can be designed so that we learn how to continually improve it (Lee 1999). The role of economics and related theories is to aid in incorporating the behaviour of human agents into decisions. Economic theory is also incomplete due to uncertainty about the effectiveness of mechanisms to foster the type and extent of the desired changes to management and an adaptive approach can be improve economic design (Walters 1997).

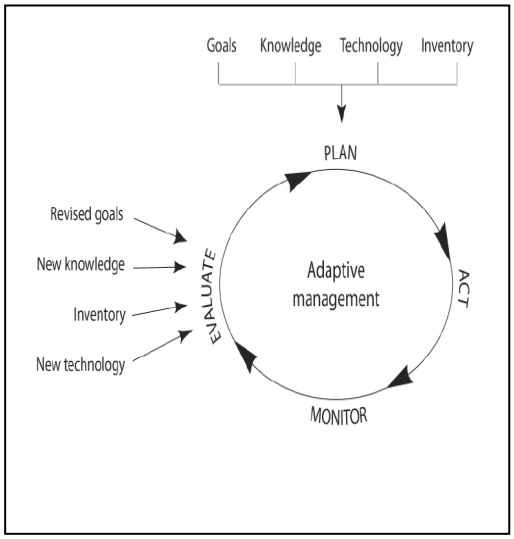
Adaptive management means different things to practitioners across disciplines and scales. Day to day decisions apply adaptive management to develop predictive tools for site specific management (McLain and Lee 1996). Policy level adaptive management provides a framework to experiment in "the design and implementation of natural resources and environmental management policies" (McLain and Lee 1996: 438). Practitioners conceptualise adaptive management in subtly different ways with different emphases depending on their objective. For example, Bearlin et al. (2002), describe adaptive management as a series of formalised and structured steps within an adaptive cycle. These steps include: modelling the system that is being managed along with alternative management scenarios; input and collaboration from those affected by management actions and alternatives; decision making about options; simulations of monitoring; implementing monitoring and evaluation strategies; and assessing the outcome with respect to the initial objective. Stankey et al. (2006) view adaptive management as a broader set of steps, namely: planning; acting; monitoring; evaluating; and learning (Figure 1). In the subsequent discussion we refer to the Bearlin et al. framework unless otherwise stated.

Adaptive management has primarily been applied to overcome uncertainty in determining the best set of physical management actions to deliver a specified biophysical objective. The process encompasses objective setting (specific ecosystem health objectives for example); goal setting to deliver these objectives (such as weed removal); implementation and management (identify, trial and modify alternative actions such as physical removal, chemical treatment, burning the paddock, or strategic

grazing); and monitoring and evaluation. The goal of an adaptive approach is to feedback the new knowledge collected to improve future decisions.



Bearlin et al. 2002



Stankey et al. 2006

Figure 1: Different interpretations of Adaptive Management

The adaptive management approach is less developed when it comes to incorporating uncertainty around human behaviour and economic information, particularly on private land. Salafsky et al. (2002) for example highlight the range of mechanisms available to generate change on the ground and the differences between them. Despite the broad acknowledgement of the uncertainty in policy mechanism design there is little consideration of how to manage this aspect of manage uncertainty in the adaptive management literature.[1] We argue that the principles of economic design can be directly included within the adaptive management framework to manage uncertainty using a four step process. The steps are as follows:

A. Define the economic and social processes, their relationship to the biophysical issue and the goals for any intervention in private land managers' decisions;
B. Deciding amongst mechanisms and identifying which are appropriate;
C. Refining and implementing the selected mechanism(s); and
D. Monitoring effectiveness and compliance and evaluating mechanism performance.

[1] To be fair, much of the historical emphasis of adaptive management has dealt with publicly owned and managed land which eliminates the issue of delivery via private land managers.

The alignment of the four step process with the adaptive management approach is presented schematically in Figure 2. The outer circle comprises the seven adaptive management steps described by Bearlin et al. (2002). The inner wheel (steps A through to D) comprises the integration of economic design into the adaptive governance framework. For simplicity we have eliminated internal feedback loops in Figure 2. In brief, the economic design process complements the planning and goal setting stages in Bearlin et al. by ensuring that the social and economic drivers important to the biophysical objective are fully included. Steps B, C and D then provide a framework for operationalising Bearlin's steps 5 through 7 (decision structure, implementation, and monitoring and evaluation). In the remainder of this paper we focus firstly on a succinct discussion of the rationale for the four step economic design process and subsequently on the adaptive management lessons from field experience in economic design.

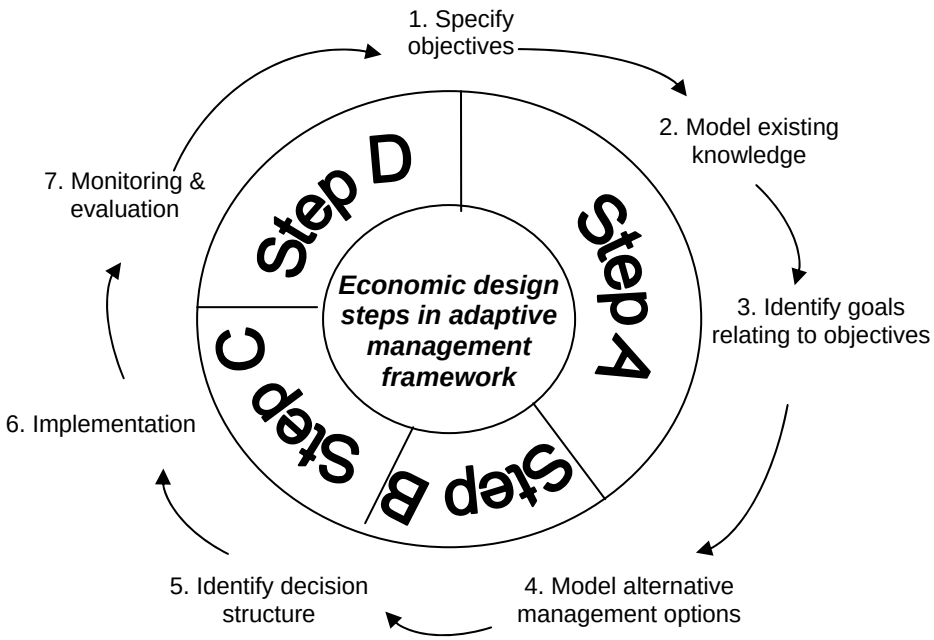


Figure 2: Integrating economic design within an adaptive management framework

3. Applying economic design to biodiversity conservation

3.1 Understanding the biophysical and policy problem (Step A)

Effective economic design requires information. Hence the first step is closely aligned with the information collection and goal setting steps within the adaptive management framework. Economic design approaches bring an understanding of the human and

institutional factors that influence the biophysical problem, albeit mainly from an economic perspective. The overlap between the biophysical focused adaptive management and the inclusion of people and institutions is demonstrated in Figure 2 where economic design Step A overlaps with Bearlin et al. Steps 1 to 3.

Understanding the human factors is essential because the managers of private land (or other resources) from which we wish to generate biodiversity conservation are economic agents, making decisions about the production of food, fibre or biodiversity conservation based on the incentives that they face (Wills 2006). In most countries land management decisions involve trading off market generated signals about the returns from production of goods such as food, fibre, housing and industrial products against weak, absent, or non-market signals about the importance of biodiversity conservation. In the absence of effective signals socially optimal biodiversity conservation outcomes will not result and market failure is said to occur (Murtough et al. 2002; Bromley 1991).

It is enough at this point to identify the likely source(s) of market failure. Common contributors include: poorly defined landholder rights or entitlements over the benefits and obligations associated with landuse; missing or asymmetric information; transaction costs; imperfect markets; and participation or access constraints. The alternate common cause is regulatory failure. Regulatory failure occurs when the cost of government intervention (through regulation) outweighs the benefits from this action. Regulatory failure may present as high cost interventions, ineffectual interventions or interventions that generate perverse or undesirable outcomes in other domains (Vining and Weimer 1990). Identifying factors such as who benefits, who pays, and why actions that ostensibly incur private benefits are not being adopted are critical at this point (Pannell 2008).

3.2 Deciding between the options available (Step B)

Adaptive management approaches emphasise identifying and testing biophysical management strategies to determine their relative efficacy in delivering the desired management objective. Effective delivery requires an equivalent process to select the most appropriate policy mechanism(s). The task at this point is to identify first, whether it is worthwhile intervening; and then to progressively narrow intervention options to

those likely to deliver the greatest benefit to the community over costs. The selected intervention(s) are then refined for further consideration in the next step. Note that interventions may target any relevant stakeholder who is able to deliver the desired outcome and not just private land managers.

It should not be assumed that intervention in landholder management is always the right approach to improving biodiversity management on private land. Rather, benefits of action should always be compared against (and exceed) the costs that will be incurred. Economic science compares the alternative options available against a base line option, which is usually defined as a status quo or 'do nothing' option, to determine whether in fact it is worthwhile introducing new policy. Alternatives include the introduction of suasive, incentive, or required actions such as those set out in Table 1. In many instances a mixture of mechanisms may be most appropriate. Pannell (2008) provides an excellent discussion of when and why private and public benefits are likely to support intervention.

Table 1: Options for intervention for biodiversity conservation

Intervention type	**Description**
Base line - status quo	Make no change if costs of change are greater than the cost of impact. Choice may also be to do nothing while investing in more information (per Step A).
Remove perverse incentives	Current policy is creating 'perverse' impacts: then if possible first modify or remove existing policy before considering alternative proactive mechanisms.
Moral suasion to foster social institutions	Social pressures (social norms) are often effective where minor changes to acceptable stakeholder behaviour achieve the desired objective. Likely to be especially effective where costs are low or lack of knowledge (rather than cost) is driving behaviour.
Incentive based approaches	Costly change (whether costs are financial, information, complexity or other) may require an incentive-based approach. Incentives may be financial or non-financial and include information provision and advice; actions which create or improve existing markets (including security of protection); and mechanisms which directly deliver an economic reward for action.
Required actions/regulations	Required actions are non-voluntary (but may sometimes be voluntarily agreed to) and usually impose a legally binding requirement on landholders. Required action approaches may be necessary when high levels of behavioural change are necessary to achieve targets.
Mixed mechanisms	There may be multiple market failures, or heterogeneous impacts of market failure which are most effectively addressed through a mixed mechanism.

Assessing whether there is likely to be a net public benefit is difficult as monetary valuation of biodiversity benefits is challenging. Proposed intervention scale is critical. For larger projects (costing perhaps several million dollars) economic theory offers several approaches such as choice modelling, contingent valuation, hedonic pricing, avoided costs and others (see for example Hanley and Spash 1993). These methods may be complex, time consuming and expensive to undertake so 'benefit transfer' from studies elsewhere may be utilised for small scale interventions (see Rolfe and Bennett 2006 for a discussion of strengths and weaknesses).

Estimating the costs of intervention may also be difficult and will need to be revisited later in the process when a specific mechanism (or mix) has been identified which will allow more accurate costing of elements such as: initial information gathering exercises; designing the mechanism; administration; monitoring and enforcement; costs of landholder support (payments and other); and any costs imposed on stakeholders (engagement, applications, reporting and so on as well any opportunity costs of lost production) (Watzold and Schwerdtner 2005). Factors such as the community attitudes, landholder rights and entitlements, organisational and landholder capacity also interact with cost.

If change from status quo is likely to deliver benefits to the community the question moves to one of selection of the appropriate mechanism. Interventions should be chosen and refined to address the reason why landholders are not managing their biodiversity to deliver public benefits – the market failures (Stoneham et al. 2000). Attention should also be paid to:

- The possibilities of regulatory or government failures (especially if information is costly or difficult to gather) (Hayek 1945; Wills 1997);
- Misalignment of incentives between political agents, bureaucracy and land managers (Vining and Wiemer 1990; Wolf 1988; Leibenstein 1982); or
- Distortions introduced by government intervention – primarily through tax collection and redistribution (Alston and Hurd 1990).

A suite of potential market failures and available design options are detailed in Table 2. In many cases there will be multiple approaches that may deliver the desired outcome – each with different costs and benefits. It is not possible to list all of the available mechanism variants since the whole objective of the economic design concept is to tailor solutions to the specific market and regulatory failures that are exhibited and which prevent effective biodiversity conservation.

Table 2: Summary of common market failures and economic design issues

Market Failure	Issues	Potential design considerations / options
Incomplete rights or entitlements	1. Definable	Create, define and allocate clear rights, obligations or entitlements.
	2. Measurable	Develop metric to objectively describe valued attributes of biodiversity.
	3. Excludable	If free-riders cannot be excluded, consider public purchase, public provision or regulation.
	4. Transferable	Where possible facilitate clear right/entitlement to desired action.
Information (lacking, or asymmetrically held)	1. Conservation outcome unknown	Formalise existing knowledge or research for new knowledge about cause and effect.
	2. Benefits of management actions unknown to buyer	Metric applied by buyer/public agency to calculate public benefits of actions by landholders. Non-market valuation to capture public non-use values.
	3. Benefits of management actions unknown to producer	Apply metric and extension programs to inform landholders how to produce biodiversity conservation, and of the associated private benefits.
	4. Scientific uncertainty	Incorporate 'risk premium' into metric. Further research to reduce uncertainty. Focus on outcomes rather than actions.
	5. Information about impacts not signalled in market	Identify product attribute or communication vehicle to provide information signal.
Market / participant structure	1. No common market place	Create or identify suitable marketplace, knowledge centre or equivalent.
	2. Thin markets / few participants	Expand scope to bring in more participants. Work to maximise participation rates.
	3. Market power / dominant participants	Expand scope to bring in more participants. Regulate participation requirements. Tailor vehicle to mutual benefits.
Linking payment to outcomes	1. Principal-agent problem	Performance-based payments, monitoring, foster mutual trust in formal/informal contracting.
Constraints to participation in mechanism	1. Capital	Upfront payments, loans, etc.
	2. Transaction costs	Public agency to provide information and advice. Minimise complexity and standardise approaches.
	3. Inexperience with mechanism	Provide training on mechanism.

Adapted from: Whitten et al 2009.

A typical suite of intervention options are summarised in Table 3, which any tailored option is likely to resemble in many respects. Most interventions will employ some mix of policy mechanisms (such as an information campaign with a new incentive payment). Some mechanisms may compliment one another. For example, regulated minimum standards may be needed to underpin payments for improved management. Similarly, nesting new mechanisms within current institutions and structures could enhance acceptability and reduce design and implementation costs (North 1990; Challen 2000). Specific market failures may require new and unique designs beyond the suite shown in Table 3 to be effective.

The strengths and weaknesses of various types of intervention are set out in Table 4 as an aid in identifying and assessing the potential net benefits available. In particular policy makers will need to assess the impact of those market or regulatory failures that are not overcome or any new impediments that are created by the intervention. For example, moral suasion is likely to be simple and low cost to implement but will take time to impact, while financial incentives may be quick to impact but costly.

Table 3: Some common intervention options and design rationale

Intervention type	Example approach	Typical market or regulatory failures addressed
Remove perverse incentives	Remove tax concessions, subsidies on undesirable activities	• Reduce regulatory failure from financial distortions and misalignment of incentives resulting from government policy • Reduce regulatory failure from institutions via reduced support for potentially damaging activities or investments (e.g. based on business type).
	Remove rule or institution advantages to potentially damaging investments	
Moral Suasion	Foster consumer / lobby group	All are designed to substitute or supplement market signals to encourage land manager behaviour:
	Government advertising	
	Pro-social rewards	
Incentive based no financial payment	Information advice & support	• Primarily intended to overcome poor or asymmetric information and thereby facilitate market provision. • Assist in reducing transaction costs and inexperience in mechanism as constraints.
	Non-financial material assistance	• Provides a surrogate market signal usually via reduced biodiversity management costs. • Can help overcome capital entry constraints.
	Security / protection of actions	Assists in defining rights or entitlements to future management and use and specifically in excluding particular options.
Incentive based financial payments	Financial assistance	• Financial assistance provides a market signal overcoming excludability and providing a market place. • Agreement or contract clarifies rights and entitlements. • Can be structured to overcome capital entry constraints and principal agent problems.
	Competitive allocation	• Market signal, clarifies rights/entitlements, entry constraints and principal agent problems as above. • Metric reduces measurement issues and may support information measures.
	Purchase (with/without resale)	Provides a market signal, creates a market place and can assist in overcoming thin markets and can reduce impact of information failures and asymmetries.
	Prohibition / Regulation on inputs, process or end products	• Clarifies rights and entitlements through exclusion, prohibition or obligation. • May reduce information failures depending on design.
Required actions (primarily regulations)	Regulation with compliance flexibility	May offer reduced regulatory failure compared to above.
	Mandatory certification	• Reduces information failures and asymmetric information by signalling impacts or outcomes in market. • Clarifies rights by imposing a minimum standard (duty).

Table 4: Some strengths and weaknesses of alternative intervention types

Intervention type	Strengths	Weaknesses
Remove perverse incentives	Low cost (may actually save money) Discourages damage Often precursor for other interventions	May (re)create other policy problems Usually does not reward actions
Moral suasion	Low cost Ongoing and self enforcing Consistent with societal expectations Simple to design and implement	Low incentive / penalty No formalised requirements Usually slow to impact Only likely effect small changes
Incentive based no financial payment	Often low cost Ongoing and cost reducing Can influence beliefs and expectations Usually simple to design and manage Voluntary	Unlikely to be effective if net costs high Few or no formalised requirements Advisory rather than enforceable Slow to impact
Incentive based financial payments	Flexibility in engagement Encourages change Encourages innovation / improvement Accepted by industry Payments may overcome larger costs Immediate impact on behaviour	No mandatory requirements Cannot enforce outcomes May be costly if payments large Cost / complexity in managing contracts Only some will change management
Required actions (primarily regulations)	Minimum performance Mandatory compliance Implies polluter pays Capable of near universal change May be cheap for government Faster impact on behaviour	Often inflexible for targeted stakeholders Incentives to avoid penalty not improve outcomes Usually input or processed-based Costly to enforce / requires enforcement Often opposed by industry Imposes costs on participants
Mixed mechanisms	Can overcome multiple impediments Can appeal to broad constituencies	Additional complexity, cost and potential for unexpected interactions

3.3 Refining and implementing the selected mechanism(s) (Step C)

The economic design approach emphasises attention to design detail in tailoring the mechanism(s) to deliver the desired biodiversity conservation outcome in the most effective and efficient way. Steps A and B produce a set of possible intervention options which then need to be refined to the specific implementation setting in Step C. Inevitably Step C will overlap with Step B as many design refinements are intended to overcome particular market or regulatory failures that would otherwise impede effective intervention. While there are many elements of design that could be refined three are crucial:

- Whether to target inputs, processes, outputs or outcomes;
- The importance (or not) of heterogeneity; and
- Achieving effective delivery of the mechanism with land managers.

Mechanisms generally target some proxy measure for the desired outcome (an output such as the number of bird breeding pairs, an input such as fencing, or protecting a

process such as area covenanted) due to the difficulty of directly targeting the desired biodiversity outcome. Targeting close to the desired outcome reduces the opportunity for misalignment between the induced land manager behaviour and the desired outcome. However targeting outcomes has some drawbacks. The long time lags associated with biodiversity response to policy change means that a mechanism based purely on outcomes places the risk of failure on the landholder: with high levels of uncertainty about outcomes, time delays to payment, and costly monitoring. As a result many interventions target intermediate input, process or output options. Decision tradeoffs focus on incentivising landholders to manage events under their control versus factors such as complexity, cost, risk-sharing and outcome uncertainty.

Landscape and land manager heterogeneity also impact through interactions with the value of actions to conserve biodiversity. Heterogeneity means there are economic efficiency benefits from targeting cheaper or more effective actions using conservation auctions and markets (Stoneham et al. 2003). The gains from a competitive approach must be traded off against additional mechanism cost and complexity. Simple, open-entry mechanisms can be administratively cheap but poorly targeted, while competitive approaches may be more expensive to design and run but deliver greater benefits through targeting scarce funds as illustrated in Figure 3. A related question is the degree to which coordination amongst landholders is required to achieve desired conservation objectives and the implications for economic design. For example, Reeson et al. (2008) use economic design to support conservation tender design for corridors and other landscape scale outcomes.

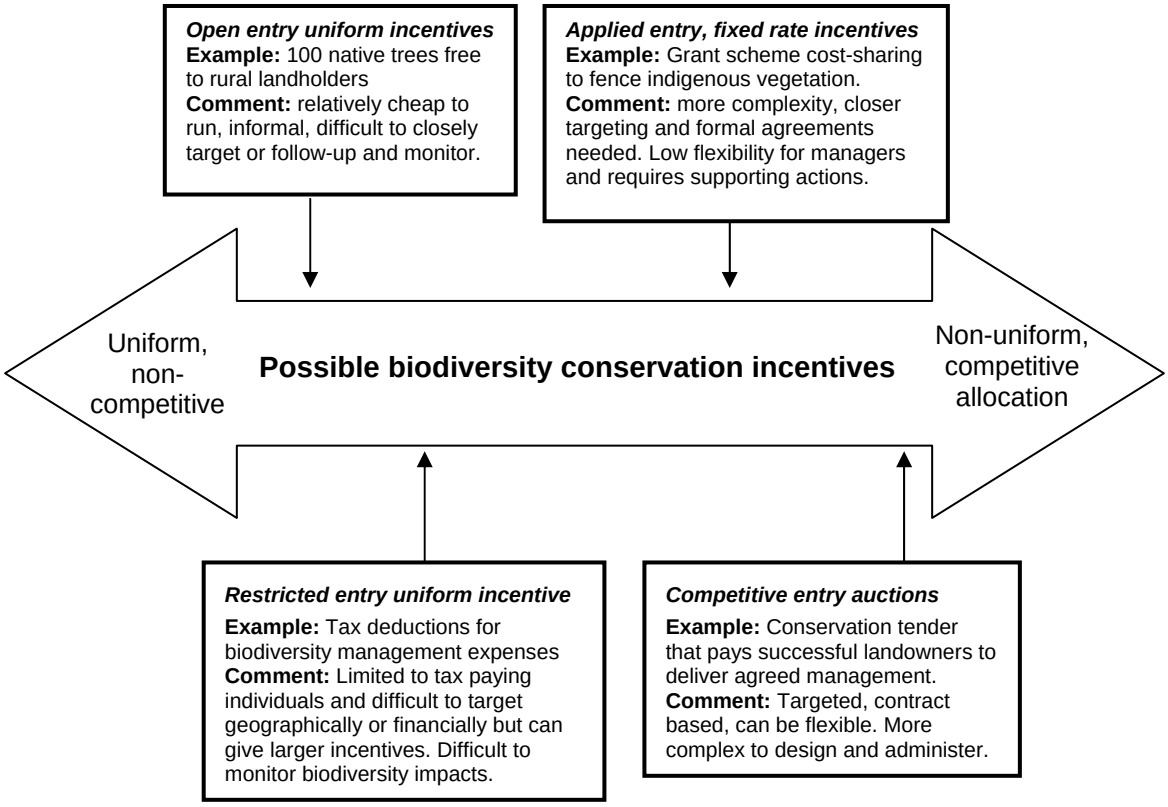


Figure 3: Some tradeoffs in incentive design

Several mechanism delivery options are usually available and decisions must be made about which government or other organisation delivers and whether delivery is shared or monopolised. While institutional governance questions are beyond the scope of this paper the economic attributes of delivery are not. As the case studies in section four emphasise, set-up costs are substantial for new policy mechanisms and can often be reduced by partnering with organisations that already operate in the geographic region (eg industry bodies) or with delivery experience. Such partnerships offer cost savings and communication advantages through use of existing communication networks, trust relationships, integration with existing programs and activities, access to additional resources, and reduction in duplication of administrative and other support requirements. Partnerships may also reduce the need for new legislative or regulatory powers required for the effective implementation, monitoring and enforcement of some mechanisms. Partnering almost always entails some loss of control which must be traded off against the benefits of the arrangement.

Finally, the implementation sequence across an intervention mix can influence the effectiveness of each components and the entire package. Careful sequencing can take advantage of the dynamic physical and human environments. Larger conservation benefits may be delivered by avoiding threshold impacts, managing for change through time, and capitalising on opportunities which would benefit from different mechanism mixes at different points in time. Landholders and others learn and adapt their behaviour to different knowledge, environments, incentives, and so on. Sequencing can leverage adoption behaviour (including social networks), peer pressure and behavioural norms, and can help avoid perverse incentives such as changes to payment expectations (polluter versus beneficiary pays).

3.4 Monitoring effectiveness and compliance and evaluating mechanism performance (Step D)

The benefits of an economic design approach cannot be achieved without the role of monitoring, evaluation and revision. While the most important impact of Step D is to identify lessons for future use internally or in other programs, a key distinction is the role of enforcement in delivering compliance with policy. While this is last step in the adaptive management process, experience suggests that it should be integrated throughout the economic design process. Practical decisions about what, how and who should be monitored, and a clear link between monitoring data and the mechanism effectiveness and outcome must be described as the mechanism is designed and implemented.

Monitoring should capture objective performance criteria that are directly linked to the impacts of key market failures to facilitate evaluation against design intent and performance targets. Performance targets will normally be clearly linked to a range of biophysical management targets, participation objectives (such as number of landholders), process objectives (such as delivery timeliness), outcome objectives (such as area treated), and financial objectives (such as budgets). Where relevant, monitoring will extend to formal compliance activities including legally binding management agreements. In a practical sense economic design can also aid in designing effective monitoring and compliance systems to support legal compliance perspectives since market and regulatory failures will also arise here.

4. The role of experience in supporting economic design? Reflections from case studies

To this point, the focus has been on integrating the concepts of economic design into the adaptive management approach. We switch our focus slightly at this point identify where field experience offers complementary lessons to the economic design approach. We explored twenty Australian experiences with mechanism selection, design and implementation. The case studies were selected to provide a broad spectrum of experience across a range of mechanism types and implementation bodies. Information was collected for each of the case studies through a semi structured interview. A summary of the case studies is provided in Table 5, more information on each individual case study reported on in this paper and the broader research can be found in the supplementary material to this paper at: www.csiro.au/people/Stuart.Whitten.html.

Table 5: Summary of practical conservation intervention schemes assessed

Intervention type	Mechanism	Case study	Description
Moral Suasion	Information provision to general public	Programs to enhance viability of native fauna	Change general public behaviour through information and support – Be Cass-o-wary, road signs and wildlife information programs
Incentive based – no financial payment	Information and support	Land for Wildlife	This scheme reduces the cost to landholders of obtaining relevant biodiversity management information, increasing landholder intrinsic motivations for conservation management.
	Security through covenant	National Trust of Australia	This scheme increases the legal security of biodiversity protection through conservation covenants over privately owned land.
	Bonus Development right	Development rights	This scheme grants additional development rights to landholders in return for conservation covenants over on-site biodiversity assets
Incentive based financial payments	Rate rebate	Various	Provide a financial incentive for conservation through a reduction in council rates if landholder conducts specified environmental actions on private land
	Competitive payments auction	Bush Tender	Competitively allocates payments for improved biodiversity conservation outcomes based on value for money criteria
	Competitive payments auction	Nest Egg	Output focused payments offer landholders incentives to reveal hidden information and an opportunity to motivate hidden actions, increase flexibility in management requirements and enhance innovation
	Competitive payments auction	Bush Incentives	Competitive tender that was modified to fit with potential applicants (had both rural and peri urban landholders to motivate)
	Devolved Grant – flat rate payments	Greening Australia Vegetation Investment Project	Provided fixed-rate payments to landholders to assist in the protection and revegetation of strategic habitat in the south east of NSW. This scheme is targeted towards work that will provide habitat for birds
	Flexible negative incentive	BioBanking offset scheme	No net impact from development can be achieved at least cost by allowing limited flexibility on how this impacted is mitigated – onsite, off site or by a third party. Both of these programs facilitate transactions of suppliers and demanders of vegetation offset credits
		BushBroker	
	Load based negative tax	South Australia Native Vegetation Council Native Vegetation Fund	Development permissions may require that a 'significant environmental benefit' be generated. Developers may provide financial payment to be invested towards this end instead of direct delivery. The financial contribution is determined based on the environmental benefit required.
	Revolving Fund	Trust for Nature	The revolving fund purchases properties with high biodiversity conservation value, covenants the biodiversity assets, and re-sells. Capital recovered from the resale then contributes to the purchase and covenanting of other properties of high biodiversity value.

Intervention type	Mechanism	Case study	Description
Incentive based financial payments	Land Purchase	Bush Heritage Australia	Properties carrying native vegetation in good condition that is not well represented in the national reserve scheme are purchased and managed. Funding for acquisition is generated through donations of cash or property as well as grants from government and philanthropic bodies.
	Cash Grants	Brisbane City Council Conservation program	Offer landholders a range of options with differential commitment and incentives with the aim of recruitment to low levels growing to higher commitments.
	Regulation/ legislation	EPBC Act	Implemented nationally by the Australian Government, the EPBC Act facilitates the regulation of activities that have impact on environments of national environmental significance. Facilitates flexibility with how impacts can be managed and mitigated
Required actions (primarily regulations)	Local Area Planning	Cardwell Council Planning	Development must comply with provisions established to maintain community environmental objectives
	Delivered through third party partnering	Alcoa and Greening Australia	Organisations with common goals and complementary skill sets partner to optimise on ground outcomes
Example of sequencing*	Partnering for delivery	National Reserve Scheme	Federal Government set the framework for National Reserve Scheme (NRS) objectives and facilitate NGO purchase and management of NRS objectives through contracts
Example of mechanism mixing*	Multiple layers of delivery	Far North Qld regional weed management planning	Weeds need to be managed at different spatial and institutional scales and accordingly with a mixture of regulatory and non regulatory mechanisms. The balance of these depends on the nature of the threat, nature of the stakeholders and capacity of agencies. A strategy that is developed and applied by many agencies and incorporates many mechanism types is likely to be most effective

* these case studies were included to demonstrate approaches to mechanism implementation such as sequencing and mixing

4.2 Findings from case studies

The purpose of the case studies was two-fold: to identify lessons from practical experience in design and implementation of biodiversity conservation measures; and to identify the opportunities that an economic design approach may offer for improving these measures. Our approach was to identify which aspects of the case study were aligned with an economic design approach, discuss the lessons arising from field experience, and to explore whether practitioners considered aspects of an economic design approach that they did not apply useful. The objective was not to evaluate the case studies against the economic design approach.

A summary of the overall consistency between an economic design approach and that applied in the case studies is provided in Table 6. Many (but not all) case studies were developed with a solid link to biophysical knowledge about the problem. For example: the Greening Australia 'Vegetation Incentive Project' (VIP) was based on research about declining bird populations, Bush Heritage Australia targeted investment in areas with high bioregional conservation status but few reserves in the national reserve scheme, and the Far North Queensland (FNQ) weed management strategy was built on information about the movement of flora and fauna pests across landscapes and the information needs of the different stakeholders involved in managing these. Fewer case studies incorporated a clear understanding of the human and institutional drivers of the problem and hence few explicit references to overcoming a market failure. Those that did primarily used financial incentives as a surrogate market signal. For example, the BushTender competitive tender was specifically designed to overcome information asymmetries and gaps, while the NestEgg tender was designed to motivate hidden actions.

Decisions about the most suitable intervention mechanism were heavily influenced by the capacity of the intervening agency. In many cases mechanisms were selected and designed to complement and build upon existing successful conservation programs, or to best leverage the strengths of organisations or relationships rather than exploring all potential options. For example:

- Greening Australia's VIP devolved grant program built on the success of existing successful native seedling propagation and volunteer programs;

- Johnstone Shire's bonus development rights scheme is built around its existing development approval requirements;
- Brisbane City Councils cash payments are based on existing land rate frameworks; and
- Alcoa's partnership with Greening Australia meets its corporate environmental responsibility objectives and generates larger change than it could in isolation.

Table 6: Summary of case study alignment with the economic design approach

Economic design component	Included in the case studies
Step A: Understanding both the biophysical and policy problem	Most had very good biophysical information but very few had a good understanding of the human and institutional elements that were driving the conservation problem
Step B: Should you intervene?	Decisions to intervene strongly driven by biophysical information rather than cost effectiveness.
Mechanism selection	Intervention type is strongly driven by current capacity and the objective to optimise impact at least administrative cost.
Efficiency and effectiveness should guide design	Mechanisms tend to be designed to minimise implementation cost. Some mechanisms targeted actions or locations while others highlighted the additional cost incurred in targeting.
Step C: Refine implementation for particular circumstances	Very few of the case study mechanisms were implemented with a formal implementation or communication plan detailing actions that link design and implementation.
Step D: Monitoring and evaluation	Very few case study mechanisms were implemented with a formal monitoring and evaluation plan and hence little is known about their effectiveness. This has significant implications for the ability to employ an adaptive management approach.

Across all case studies there was an emphasis on selecting and designing the mechanism to maximise a specified benefit from the mechanism at the least cost – but sometimes the focus was on process or inputs without evaluated linkages to environmental outcomes. Efficiency objectives were further achieved by finding ways to reduce the costs of mechanism implementation. Practical examples that emerged include:

- Land for Wildlife's development of a uniform information kit which is supplied to all new applicants; and
- Brisbane City Council's incorporation of a minimum land size for acceptance into their Conservation Partnerships Program.

There were also many examples where the accuracy in targeting and measurement was traded off against the costs that increased targeting would incur. Other refinements in mechanism implementation to manage costs include:

- Bush Heritage Australia's careful consideration of ongoing management costs when prioritising properties to target for purchase;
- The Victorian Trust for Nature portfolio risk management approach of a mix of rural properties with slower turn-over and higher management requirements compared to less demanding blocks nearer to Melbourne; and
- South Australia's design of a load-based biodiversity development payment has focused on areas where applications occur most frequently.

In most cases individual mechanisms were implemented in isolation from other interventions. Yet in many instances these programs have been implemented to complement or work with other conservation programs thus increasing overall environmental effectiveness. For example:

- Land for Wildlife do not provide conservation covenants but provide a link to the Victorian Trust for Nature; and
- Both BushBroker and BioBanking are intended to complement other regulatory approaches to managing development impacts.

Formal approaches to selecting, designing, implementing and even monitoring were not well developed for many of the case studies. In most cases the refinement and implementation of the scheme seemed to be driven by the parameters of the initial funding application rather than the implementation environment. Exceptions to this included the BushTender competitive tender, which had a clear communication, implementation and evaluation structure, and the staged development and implementation of the biodiversity offset schemes in NSW and Victoria. It should be noted that some mechanisms, particularly ongoing security oriented programs involving covenanting and revolving funds, had evolved into their present form over many years including formal and informal reviews.

Effective monitoring was limited in many case studies due to the duration of funding and overall funding limitations. In most cases data was collected against at least one measure of the outcomes achieved but few had conducted a formal evaluation to assess the overall effectiveness of the incentive measure against stated performance criteria or compared to alternative approaches. There were exceptions: a review of Brisbane City

Council's Conservation Partnerships Program (which included rate rebates) identified program refinements and opportunities to develop complementary programs. The BushTender pilot has also been comprehensively reviewed with the results feeding into further applications of competitive tenders in Victoria.

4. Discussion and conclusions

In this paper we have set out a practical integrative approach to bring together the biophysical and management implementation aspects of the adaptive management cycle. The economic design approach provides a clear construct that supports the assessment of intervention options and any resultant mechanism(s) selection, design and implementation. The two approaches need to be undertaken together in order for communities to have confidence that interventions intended to solve biodiversity conservation problems present good value for the time, money and other resources invested.

The approach set out in this paper nests an economic design cycle within the traditional adaptive management cycle. The economic design cycle contains four steps which can be loosely summarised as: problem definition, solution selection, solution implementation, and monitoring, evaluation and assembly of lessons for the future. The economic design process is applied within these steps as a process for deciding whether an intervention is warranted, what market and regulatory failures any intervention would need to be overcome, which mechanisms are available and the type of refinements required for effective application, and to guide what should be monitored and evaluated for future interventions.

The theoretical framework presented through the economic design construct was complemented by a set of case studies of mechanisms implemented in various Australian jurisdictions. The results from the case studies suggest that synergies with existing organisational capacities are an under-rated aspect of formal program design. Case study evidence also suggests a complementary focus on economic efficiency by minimising implementation and on-going costs. However the case studies also suggest that attention to the economic design approach could benefit future intervention decisions via a clear focus on overcoming market and regulatory failures and explicitly

considering the resultant design needs in a formal implementation plan supported by greater attention to monitoring and evaluation.

There are likely to be further rich learnings in this space as the field of economic design continues to mature and field experience grows. Similarly there were several important areas which this paper does not address and are likely to benefit from an economic design approach including decisions about delivery detail (for example when to split delivery between different agents) and in supporting legal compliance with different mechanisms and in different settings. There are also likely to be additional practical lessons as field implementation of mechanisms targeting biodiversity conservation continues.

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