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Project Final Report

Establishing east-west landscape linkage in the Southern Desert Uplands research reports

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RESEARCH REPORT No. 6

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ESTABLISHING EAST-WEST LANDSCAPE LINKAGE IN THE SOUTHERN DESERT UPLANDS RESEARCH REPORTS

February 2005

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These reports represent the provisional findings of the research project 'Establishing East-West Corridors in the Southern Desert Uplands'.

The project is funded by a partnership of the Commonwealth and State Governments through the National Action Plan for Salinity and Water Quality. The partners in the project are the Desert Uplands Buildup and Development Strategy Committee, the Queensland Environmental Protection Agency, Central Queensland University and CSIRO.

Any comments will be gratefully received and should be directed to Juliana McCosker

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Executive Summary

The Desert Uplands Buildup and Development Committee, Queensland EPA, Central Queensland University and CSIRO were collaborating partners on a research project funded through the National MBI program. Funding for the project was $100,000, and it ran from August 2003 to December 2004.

The aim of this project was to design a competitive process to establish landscape linkage corridors across a region. These may be blocks and strips of vegetation that form 'stepping stones' or a broad corridor across a region. The case study for the project was the Desert Uplands region in central-western Queensland, but the environmental issues of landscape fragmentation and better management for biodiversity protection at the farm level are more general across Australia.

The market-based instrument analysed in this case study was a conservation auction (commonly referred to as a competitive tender). This framed the situation of interest in terms of landholders supplying management actions over parts of their properties in return for incentive payments through a regional NRM group. The framing was appropriate in terms of perceptions that landholders have about their property rights, and the political reality that regulation is very unlikely to be used to achieve the environmental goals.

The key research question was how to design a conservation auction process where landholders were expected to compete on price, but where cooperation was also needed to ensure that corridors linked at property boundaries. Other research questions addressed related to:

- the potential efficiency gains of multiple round auctions over single round auctions,
- issues affecting participation rates,
- the level of transaction and administration costs involved, and
- the use of a conservation auction 'game' to familiarise respondents with the process.

The methodology used in the project was a series of field experiments, where landholders from the Desert Uplands participated in a conservation auction 'game' specifically designed for this project. A series of dummy properties were developed and allocated to participants in the workshop. Using their knowledge of the region, participants had to design a corridor across their dummy property, and then identify what annual payment would be needed before they would enter into a five year conservation agreement. Different mechanisms were tested for participants to link their corridors at property edges, and incentive prizes were awarded to encourage cost-effective bids. A simple metric was employed to evaluate bids according to the environmental benefits generated.

There were a number of key results identified from the project. These are outlined as follows:

1. Significant efficiencies in bid formation were identified with the use of multiple round auctions. The average bid price fell under the competitive pressure of successive bidding rounds, while the amount of biodiversity credits that could be purchased for a fixed budget allocation rose. Reductions in bid prices are likely to be generated from a number of sources, including adjustments for uncertainty and rent seeking as learning effects occur and competitive pressure is recognised. However, there are also likely to be increased transaction and administration costs associated with multiple bid rounds, suggesting that only a small number of rounds will be efficient in conservation auction systems. The number of rounds necessary to generate efficient bids may be reduced if participants are familiar with the process prior to a 'live' auction.

2. A 'limited cooperation' approach was found to be practical in designing corridors with a small number of participants. This model involved the cooperation of neighbouring landholders to plan a corridor location, and then submission of sealed bids for individual components. The key advantages of the 'limited cooperation' model were that participation and compliance rates were likely to be higher than in an 'individual bid' model. The key disadvantages of the 'limited cooperation' model are that transaction and administration costs are likely to rise as a factor of the number of participants involved, the model generates only a small number of potential possible corridor locations, and bid prices are likely to be higher. This is because, even though bids are sealed, participants with lower marginal opportunity costs are likely to raise bid prices towards those with higher opportunity costs, and because there is more incentive to include some rent component in bid prices (because bidders think their bids are disguised in the larger group bids).

3. There was anecdotal evidence that a 'full cooperation' model, where landholders plan corridors together and then submit open bids, would not be viable. This is because there is a strong preference in rural areas for bids to be sealed, and because an open bidding format would encourage all bids to be set at the level of landholders with the highest opportunity costs. The first factor would reduce participation rates, while the second would reduce the economic efficiency of the bidding process.

4. An 'individual bid' model was found to be practical in designing corridors, with some evidence that the model was more cost efficient than the 'limited cooperation' approach. An 'individual bid' model for corridor establishment only works with multiple bidding rounds. After an initial round of bids, participants are shown the location of other bids (including those of neighbours) in the area. Because bids will only be successful if they form part of a viable corridor, participants have clear incentives to change or add to their bid designs so that corridors line up at property boundaries. In this way there are incentives for individual behaviour that lead to group outcomes. Other key advantages of the 'individual bid' model are that they allow a large number of potential corridors to be identified (thus enhancing the competitive process), and there is more

competitive pressure on individual participants (leading to more cost-efficient bids). Potential disadvantages are that it may be more difficult to encourage participation, and there may be higher transaction and administration costs associated with multiple auction rounds.

5. Transaction and administration costs associated with a corridor auction mechanism may be high. This is because of very limited knowledge and familiarity about these mechanisms by landholders, and because of reluctance to be engaged in something novel. Low participation rates are a key issue to be addressed in a corridor design. There is also limited skills and knowledge about these mechanisms at the regional NRM group level. These factors mean that initial trials will have high transaction and administration costs, but these should fall as participants become more familiar with the process.

6. There do not appear to be suitable metrics available for evaluating corridor bids. Two metrics have been developed in the course of the project. One was a very simple metric which was used in the workshop process, while the other was a technical design that can be used to evaluate bids very precisely. Complicated metrics have disadvantages in terms of assessment costs, complexity and reduced transparency. In the Desert Uplands where biodiversity issues are not critical, it may be advantageous to choose a simpler metric.

7. A key issue that was not fully resolved was whether the environmental service being purchased should be a corridor only, or a corridor plus special vegetation areas. The latter has key advantages in terms of being more inclusive, and allowing outcomes to be generated if participation rates are low. However, it would require a more complex assessment process and a different metric, and may require higher initial levels of funding.

8. The experimental workshop game that was developed for this project has key benefits in terms of showing landholders, regional body staff, agency staff and other stakeholders how an environmental auction works in a hands-on manner. The workshop results also help to identify the key factors that drive landholder bids, and allow the potential supply of environmental services to be modelled.

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Introduction

This report is the final report from a research project funded under the National Market Based Instruments program. The report includes a number of recommendations about the design of a MBI to establish a vegetation corridor zone across the region. These outcomes should be more widely applicable in other regions of Australia where engaging groups of landholders to achieve resource protection goals is important. The focus of this report is to outline a number of the issues that have been considered, and to give a summary of the key findings. Further detail on the project is available in the earlier reports that have been produced.

Research Partners

The research was carried out by four research partners:

The Desert Uplands Buildup and Development Committee
Queensland Environmental Protection Agency (Juliana McCosker)
Central Queensland University (John Rolfe and Jill Windle)
CSIRO (Stuart Whitten)

Project funding and timelines

Funding allocated by the National MBI program was $100,000. The project ran from August 2003 to December 2004.

Project outputs

The project results have been summarised in a series of reports, as follows:

> Rolfe, J.C. and McCosker, J.W. 2003 *Overview of the Issues in Planning a Corridor Tender Process,* Establishing East-West Corridors in the Southern Desert Uplands Research Report No 1, Central Queensland University, Emerald.
>
> Rolfe, J.C., McCosker, J., Windle, J. and Whitten, S. 2004 *Designing Experiments to Test Auction Procedures*, Establishing East-West Corridors in the Southern Desert Uplands Research Report No. 2, Central Queensland University, Emerald.
>
> McCosker, J. and Rolfe, J. 2004 *Designing a Biodiversity Index to Assess East-West Landscape Linkage*, Establishing East-West Corridors in the Southern Desert Uplands Research Report No. 3, Central Queensland University, Emerald.

Windle, J., Rolfe, J.C., McCosker, J. and Whitten, S. 2004 *Designing Auctions with Landholder Cooperation: Results from Experimental Workshops*, Establishing East-West Corridors in the Southern Desert Uplands Research Report No. 4, Central Queensland University, Emerald.

Rolfe, J.C., Windle, J., Coggan, A., McCosker, J. and Whitten, S. 2005 *Recommendations for Establishing Linkage Zones*, Establishing East-West Corridors in the Southern Desert Uplands Research Report No. 5, Central Queensland University, Rockhampton (in preparation).

Rolfe, J.C., Windle, J. and McCosker, J. 2005 *Final Report for MBI Project 18*, Establishing East-West Corridors in the Southern Desert Uplands Research Report No. 6, Central Queensland University, Rockhampton.

There have already been some conference papers prepared from the research material, as follows:

Windle, J., Rolfe, J., Whitten, S. and McCosker, J. 2005 "A competitive bidding process with landholder cooperation for landscape linkage", Paper presented at the 49th Annual Conference of the Australian Agricultural and Resource Economics Society, 9th – 11th February, Coffs Harbour, NSW.

Rolfe, J.C. 2005 "The potential for market mechanisms to achieve vegetation protection in the Desert Uplands", paper presented at the International Workshop on Rangeland Property Rights, Undara (Mt Surprise), Queensland, 1 – 3 March.

Windle, J., Rolfe, J., Whitten, S., McCosker, J. and Reeson, A. 2005 "Exploring cost efficiencies in conservation auctions with multiple bidding rounds", Paper submitted for presentation at the 2005 National Workshop of the Economics and Environment Network 5th – 6th May 2005.

A number of research publications are being prepared and will be submitted for publication.

Background to the issue being considered

Rapid land development in the southern Desert uplands bioregion has fragmented the landscape, especially in the central part. To minimise risks of long-term biodiversity losses, it is desirable to establish a number of strategic east-west vegetation linkages across the region. The Vegetation Management Act (2004) was enacted in Queensland just as the project commenced and will limit further land development. However the establishment of landscape linkages across the bioregion to be primarily managed for their biodiversity values is still justified. Landscape linkages are important because there are still substantial pressures to further increase the intensive agricultural management of

this bioregion as land prices escalate and cell grazing practices are in vogue (Rolfe and McCosker 2003). Linkage zones would reserve some areas from these pressures and provide buffer and migration zones in terms of adverse climate conditions.

Agreements with 10 to 12 landholders are needed to establish each vegetation corridor. In this instance landholders would be paid to not increase the intensity of grazing use in the bid area and they have one of four broad management options:

1. Maintain current production outputs by forsaking increased production outputs i.e. not putting in additional waters or reducing paddock sizes.
2. Modify current production outputs to have a better biodiversity vegetation condition outcome i.e. de-stock area over wet season.
3. Decrease production outputs.
4. Eliminate production outputs i.e. totally de-stock.

The key challenge in this process is to identify the most cost-effective corridors across the region given that a number of potential routes exist and landholder choices are inter-related. Market-based incentives (MBIs) offer a potential cost-effective means of establishing corridors. Potentially useful MBIs include competitive tendering and iterative negotiation rounds, as well as within-property transfers of vegetation clearing permits (this option is no longer possible due to legislative changes).

Objectives of the project

The overall aim of the project was to plan and develop a proposal for vegetation corridors to be established across the Desert Uplands through the use of an auction or other MBI-related voluntary landholder participation processes.

The main issues to be addressed in the project were:

1. How to involve landholders in a bidding process,
2. How to assess the environmental/ecological values of different corridor options,
3. How the auction/bidding process might work, and how to ensure that landholders and funding bodies achieve a “fair” deal.

There are, however, a number of uncertainties about how a competitive bidding process for corridors might work, as this approach has not been tried in Australia before. The key considerations in addressing each of these issues are outlined below.

Selection of the market-based instrument

The market based instrument analysed in this case study was a conservation auction (commonly referred to as competitive tenders). These framed the situation of interest in terms of landholders supplying management actions over parts of their properties in return for incentive payments through a regional NRM group. The framing was

appropriate in terms of perceptions that landholders have about their property rights, and the political reality that regulation is very unlikely to be used to achieve those goals.

It would have been difficult to have used another instrument. Vegetation management is already a sensitive issue in Queensland, and the use of a quantity-control mechanism or other price-based mechanisms would not have generated cooperative behaviour. Members of the steering committee emphasised that the mechanism had to be voluntary for landholders to cooperate.

Key research questions

The key research question was how to design a conservation auction process where landholders were expected to compete on price, but where cooperation was also needed to ensure that corridors linked at property boundaries. Other research questions addressed related to:

- the potential efficiency gains of multiple round auctions over single round auctions,
- issues affecting participation rates,
- the level of transaction and administration costs involved, and
- the use of a conservation auction 'game' to familiarise respondents with the process.

Methodology

The methodology used in the project was a series of field experiments, where landholders from the Desert Uplands participated in a conservation auction 'game' specifically designed for this project. Although it is more common to conduct experiments in a laboratory environment, a workshop setting was considered more appropriate when landholder participation was being sought (Rolfe *et al.* 2004). The experimental workshop was a new hybrid model developed for this project to explore issues of auction design. The approach is a form of synthesis between experimental economics and a field pilot without being easily classified into either group. It is like experimental economics in that it utilizes a simulated environment to test how people would form bids, but is not as tightly controlled as a normal experimental procedure. It is also like a field pilot in that it is focused on a real world application with actual landholders, but does not go beyond hypothetical scenarios in a half-day workshop.

The use of landholders in the region as workshop participants has potential advantages in terms of:

- identifying the opportunity costs (and heterogeneity in costs) faced by landholders,
- identifying likely participation rates in an auction system, across different auction formats, and

- identifying the transaction costs and potential administration costs associated with a competitive tender mechanism.

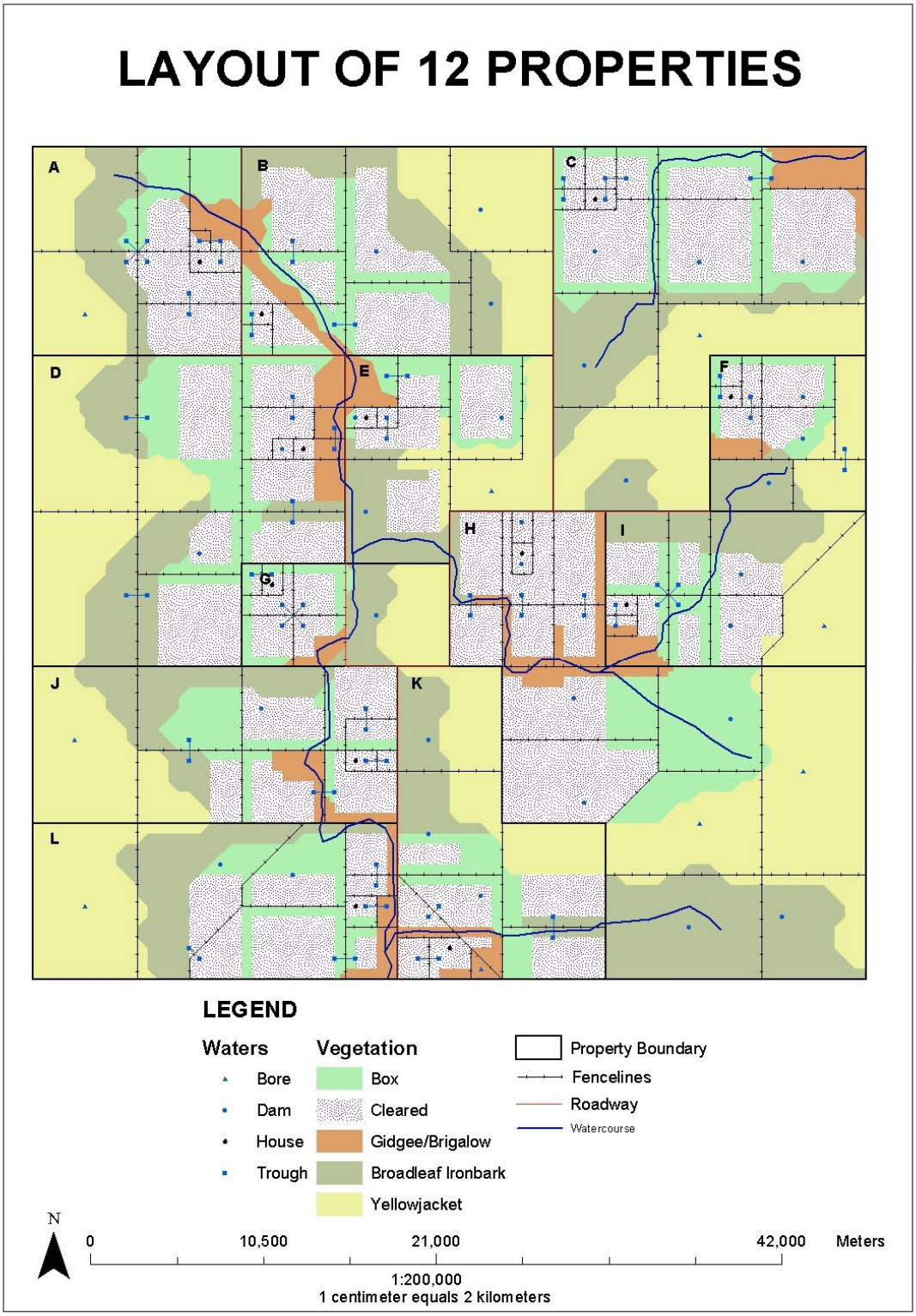
The workshops were designed around the use of an experimental 'game' developed specifically for this project. A series of dummy properties were developed that were realistic for landholders while minimizing the number of variables that could affect participants' bid behaviour. The workshops involved up to 12 landholders, and lasted for approximately 3 – 4 hours. Using their knowledge of the region, participants had to design a corridor across their dummy property, and then identify what annual payment would be needed before they would enter into a five year conservation agreement. Different mechanisms were tested for participants to link their corridors at property edges, and incentive prizes were awarded to encourage cost-effective bids. A simple metric was employed to evaluate bids according to the environmental benefits generated.

Each participant in the game was randomly allocated one of the 12 properties available. While participants were using dummy properties they were asked to develop their bids based on their experience on their own properties. Full details and results from the workshops are presented in Windle *et al.* (2004). The planning issues involved in designing the workshops and auction design are presented in Rolfe and McCosker (2003) and Rolfe *et al.* (2004). A copy of the maps of the 12 properties is shown in Figure 1.

The experimental workshops were designed primarily to test different bidding processes when landholder cooperation is required for vegetation corridor linkage across the region. However, the structure of the game meant that it was possible to ask for individual bids from participants which modeled a BushTender type of system. Like BushTender, the auction system adopted involved sealed, discriminate bids. Sealed bids meant that participants did not know what other landholders were bidding, while discriminate bids meant actual bids were accepted up to some threshold point (rather than paying a uniform price to all participants).

The workshops were separated into two sessions. In the first part, multiple individual bidding rounds were held to test the efficiency of multiple round auctions and to familiarise participants with the process. In the second part, the focus was on testing bidding formats to ensure landholder cooperation for the formation of a corridor.

Figure 1. Landscape map of 12 'dummy' properties



Key results of the project

(a) Efficiency of multiple round auctions

Significant efficiencies in bid formation were identified with the use of multiple round auctions. The average bid price fell under the competitive pressure of successive bidding rounds (Figure 2), while the amount of biodiversity credits that could be purchased for a fixed budget allocation rose (Figure 3). There was substantial statistical evidence that bids became more cost-efficient as successive auction rounds were held (Windle *et al.* 2005b).

Figure 2. Average relative bid values for successful bidders

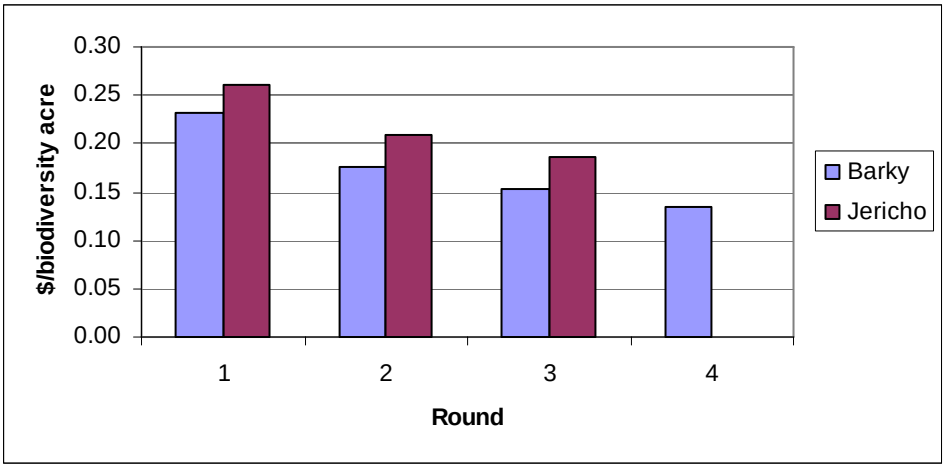
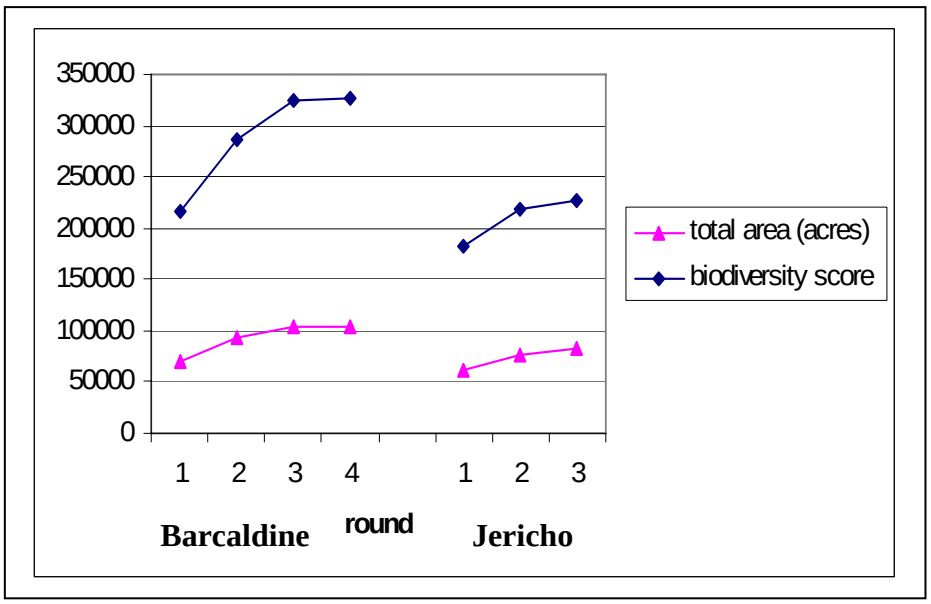


Figure 3. What could be purchased from landholders for $50,000



Reductions in bid prices are likely to be generated from a number of sources, including adjustments for uncertainty and rent seeking as learning effects occur and competitive pressure is recognised. However, there are also likely to be increased transaction and administration costs associated with multiple bid rounds, suggesting that only a small number of rounds will be efficient in conservation auction systems. The number of rounds necessary to generate efficient bids may be reduced if participants are familiar with the process prior to a 'live' auction.

(b) Efficiency of a 'limited cooperation' approach to corridor formation

A 'limited cooperation' approach was found to be practical in designing corridors with a small number of participants. This model involved the cooperation of neighbouring landholders to plan a corridor location, and then submission of sealed bids for individual components. Participants in the workshops seemed to prefer this model because of the social interactions involved and because bids were still sealed.

The key advantages identified for the 'limited cooperation' model were that participation and compliance rates were likely to be higher than in an 'individual bid' model. This means that where low participation rates are a potential problem, some aspects of this model may provide real benefits.

There are three key potential disadvantages of the 'limited cooperation' model. The first is that transaction and administration costs are likely to rise as a factor of the number of participants involved. Once group sizes rise above 6 – 10 people, and when they are not familiar with each other, coordination difficulties are expected to rise exponentially. These issues can be addressed to a large extent by using a coordinator, so that the amount of negotiation between landholders is reduced.

The second disadvantage with the 'limited cooperation' model is that only a very small number of corridor options are likely to be generated, which may reduce competitive pressures.

The third disadvantage is with this model is that bid prices are likely to be higher. One reason is that, even though bids are sealed, participants with lower marginal opportunity costs are likely to raise bid prices towards those with higher opportunity costs. It will be very difficult for negotiations over corridor location to occur without some information about bid prices also being transmitted. The other reason is that under this model there is more incentive to include some rent component in bid prices (because bidders think their bids are disguised in the larger group bids).

There was anecdotal evidence that a 'full cooperation' model, where landholders plan corridors together and then submit open bids, would not be viable. This is because there is a strong preference in rural areas for bids to be sealed, and because an open bidding format would encourage all bids to be set at the level of landholders with the highest opportunity costs. The first factor would reduce participation rates, while the second would reduce the economic efficiency of the bidding process.

(c) Efficiency of an 'individual bid' approach to corridor formation

An 'individual bid' model was found to be practical in designing corridors, with some evidence that the model was more cost efficient than the 'limited cooperation' approach. An 'individual bid' approach to corridor formation only works with multiple bidding rounds. In the experimental workshops, landholders were asked to submit a bid for a corridor across their property, with the knowledge that a full corridor would need to be achieved before any individual bids could be successful. After the first round, bids were assessed and the location of each property corridor was drawn on a large map for all participants to view. As expected, the number of individual bids generated a series of discrete links that rarely happened to join at property boundaries. Participants could then see where potential corridors could be formed across the area covered by the 12 properties. It was also apparent that a number of options existed to form a corridor, and it was not clear from a bidder perspective (seller) where the buyer might choose to locate the corridor and if their bid would be successful.

Participants were then informed that their first bid would remain "live" but they could put in another bid if they wished. They would only win an incentive prize if they were part of the most cost-efficient corridor bid, giving clear incentives for participants to be part of one or more corridors linking across their dummy property. There are several potential strategies landholders might adopt in the second round to increase their chance of success. For example they could:

- relocate their first bid to link with one or more neighbours,
- provide an additional area to link to a different corridor option, or
- reduce their bid price.

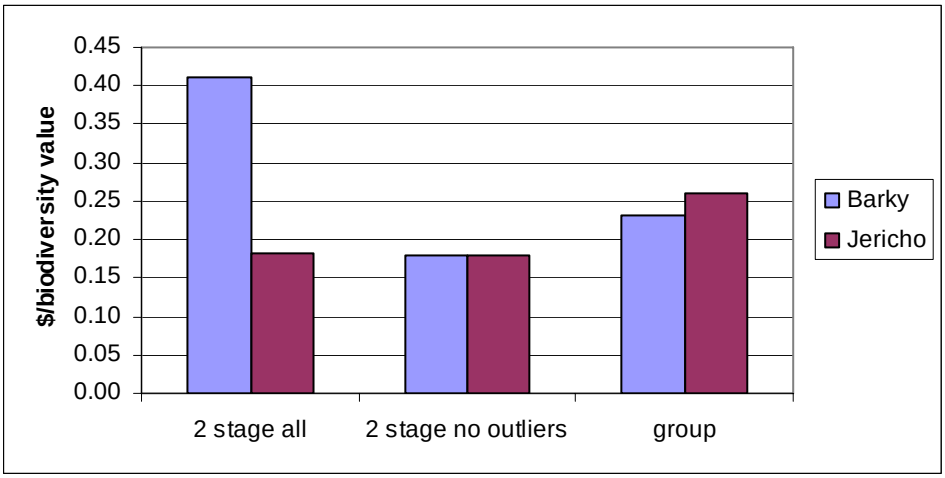
This bidding format was very successful and the layout of the corridor areas in Round 1, Round 2 and combined rounds are presented in Windle *et al.* (2004). Many landholders bid for multiple corridor locations across their property, with the result that many options for different corridor linkages were identified (a total of 18 in Barcaldine). Some landholders preferred this approach to that of working in a group, particularly those who had been placed in a group with people who had contrasting viewpoints. However, some of them did consult and negotiate with their neighbour in developing a second bid.

This 'two stage' format was efficient in that there were incentives for individual behaviour that led to group outcomes. A key advantage of the 'two stage' format is that it allows a large number of potential corridors to be identified (thus enhancing the competitive process). Another key advantage is that there is more competitive pressure on individual participants (leading to more cost-efficient bids).

The average relative bid prices for the different corridor bidding formats at the two workshops are presented in Figure 3. The lowest relative bid values represented the best value for money. The influence of two individual bidders at Barcaldine was strong, and once removed the results from Barcaldine appeared similar to those at Jericho. The

relative values of the group bids were higher than those for the two-stage bidding process, implying that additional transaction costs might be incurred in dealing with a neighbour. However, T-tests were conducted between the different formats and workshops, indicating that there was no significant difference in the results (Windle *et al.* 2005a).

Figure 3. Average relative bid values for corridor formation at Barcaldine and Jericho



Differences between the corridor formation processes are more apparent when only winning bids are compared. Details from Barcaldine of the corridor bids from three group (combination of four individuals working together) bids and the top three two-stage (combination of four individuals bidding independently) corridor bids, are presented in Table 1.

Table 1. A comparison of successful corridor formation bids at Barcaldine

Bidding format	Bid amount ($/year)	$/acre	Biodiversity score*	Area of Corridor (acres)	Biodiversity and corridor score* (BS*CS)	Relative bid value $/(BS*CS)
Group 1	23682	0.43	117697	55150	110340	0.215
Group 2	17977	0.70	96050	25625	80442	0.223
Group 3	24032	0.86	104355	27950	104355	0.230
2 stage	13306	0.41	119193	32450	108763	0.122
2 stage	12887	0.41	115728	31250	105601	0.122
2 stage	37954	0.82	179726	46200	146027	0.260

* details of how the biodiversity and corridor scores were assessed are presented in Windle *et al.* (2004)

There is little different in the average relative bid values in the group bidding format, whereas in the two-stage format the first two combinations had a significantly lower relative bid values than the third. If the wining bid combination from each group is

compared, the relative value of the group bid is significantly higher than the two-stage combination (T statistic:-2.791; d o f = 6). The value of the group bid was nearly double that of the winning two-stage combination. This confirms that there are significant cost efficiencies in adopting an individual bidding approach to corridor formation.

Potential disadvantages of the individual bidding approach are that it may be more difficult to encourage participation, and there may be higher transaction and administration costs associated with multiple auction rounds. These issues are explored further below.

(d) Transaction and administration cost issues

Transaction and administration costs associated with a corridor auction mechanism may be high. This is because of very limited knowledge and familiarity about these mechanisms by landholders, and because of reluctance to be engaged in something novel. Transaction costs can be expected to include the costs that landholders face in gaining knowledge about the bidding process, preparing bids and monitoring successful contracts. There is potential for transaction costs to be minimized in a number of ways. These include having high quality information and learning processes, and simple auction and contract design processes that maximize participation. The difficulty is that transaction costs may be offsetting with both administration costs and efficiency gains; transaction costs can be reduced, but only at the expense of high administration costs and/or moves away from the most efficient forms of auction and contract design. The extent of these tradeoffs have not been assessed in this project, apart from identifying that they are substantial issues.

Some indirect evidence about the size of transaction costs involved in bidding processes came from a regression analysis of the bids in the individual bidding rounds across the two workshops (Table 2).

Table 2. Predictors of bid value in individual rounds at main workshops

Coefficients	Coefficent	Std. Error	Significance
Constant	-17793.26	3657.38	.000
Gidgee scrub (acres)	11.62	2.21	.000
Box (acres)	2.77	.86	.005
Broadleaf Ironbark (acres)	-.06	.67	.931
Yellowjacket (acres)	-.11	.31	.727
Cleared (acres)	5.31	.52	.000
Enterprise size (dummy)	3549.27	1091.21	.004
% of property developed	-331.48	116.88	.011
Interested in being paid by govt (dummy)	8355.42	1684.95	.000
BID ROUND	-2814.92	427.07	.000

Dependent Variable: Bid amount
Model fit: Adjusted R square = .973

The model shows that the areas of the three most productive country types (cleared, Gidgee and Box) are very important, but areas of Ironbark and Yellowjacket were not. The coefficients for vegetation type show that respondents wanted on average: $11.62 for each acre of Gidgee, $2.77 for each acre of Box, and $5.31 for each acre of cleared country that was involved.

The model results also indicate that:

- bids are strongly influenced by factors apart from the areas of vegetation involved,
- bids are positively linked with enterprise size (participants from smaller properties tended to make more competitive bids),
- bids are negatively linked to development level (indicating that landholders on more developed properties have less to offer – and perhaps don't need the money as much), and
- bids are linked to interested in being paid by government for ecosystem services (those not interested would need to be paid more money).

The model is very significant (Adjusted r-square = .973) but there is a very large constant, indicating that other variables not in the model may also be important. The dominance of factors other than vegetation type in the model suggests that a number of factors not related to opportunity costs are driving bid formation, indicating that high transaction costs are associated with these bids. It is possible that the substantial efficiencies shown for multiple bidding rounds was associated with the reduction in transaction costs as participants became more familiar with the auction process.

(e) Participation rates

Low participation rates are a key issue to be addressed in a corridor design, because the formation of a corridor will depend on reasonably high levels of participation in the region of interest. It is anticipated that at least 50% of landholders would need to be involved in an area before a bidding process could operate. Feedback from landholders in the project steering committee and the results of the workshops (eg high bid levels) suggested that participation is a key issue to address.

One mechanism to use for encouraging participation is direct incentives. For example, landholders could receive bid payments for lodging a bid, so as to meet the opportunity costs of preparing the submission. There may also be other rewards, such as the provision of property maps.

Another mechanism to employ is to develop a trust relationship that encourages participation. There was strong anecdotal evidence from the workshops that landholders were uncomfortable dealing with government, and that an independent body, such as an NRM group, was more appropriate. Other ways of developing a trust relationship include the use of facilitators, and encouragement of joint bid submission. The latter might

involve a hybrid between the group corridor bid and the individual two-stage format, where landholders might be encouraged to put in small group bids as part of an individual two-stage process. This would mean that a number of small group bids might be submitted, and could be encouraged through additional bid lodgement payments.

An important way of encouraging participation is to have a simple and transparent process. The simplicity issue was addressed in three key ways in the experimental auction process: metrics (discussed in the section below), management actions and contract design.

(i) Management actions

For management actions, bid complexity was reduced by specifying a simple management action that landholders could consider. The main condition was that landholders would have to ensure a minimum level of biomass was maintained throughout the year. In a region where extensive grazing is the main land use, maintenance of a threshold level of biomass is likely to be associated with:

- improved levels of ground cover,
- reduced runoff and associated movement of sediments and nutrients,
- continued plant diversity,
- protection of habitat for small biota, and
- habitat for larger biota in periods of climatic variation.

Specifying the management action required meant that all participants were bidding to provide the same service, although they were free to design the area and shape of nominated vegetation on their dummy property. This made bid assessment more manageable in the workshop and allowed the heterogeneity in opportunity costs between landholders to be explored.

The following baseline conditions were outlined for the management of nominated areas on properties:

- *Commitment to retain a certain amount of pasture at the end of the dry season annually – about 1500kg/ha* (Pasture photographs were provided*).*
- *Fire is allowed but the area must be destocked until minimum biomass is reached.*
- *No additional exotic plant species can be introduced deliberately.*

While the choice of a single management action has advantages in terms of simplicity, there are two key reasons why an expanded list of management actions may need to be considered in a real life auction process. The first is that a range of management actions may be needed to allow for heterogeneity in resource use, especially when there is large variation in resource conditions and management activities across a region. These variations tend to expand as a region becomes defined more broadly.

The second reason is that a focus on achieving a single management standard may ignore potential movements to other management standards that landholders may be prepared to make. While there may be substantial benefits in signaling uniform desired resource management standards, there may be net benefits for individual landholders to move to lower or higher levels of resource management, particularly in the short term. A focus on a single management outcome may reduce the number of options that landholders may be prepared to consider in terms of changed management actions, and hence reduce participation rates and the possible number of cost-effective outcomes.

(ii) Contract design

In the workshops, simplicity was also achieved by specifying a contract process that was simple to understand and familiar to landholders. There were three key components of the agreements specified:

- *They would be for a 5 year period with annual payments,*
- *They would be in the form of a contract, and*
- *They would include a monitoring process based on an annual visit, with two weeks notice.*

The length of period was an important issue. If the period is too long, then it may be a major disincentive for landholders to be involved. A shorter period has advantages in terms of making it easier for landholder to 'trial' the mechanism. In cases where only limited opportunity costs are involved and the issue is more about changing behaviour patterns, then a short time period may be all that is necessary. However, if time periods are too short, then the payments to landholders may not cover the transaction costs involved. The five year period was seen as being a good compromise between these objectives.

The annual payment mechanism was chosen to reinforce the message about an annual provision of services, as well as providing leverage for contract compliance. In case where it is important to attract participation and/or to meet capital costs, it is common to have some or all of the payment as an initial lump sum. In the workshops, participants were told that all capital costs involved (for providing fencing and waters) would be met separately. This made an annual payment stream more plausible.

Payments may also be structured with a lump sum at the beginning or end of the contract. The former is to encourage take-up and meet any capital costs involved, while the latter would be to encourage compliance. The optimal structure of payment schedules were not explored in the workshops, and remain a topic for further research.

Contracts were chosen as being the least threatening of an enforceable mechanism. The main options were the use of covenants, or, in the case of leasehold land, some revision of lease conditions. Both have problems in terms of plausibility or acceptability, so simple contracts were chosen. The monitoring system that was presented was a brief

annual visit with 2 weeks notice. These conditions were generally well accepted in the workshops, indicating that the contract details in the workshops were unlikely to be a major deterrent for participants.

Monitoring and enforcement mechanisms may also be a very important part of contract design. In the workshops, participants were told to anticipate an annual visit with 2 weeks notice (and negotiation of assessment date). This was accepted by participants as being realistic. A realistic monitoring mechanism is an important precursor to be able to enforce contract conditions, and, in the workshop scenarios, avoid incentives for strategic behaviour. As well, there is expected to be a close relationship between the metric used for bid assessment and the monitoring conditions.

A key issue with monitoring is to ensure that it occurs at a realistic cost. Annual inspections may be an ideal monitoring condition, but could be very expensive, particularly when detailed site inspections are involved. It may be more cost-effective to focus monitoring on a small number of key attributes, base most monitoring on remote sensing data, and have a small number of random inspections to encourage compliance. The monitoring approaches employed by the Australian Tax Office provides some guidance to the most cost-effective options available.

(f) The choice of metrics

There do not appear to be suitable metrics available for evaluating corridor bids. Two metrics have been developed in the course of the project. One was a very simple metric which was used in the workshop process, while the other was a technical design that can be used to evaluate bids very precisely. Complicated metrics have disadvantages in terms of assessment costs, complexity and reduced transparency. In the Desert Uplands where biodiversity issues are not critical, it may be advantageous to choose a simpler metric. Both the simple and technical index can be used to assess landscape linkage options across the southern Desert Uplands taking into account both the biodiversity and landscape linkage values of possible vegetation connections across a bioregion.

There are three broad components of a metric: the biodiversity score, the management actions and the corridor score. In this case study, the use of a specified management action has avoided the need to have a separate score for this issue, reducing the metric to a biodiversity score and a corridor score. A key question in the development of the metric is how these two functions should be related.

The first option is to multiply the biodiversity score by the corridor score. This achieves a corridor only result, as any bids that do not contribute significantly to a corridor option would be severely downgraded. The second option is to make the scores additive, which is essentially a 'biodiversity hotspot plus corridor' option. In this case, sites might rate highly if they hold significant biodiversity and/or if they contribute to a corridor option.

The second option has some attractiveness in terms of appealing to landholders and encouraging participation rates. It means that a landholder might be successful if they

place a cost-effective bid for biodiversity protection even if they are not part of a winning corridor. However, the mechanism is more cumbersome to use and requires an allocation of weights between the two scores to reflect the importance of a corridor over simple biodiversity protection. For these reasons, a multiplicative form of the metric has been used in this project.

(i) Technical metric

For the technical option, a Total Biodiversity Index is proposed that is a combination of Biodiversity Benefits Indexes for individual bids on properties and an overall Landscape Linkage Index (McCosker and Rolfe 2004). The type of Biodiversity Benefits Index proposed for the assessment of individual property bid areas is a modification and simplification of those developed in Victoria and New South Wales. The proposed index covers the conservation significance, the vegetation condition and landscape context for each individual property contribution.

The Biodiversity Benefits Index for each property bid area can be calculated by using the following formula

$$BBI = Biodiversity\ Significance\ Score \times Land\ Use\ Change\ Score \times ha$$
$$= (CSt_0 + LC)VCt_0/200 \quad x((CS\ t_n - CS\ t_0) + (VCt_n - VCt_0))/2 \times ha$$

where: CSt_0 = Initial Conservation Significance
CSt_n = Potential Conservation Significance*
LC = Landscape Context
VCt_0 = Current Vegetation Condition
VCt_n = Potential Vegetation Condition*
Ha = Area

* In this case the emphasis is on maintaining current conditions and so the "potential" rating is the same as the "current" rating.

The conservation significance will be determined from the Biodiversity Planning Assessment (BPA) completed by the Environmental Protection Agency.

It is proposed to ascertain the average vegetation condition of the bid by determining the pasture biomass (kg/ha), the percentage of bare ground, the percentage of buffel (introduced) grass and the ratio of perennial grasses to annual grasses. This vegetation condition assessment should be linked to the ABCD framework that is currently in use in the Grazing Land Management guidelines used to quantify natural resource health.

The vegetation site condition (Landscape Context) would be indicative of the average condition for the bid area. A simplified Biodiversity Benefits Index is appropriate in this case where the focus is on maintaining or improving existing conditions. In bid areas that include regrowth a record of the average height and density of the regrowth needs to be measured as well. The vegetation site condition assessment should also record the area of

each vegetation type and the distance from artificial water where over 50% of the bid area lies.

In the short-term, an agreement will only result in measurable change/ maintenance in the understorey component – species composition, ground cover and biomass. This means that a monitoring process might focus on those outcomes, or a metric focused on assessing potential outcomes might concentrate on those items.

The assessment of the corridor function can be measured by a Landscape Linkage Significance Index (LLS) which incorporates the average percentage of five key measures namely:

i. The percentage of the whole distance east-west that the landscape link covers via undeveloped vegetation,
ii. The percentage of the linkage area in core areas,
iii. The percentage of the core areas within the landscape link cover with an area to perimeter ratio greater than 20:1,
iv. The percentage of interlinking strips in the landscape link with a length to width ratio of at least 5:1 between core areas, and
v. The percentage of the number of regional ecosystems that landscape link covers.

The Total Biodiversity Index (TBI) for a corridor is established by multiplying the Biodiversity Benefits Index by the Landscape Linkage Score:
$= \Sigma BBI$ for each nominated property bid area in a corridor option x *LLS*

The total cost of each corridor option can be identified by summing the nominated bids for all property bids that are included in a corridor option*: Total Bids* $= \Sigma$ *Bids.* The cost-effectiveness of each corridor option is identified by dividing the Total Biodiversity Index by Total Bids: = *TBI/Total bids*.

(ii) Simple metric

For the bids in the experimental workshop, a more simplified metric was used. A version of this may also be appropriate in a 'live' application. There were two main components in the simple metric; the biodiversity score and the corridor score[1].

The biodiversity score was calculated for each property by five main vegetation types or classifications. Weights were assigned to each vegetation type, based on relative scarcity in the region (Table 3). General estimates (inversed) were made of the percentage of each broad vegetation type that remain in the Desert Uplands area. For example, a rating of 10 for Brigalow/Gidgee means that there is about 90% cleared in the region (the real figure is in the high 80% range), while a figure of 5 for Box means that about 80% has been cleared (the real figure is probably slightly lower). A weighting of 0.5 was adopted for cleared country to identify that while it has some value for conservation purposes

[1] An endowment score was also used in the experimental workshops to adjust bids for the size of the dummy property allocated to participants.

(perhaps to allow regrowth in connecting strips), it has a much lower benefit than the vegetated areas.

Table 3. Weightings for different vegetation types in the biodiversity index

Vegetation type	% cleared	% remaining	Weight (Inverse of % remaining)
Brigalow/ Gidgee	90	10	10
Box	80	20	5
Silver-leaf ironbark	60	40	2.5
Yellowjacket	30	70	1.5
Cleared land			0.5

The biodiversity score was assessed by adding the relative contribution of each vegetation type.

*Biodiversity Score (BS) = Brigalow area *10 + Box area * 5 + Ironbark area * 2.5 + Yellowjacket area * 1.5 + cleared area * 0.5*

The corridor score related to the percentage of east-west linkage in the offered bid area on the property. In effect, relative bid values were not altered if the offered bid area formed a corridor across the property, but were reduced if the bid area did not form a corridor. For example, if a submitted bid only represented 80% of a corridor linkage, the relative bid value was reduced accordingly.

Corridor score (CS) = percentage of corridor across the property

The relative value of the bids was assessed in the following stages:

1. Assess the biodiversity score (BS),
2. Include the corridor score adjustment (BS*CS), and
3. Assess relative bid value ([BS*CS]/$ bid offer).

(g) The experimental workshop game

The experimental workshop game that was developed for this project has key benefits in terms of showing landholders, regional body staff, agency staff and other stakeholders how an environmental auction works in a hands-on manner. The workshop results also help to identify the key factors that drive landholder bids, and allow the potential supply of environmental services to be modelled.

The 12 dummy property game can be used in a workshop scenario lasting 2-3 hours to introduce the concept to landholders. The workshop format demonstrated how a bidding game can be used with landholders to show how a competitive tender system might work and encourage participation. Because the game is ‘hands-on’, participants learn more

quickly and are more inclined to be interested than if the information was simply presented to them. As well, participants are introduced to methods for calculating the cost of implementing management changes, which then helps them in the bid formation process.

The results of the workshops showed that substantial learning effects occurred as participants moved through the bidding rounds, implying that in a real application, participants need to be familiar with the issues and the auction design to generate efficient bids. The use of this type of workshop is a very efficient process to familiarise landholders with the issues involved in competitive tenders and bid information before a 'live' auction is conducted. The workshops familiarises landholders with the process, and identifies the monetary tradeoffs associated with setting aside conservation blocks.

It is recommended that the game be developed as an awareness/information tool to be used in the application of any corridor conservation option.

Recommendations for a corridor auction process

The key recommendations for developing a corridor conservation auction process are as follows.

1. **The focus should be on a linkage zone rather than a traditional corridor**

It is anticipated that in order to avoid holdouts and excessive/unrealistic bids that total linkage via adjacent blocks across the bioregion should not be the desired outcome. It is more realistic to focus on a series of 'stepping stones' or varied linkage components. Gaps in a corridor may potentially be filled by future funded schemes. This change in desired outcome results in less risk of investment and allows landholders to warm to the concept over a longer time frame. It means that if a corridor is not available from submitted bids, that strategic 'stepping stones' and other elements of a linkage zone may still be selected as a key outcome. Where key stepping stones exist, then relatively narrow corridors may suffice to join them. It also means that if participation rates are low, it may be feasible to select the key stepping stones as a first stage in the corridor formation process.

The focus on a flexible linkage concept has implications for both the selection metric and the auction process. The selection metric needs to be capable of evaluating strategic options, including a corridor option compared to strategic stepping stones. This form of a complex metric has not been developed for this project, but is recommended in a full scale trial.

The use of a discriminate bidding process (as trialed in these workshops) may be problematic if applied for successive auctions. Successive auctions may be necessary to form a corridor if key 'stepping stones' are accepted first, and then subsequent auctions are used to fill in gaps. The use of successive auctions will increase incentives for holdout bids. To minimize these problems, it may be appropriate to maximize the time between different auction rounds, and to move to uniform pricing rather than discriminate

pricing. These options have not been addressed in this project, and remain topics for further research work.

2. Protection of biodiversity hotspots together with a linkage zone

It is desirable to run a landscape linkage program in conjunction with a biodiversity protection (hotspot) scheme. The reasons for this are:

(a) it allows the scheme to be marketed to all landholders,
(b) it maximises the expressions of interests that might be submitted,
(c) it disguises the amount of money that might be allocated for the corridor component of a project,
(d) it allows for extra vegetation to be added to corridors where strategic blocks are available,
(e) it gives a rationale for protecting key blocks of vegetation that might form corridor stepping stones if sufficient bids are not registered for a corridor.

These form powerful reasons for running what would be effectively multiple-outcome auctions. The key advantage is that if there are not enough bids for a full corridor to be formed, there is still a rationale for protecting biodiversity in the region of interest. The key disadavantages of this approach are that it increases complexity, adds to metric design and auction design issues, and may increase the level of scheme funding required.

3. Landholders need assistance to encourage participation

Low participation rates are a key potential problem. Landholders may need to receive direct incentives for entering into the bidding process, perhaps in the form of incentive payments. They may also need some technical assistance to develop their bid in terms of understanding a) what biodiversity values exist on their property, b) how conservation areas should be left, c) what the production losses of the bid area are and d) what management actions are required over the bid area.

4. A simple but robust metric needs to be developed

A simple metric has key advantages in terms of being transparent to potential bidders and being more efficient to assess and analyse. This may be very important in an auction process where a slow assessment process impacts on the speed of the auction. Where multiple rounds are being conducted, a swift assessment process is important. Consideration should be given to focusing the assessment (and monitoring) on remote sensing data.

Where the focus of conservation is on protecting a sample of existing vegetation, then a highly accurate metric is not required. An additive form of metric is needed to assess a 'hotspots plus corridor' program.

5. A multiple bidding round design with sealed bids should be used

The use of a two or three bidding round auction will generate much more cost-effective bids and is recommended. A multi-round auction does increase administration and transaction costs, so a process needs to be developed to minimise these. The use of a simple metric, remote sensing data and an electronic bidding system may minimise

transaction costs, while the development of a program website and use of a coordinator may help to minimise landholder transaction costs.

Coordination of bids can occur through the provision of information about bid location (through a website or mailout). Allowing bids to remain live across rounds will reduce the requirements on participants while encouraging extra bids to be submitted.

6. **The contract design should be kept as simple as possible.**

Key options for making a process simple are to standardise the potential management actions and contract options as much as possible. This makes the process more transparent and simplifies the metrics. In regions where there is more diversity in agricultural activities a wider group of management actions and contract options may have to be considered.

Annual payments for the life of the contract are recommended to encourage compliance. Payments should be linked to delivery of natural resource condition outcomes. In this case study monitoring of understorey attributes only is recommended at the end of every dry season. Monitoring can occur by remote assessment or a brief site inspection.

7. **Steps recommended for a corridor auction process**

Step 1. Project preparation: Appointment and training of staff and project steering committee. Development and preparation of project information, i.e. communication strategy, assessment process and contract details. If appropriate, web-based tool for bid submission and assessment may be developed. **Six months**

Step 2. Awareness program: Conduct workshops (experimental workshop game) with landholders to familiarise them with process and gauge interest. Conduct awareness program. **Three months**

Step 3. Open tender - First round: Call for expressions of interest/ preliminary bids. Provide feedback to participants (location of neighbouring bids, information about bid competitiveness), desktop assessment of expressions of interest, property inspections where appropriate. **Two months**

Step 4. Second round - Call for revised bids: More feedback on bid success. Mentor actively promotes and provides the availability of support to develop bid(s). Bid development stage. **One month**

Step 5. Selection of bids: Closure of bids – final assessment of bids – **One week**

Step 6. Contract finalization: Contact all successful bidders and write contractual agreements. Set out monitoring and payment schedules. Publicly announce and document results. **Two months**

Step 7. **Implementation:** Monitoring, reporting and annual audit. Complete all contracts. **Ongoing**

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