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Achieving coordinated landscape scale outcomes with auction mechanisms

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Abstract

Competitive tenders, a form of market-based instrument (MBI), provide a cost effective policy tool for allocating payments for ecosystem services. This report describes the application of competitive tenders to conservation corridors and other landscape-scale objectives which require coordinated actions by landholders. Running tenders over a number of rounds, with opportunities for landholders to modify their bids between rounds based on information provided to them about the location of other bids across the landscape, can facilitate corridor formation. The competitive nature of the tender is maintained, particularly if the number of rounds is unknown in advance and participants are not able to increase their price if they find themselves in a potential corridor. Bid assessment is a complex process, as the value of any one bid depends on what other bids are also in the final package. It is therefore necessary to calculate the value of each possible combination of bids for the landscape as a whole, accounting for habitat condition and management, as well as connectivity and complementarity where appropriate. This project also provides recommendations on the design and implementation of competitive tenders to ensure optimal participation by landholders, and on the use of simulated tender exercises in workshops with potential tender participants as a valuable engagement tool.

Accompanying publications (produced solely through this project):

Policy brief – Competitive tenders at the landscape scale (to be published online and disseminated through MBI networks)
Policy brief – Optimising landholder participation in competitive tenders (published online and disseminated through MBI networks)
Paper – Barriers to and Opportunities for Increasing Participation in Conservation Auctions (published online; version to be submitted to academic journal)
Paper – Applying Competitive Tenders for the Provision of Ecosystem Services at the Landscape Scale (to be published online and submitted to academic journal)
Paper – Ecological Metrics for Evaluating Landscape Scale Outcomes from Competitive Tenders (to be published online and submitted to academic journal)
Report – Interactive experimental workshops (disseminated through MBI networks; to be published online)
Report – Mission Beach Stakeholder Workshop (disseminated to stakeholders)
These publications will be available shortly on the CSIRO website.

Related publications:

Conference paper – Designing auctions for conservation corridors: An experimental approach (Contributed to Australian Agricultural and Resource Economics Society conference, Canberra, February 2008)

Conference paper – Current, pre-clearing and 2025 scenarios of vegetation cover and cassowary habitat in Mission Beach and Surrounds (Marine and Tropical Scientific Research Facility Conference, Cairns, April/May 2008) (combining outputs from this and other projects)

Conference paper – Potential gaps in the complementary representation of regional ecosystems within protected areas of the Wet Tropics NRM region (Marine and Tropical Scientific Research Facility Conference, Cairns, April/May 2008) (combining outputs from this and other projects)

Project poster - Accounting for vegetation condition in the landscape: An approach in the Tully-Murray using VAST criteria and GIS (Townsville, June 2007).

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Introduction

Payments for ecosystem services are increasingly being applied to promote conservation and other environmental policy goals. Auctions, or competitive tenders, are a proven method of efficiently allocating limited amounts of funding for such payments (Latacz-Lohmann & van der Hamsvoort 1998; Stoneham et al. 2003; Windle & Rolfe 2008). A typical competitive tender involves landholders submitting bids to carry out conservation activities. They have some flexibility around the details of their bid proposal, and they are also free to choose their price. The purchaser in a tender (typically an NRM or conservation agency) ranks the bids in terms of value for money. Just as in any other market, the agency will first purchase those projects which offer the best value for money, and keep going until all funds are allocated (or a target or cut-off point is reached). Landholders whose bids are accepted are contracted to carry out their conservation project. The competitive nature of the auction mechanism encourages landholders to reveal their private information by submitting bids at or around their true opportunity cost of providing conservation.

Tenders have been applied for a range of ecosystem services. They fit in well with existing NRM institutional arrangements as they make best use of an amount of money allocated to a particular issue, and do not generally require special statutory arrangements. In order to rank the offers made by landholders in an auction, a metric is required to measure and compare the level of environmental benefits provided by alternative bids. This means the auction mechanism selects the individual projects which provide the best value for money, in terms of environmental outcomes per dollar requested. However, by focussing at the level of the individual property, this approach may select conservation projects which are scattered across a landscape.

In many cases there is a need for a landscape-scale approach to the provision of ecosystem services. In the case of biodiversity conservation, connectivity between conserved sites facilitates the dispersal of fauna and seeds, potentially increasing the contribution of individual projects to viable populations. The desired spatial configuration of conservation actions will depend on the characteristics of the target species or community, such as dispersal ability and range requirements. Some degree of habitat connectivity is required for most conservation outcomes in the short term. In the medium and long term, connectivity is likely to be of even greater importance, allowing species and communities to progressively adjust their ranges in response to climate change.

Project objectives

The objectives of this project were to advance and refine techniques for the design and implementation of competitive tenders to deliver cost-effective conservation at the landscape scale. This requires a number of separate issues to be addressed. Firstly the auction mechanisms within the tender process must be adapted to facilitate the coordination required for individual landholders to collectively deliver connected conservation projects in a cost-effective manner. Secondly, ecological metrics incorporating connectivity must be developed in order to select the best possible package of bids. These issues are considered in sections three and four. Section five considers landholder participation in tenders, since landscape-scale objectives can only be achieved if sufficient individual landholders are prepared to take part. Section six reports on methods of engagement with potential tender participants, which can in part facilitate high levels of landholder participation. Applications of the research to specific case studies in northern Queensland and New South Wales are described in section seven. Section eight presents the resulting policy recommendations for the application of competitive tenders to landscape scale conservation. There is an accompanying paper for each section of this report to which readers may refer for a more complete account of the research undertaken in this project.

Auction mechanisms

(see doc – Applying competitive tenders for the provision of ecosystem services…)
Multi-round auctions, in which landholders are provided with information on the location of offers from the previous round, have the potential to promote the coordination required to achieve landscape connectivity (Rolfe et al. 2005). Between rounds landholders are provided with information showing the location of offers made in the previous round. They then have the opportunity to modify their offer, or submit a new offer, in order to better coordinate with their neighbours and so increase their chances of success in the tender. However, auctions work by compelling landholders to compete, thereby revealing their costs and enabling the purchaser to select those projects with the lowest cost per unit of biodiversity. There is a danger that a mechanism intended to promote coordination among landholders may at the same time reduce competition. For example, neighbours may collude on price, or an individual at a key node in a potential corridor may be tempted to submit an offer well in excess of costs. Such behaviour will erode the efficiency gains achievable in an auction, and could result in the environmental objective not being met.

A critical problem in corridor formation is individuals not participating, or holding out for excessively high prices. In this form of iterated auction there will be greater opportunity for participants to identify and work around such hold-outs. Where there are many different ways of forming a corridor across a landscape, corridors can evolve over multiple rounds according to the bidding behaviour of individual landholders. Iterated auctions can potentially deliver coordinated actions across a number of properties without requiring individual or group level negotiations. A confidential discriminate price mechanism means that different landholders can be paid different amounts based on their opportunity costs, whereas in collective negotiations it is likely that all would seek the same payment, which would have to be at least as much as the highest individual opportunity cost (see Rolfe et al. 2005).

Minor details in the design of auctions and other market institutions can have a major impact on market performance (e.g. Klemperer 2002). Economic theory provides limited guidance as to the design of iterated auctions for conservation, necessitating an alternative approach. Experimental economics provides a methodology for integrating human decision-making behaviour with economic theory. Experiments were run to test a range of alternative auction design rules. Results indicate that iterated auctions can deliver coordinated outcomes, and work most efficiently where the number of rounds is unknown to participants in advance, and provisional winners cannot raise their prices. An agency may run the tender over a number of rounds, stopping once a desired target is reached. Clearly transaction costs will increase with the number of rounds. Allowing bids to automatically carry over from one round to the next minimises the impost of the iterated process. Uncertainty about whether any particular round will be the last minimises strategic bidding, which actually means that only two or three rounds are likely to be required. These simple rules can enable complex landscape scale objectives to be achieved in a relatively straightforward and cost effective manner.

Ecological metrics incorporating connectivity

An important principle of landscape ecology is that the size, shape and spatial relationships of land cover types influences the dynamics of populations, communities and ecosystems. The ability to describe and quantify landscape structure and connectivity is necessary to successfully characterise ecological processes and prioritise habitat networks for conservation management.

The biophysical outcome from a tender is only as good as the metric used to assess the bids. Landscape-scale tenders require metrics which can account for connectivity and complementarity across the landscape, as well as the value of each individual site.

The spatial links method and tools developed by Drielsma et al. (2007a,b) enable automated mapping of habitat linkages in the landscape. The link value of an individual site is combined 4

with connectivity measures from metapopulation ecology (Hanski 1994; Hanski 1999) and the least cost path algorithm from graph theory (Dijkstra 1959;

Drielsma et al. 2007a), resulting in continuously variable landscape data. Data and expert opinion are used to indicate the range of distances across various habitat qualities (different environments and disturbance levels) that an individual creature would move, on average, within a day. The estimate of distance may be constrained to particular lifecycle phases such as breeding. Different distance-decay parameters are therefore derived depending on the life history and movement behaviour of a species.

In conservation planning, complementarity is a measure of the contribution an area makes to the full complement of biodiversity features: species, assemblages, ecological processes, etc (Vane-Wright et al. 1991; Margules et al. 1988; Pressey et al. 1993; Margules & Pressey 2000; Margules & Sarkar 2007). This means that the conservation value of any given location in a region is assessed not only in terms of the attributes of that location (e.g. local species or ecosystem richness, patch size and connectivity), but also in terms of the contribution that location makes to regional biodiversity in combination with other areas. Complementarity can be applied in many ways. Spatial information needs to be collated and decisions need to be made about the data inputs including a surrogate for biodiversity such as vegetation mapping or models, a target or goal for the amount of each type to be represented, and a benchmark against which progress is measured, such as the amount of biodiversity within existing conservation areas (e.g. national parks and protected areas). Furthermore, the quality and configuration of habitats, or their 'intactness' (sensu Scholes & Biggs 2005; Faith et al. 2008), in fragmented landscapes has medium to long-term implications for biodiversity persistence and complementarity outcomes.

Our metric framework integrates landscape connectivity and complementarity measures and interacts with the auction process through spatial scenario analyses of landscape condition change. Given information about current condition of the landscape, the change achieved through the provision of conservation is used to assess the change in effective habitat area. Landscape condition is updated using a state-transition modelling framework (Drielsma & Ferrier 2006) incorporating edge-effects and other phenomena that negatively impact on biodiversity (Ferrier & Drielsma in prep.). Future effective habitat area is analysed in terms of change in connectivity and complementarity measured as a landscape outcome. Weights for combining the two measures are set within the objectives of the tender.

This landscape scenarios framework allows the various bids submitted in a conservation tender to be assessed to select the combination which offers the best possible biodiversity outcome within a given budget limit. The process requires a spatially-explicit and dynamic modelling framework and reasonable accuracy in the way landscape ecological and biodiversity processes are represented. Like many combinatorial modelling problems, the computation issues require the development of specialised but user-oriented software to ensure the methods can be adapted by NRM and conservation agencies.

Landholder participation in tenders

(see doc – Barriers to and opportunities for increasing participation…)

As competitive tenders are increasingly applied around Australia as policy instruments for achieving voluntary land-use change there is a perception that landholders can be reluctant to participate. This is a fundamental concern as tenders are reliant on competition between participants to secure the efficiency dividend that they promise. However, examining case studies of tender applications indicates that participation, while sometimes apparently low, has usually been sufficient for the tender to achieve its goals. High levels of participation may be particularly important to achieve certain landscape scale objectives – for example it is unlikely that a wildlife corridor can be formed if only a small number of landholders submit bids. It is therefore important to consider landholder participation throughout the process of designing and implementing a competitive tender.

In narrow economic terms, increased participation will lead to greater economic efficiency and increased environmental outcomes per dollar of public investment on-ground, which is a desirable outcome in itself. However there is a downside in the form of higher administration and transaction costs and a greater proportion of unsuccessful bidders. Therefore agencies should aim to optimise rather than maximise participation. The optimal level of participation will depend on the amount of money to be allocated and the objectives of the tender. If the available funding is likely to be sufficient to contract with only a small number of landholders, then clearly there is less to be gained from having a large number of bids. However if the objective of the tender is to form a wildlife corridor there will be stronger benefits from increased participation rates.

A target for participation should therefore be set early on in the process of implementing a competitive tender. The ideal number of bids will depend on a number of factors, including how much variation there is among landholders in terms of their costs of providing the ecosystem service, the transaction costs incurred in submitting a bid (for both the agency and landholder) and the likely impact of unsuccessful bids on future landholder actions and engagement. As a very rough approximation for a basic tender, if there are around 1.5-2 times as many bids as can be funded then there will have been strong competition without an excessive number of losers.

Having set a target for participation, the next task is to identify if there is likely to be a problem meeting the target. This will determine what, if any, actions should be undertaken to increase participation rates (or avoid excessive participation). Focussing on a land management issue which has a closer alignment with existing landholder aspirations is likely to increase participation rates. However by definition alignment should never be complete, otherwise there would be no case for incentive payments. Rather, an agency should look to achieve its objectives in ways which most closely align with landholder interests. In some cases an extension-style communication strategy may be of benefit in demonstrating to landholders that a new management practice does align with their objectives.

Competitive tenders offer opportunities to landholders, financial and otherwise. Clearly the more money on offer, the more people are likely to get involved. To some extent participation rates are likely to be self-regulating, based on landholder perceptions of the amount of funding available and the number of people likely to take part. Tenders also provide non-financial opportunities such as knowledge, support and recognition in changing management practices which may be emphasised if they are believed to be important to landholders. Local bodies with a strong community presence are generally best placed to engage with landholders. A site visit by a knowledgeable field officer can provide landholders with clear expectations about the process and greatly facilitates their engagement with it – this is generally the most important part of the engagement process.

Contract length is a difficult issue in any tender. Experience indicates that most landholders generally prefer shorter duration contracts (i.e. <5 years), and are particularly wary of binding permanent agreements (e.g. covenants), although the opposite is the case for some conservation-focussed landholders. Longer contracts provide greater certainty in terms of any ongoing incentive payments. However, for production-oriented landholders, longer contracts may involve more exposure to uncertainty such as changes in management costs or commodity prices. Laboratory economic experiments were carried out to examine how uncertainty affects decisions regarding length of contract. These showed that, all things being equal, the greater the variability in opportunity costs from year to year, the shorter the contract length sought by experimental participants. As well as preferring shorter contracts, participants also sought higher prices as uncertainty increased, incorporating a risk premium into their bids.

Conserved land is likely to require ongoing management for pests and weeds, the costs of which are difficult to quantify in advance as they are impacted by many factors behind the control of an individual landholder. Native vegetation therefore has the potential to represent an ongoing liability. Where weeds and pests are a significant issue, conservation agencies might consider policies to control them in native vegetation at the district level, rather than leaving it to individual landholders. As well as being more effective and efficient in their own right, such efforts would also minimise the ongoing costs of maintaining 'unproductive' native vegetation for landholders. In other cases uncertainty may be reduced by linking ongoing incentive payments to management costs (e.g. the price of water required to maintain a wetland) or commodity prices (e.g. where cattle production is scaled back to maintain native vegetation). If such uncertainties can be reduced, the evidence suggests landholders will be willing to enter into longer contracts at lower prices.

Experience of any incentive scheme will affect perceptions and expectations of future schemes. This is particularly relevant for competitive tenders, in which there will inevitably be unsuccessful participants. The impact of being unsuccessful may be limited if constructive feedback can be provided. In many cases there may be alternative schemes available to which they could be directed. It is important to continue the engagement process beyond simply announcing the tender results in order to maintain relationships and build support for future initiatives.

Engagement with potential tender participants

(see doc – Interactive experimental workshops)

Conservation tenders are grounded in ecological and economic science. However science alone cannot design a tender, nor communicate it to stakeholders. Engaging with landholders and other stakeholders is a key part of the process. A valuable tool for facilitating this engagement is the use of participatory experimental workshops. This approach builds on laboratory experimental economics to provide participants with a hands-on demonstration of the tender process by running through a simulated tender exercise. Such workshops can be used to test, communicate and seek feedback on proposed tender mechanisms.

In particular, experimental workshops provide a valuable training tool. Tenders are often a novel incentive mechanism, both for landholders and those charged with communicating and implementing them. These workshops can familiarise potential participants, administrators and communicators with the way in which the mechanism works, and why it is being applied. They can also provide information which assists people in formulating an offer. Attending such a workshop can increase the likelihood of participation in a subsequent tender as well as increasing the quality of bids (Windle & Rolfe 2006). Interactive workshops are therefore a recommended step in the implementation of tenders. However, they do involve costs, both for landholders and agencies, which must be traded-off against the potential benefits.

The key aspect of designing and running a workshop with stakeholders is to focus on the desired objective. Different approaches are required for eliciting information and testing tender mechanisms. Equally, when the objective is communication, it is important to consider exactly which aspects to focus on, in order to ensure that the right message is communicated. Face to face contact with stakeholders is almost always valuable, and can facilitate future interactions. Additionally, workshops provide a good opportunity to encourage landholders to sign up for the next stage of a tender, such as a site visit, and thus assist in moving potential participants through from expressing interest in a scheme to full participation.

Case studies

(see doc – Mission Beach workshop)
This project included ecological and economic components to address various aspects of the design and implementation of competitive tenders for landscape-scale conservation. Case studies were developed based on real world scenarios in order to test how these various components could be integrated, as will be necessary to achieve real policy outcomes. The Mission Beach study area straddles the Wet Tropics World Heritage Area and has been identified as a priority area for natural resource management in general, and biodiversity conservation in particular. The predominant land use is urban and residential along the coastal margins with cropping and grazing in the agricultural zones. Rural-residential blocks are scattered throughout the coastal and hinterland regions usually backing onto forest edges, and development pressures mean there is a risk of further habitat fragmentation. Large tracts of forest lie among and between these areas, some of which is protected.
The cassowary is an iconic species of the region, and is listed nationally as endangered. Their large size and varied habitat requirements mean that connectivity is particularly important for cassowary populations. A variety of corridor plans developed by government and non-government organisations identify key local and regional linkages among habitats potentially frequented by cassowary (Latch 2007). While extensive areas of habitat are protected within National Parks and World Heritage Areas, much of the remaining habitat identified for corridor management is managed by private landholders. An ecological metric was developed based on habitat condition, connectivity and complementarity.
In April 2008 a series of conservation incentive workshops were held in the region. The workshops involved presentation and discussion of competitive tenders and their role in NRM policy, followed by a simulated tender exercise. This exercise was based on the landscape around Garners Beach, to the north of Mission Beach, involving 40 hypothetical properties (loosely based around actual property boundaries). Participants were asked to take on the role of landholder for a hypothetical property and submit a bid in a conservation tender. Maps were provided for each property, showing vegetation and current land uses. In this exercise tenders were submitted for 29 of the 40 hypothetical properties. The farm maps were translated into GIS layers for tender evaluation. Scenarios of land use change (e.g. revegetation, regrowth management, remnant protection) were created for each tender, applicable to a 10 year restoration cycle in the wet tropics, by assuming 'best practice' conservation actions were applied.
The tender mechanism was well received by workshop participants, who considered it to have good potential to contribute to NRM in the region. Bids submitted in the tender exercise were run through the metric developed for the region. The required level of computation proved even lengthier than expected. However, it did prove

possible to select the best package while accounting for a range of assessment criteria including habitat condition, connectivity, complementarity.

A second case study was developed based on long-nosed potoroo populations on the north coast of NSW (in collaboration with Mick Andren of NSW DECC). There are similar issues of habitat fragmentation under intense development pressure. However, potoroos have a much smaller range and hence higher population densities than cassowary, so metapopulation dynamics are more important in this case. The auction and metric will be demonstrated in a workshop with policy makers and other stakeholders in the region in the next few months. (This has been delayed due to a number of key people leaving their positions recently, with new appointments yet to be made.) This workshop will focus on policy makers rather than landholders as, unlike Mission Beach, there is little likelihood of a real tender being rolled out in the foreseeable future.

Policy recommendations

(see doc – Policy brief)

- Competitive tenders can be applied to provide a cost-effective mechanism for achieving biodiversity corridors and other desired mixes of ecosystem services provision
- Tenders for landscape-scale outcomes should be run over multiple rounds with the number of rounds unknown to participants in advance; participants should not be able to increase their prices from round to round
- Metrics for landscape-scale conservation tenders must be based on sound ecological knowledge, and account for condition, connectivity and complementarity where relevant
- Bid assessment will require computational methods such as simulated annealing to make the solution space tractable
- For any sort of tender, it is necessary to consider how to engage with landholders at all stages of design and implementation in order to get the optimal level of participation, for both current and future schemes
- Interactive experimental workshops are recommended as a method for engaging with landholders for whom the tender process is unfamiliar

Communication and adoption

(see doc – Impact and influence reporting)
Communication and engagement has been extensive throughout this project. We have engaged directly with policy makers at local, state and federal levels. We have also talked directly with landholders. There has been some media coverage, including an interview on ABC Rural, with further media releases planned following the conclusion of the project. Our reports will be disseminated through our networks, and will shortly appear on a dedicated project webpage within the CSIRO website. We have written two policy briefs to facilitate adoption of our outputs by policy makers. We will continue to disseminate our research results and encourage NRM practitioners to adopt competitive tenders for landscape-scale outcomes over the coming months and years. Please see the attached document for more details regarding our communication activities.

Commercial potential

None envisaged

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