Assessing the incentives needed to improve riparian management in grazing systems: Comparing experimental auctions and choice modelling approaches

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Abstract

The Fitzroy basin in central Queensland is the largest basin in the Great Barrier Reef catchment area. The large quantities of sediment and nutrient export are of concern and come predominantly from diffuse sources in the grazing industry. The focus of the research reported in this paper was on the potential supply of mitigation actions from this group. This potential supply is very difficult to establish ex ante. However, such information may be crucial to the design of a quantity-based mechanism that requires supply of mitigation actions. In this study, the use of a stated preference technique called "choice modelling" and an experimental economics technique termed "experimental auctions" were applied to ascertain potential supply relationships.

Keywords: **Water quality mitigation, diffuse sources, choice modelling, experimental auctions**.

Paper presented at the 50th Annual Conference of the Australian Agricultural and Resource Economics, Sydney, 7 – 10th of February, 2006.

Introduction

The impact of agriculture on water quality in freshwater and marine water resources in Australia has become an important issue. There are significant levels of public funding committed to programs such as the *National Action Plan for Salinity and Water Quality*, and there is potential for further funding required to implement programs such as the *Reef Water Quality Protection Plan* (a joint initiative of the Australian and Queensland Governments). A key element of these programs is that they are largely focused on water quality issues where agriculture is a key contributor to impacts (SQCA 2003). It follows that engagement with agriculture is likely to be crucial to any attempts to improve water quality or to arrest further declines.

Despite the level of investment and activity, engagement with landholders remains very low. For example, Lockie and Rockloff (2004) report that only one or two percent of landholders in Great Barrier Reef (GBR) catchments have been engaged with many programs to improve water quality and wetlands management. There is increased interest in trialing better incentive mechanisms to engage with landholders, including a range of market-based instruments. These have potential advantages over simpler incentives such as devolved grants because they have more ability to focus on the environmental outputs of interest and because they generate incentives for landholders to find better ways of meeting environmental targets.

Given current political and institutional settings in Australia, landholders are most likely to be engaged in market based instruments that give them positive incentives to supply mitigation actions. Landholders might be involved in price-based mechanisms such as competitive tenders, or as suppliers of mitigation actions in offset programs or cap-and-trade arrangements. In each of these cases, landholders might be responding to financial incentives to supply water quality improvements, perhaps above some minimum standards of property management.

A key issue in understanding the potential application of MBIs to water quality issues is the tradeoffs that landholders might face in supplying mitigation actions. There has been some debate over factors that influence adoption rates for sustainable land management practices (Fenton, MacGregor and Cary 2000, Curtis and Robertson 2003, Lockie and Rockloff 2004, Herr, Greiner and Stoeckl 2005). Results of studies focused on GBR catchments by Lockie and Rockloff (2004) and Herr et al. (2005) suggest that financial profitability remains a key driver for landholders. Agricultural producers will adopt new practices where these lead to improved production outcomes, but are less likely to adopt practices that are focused mainly on improved ecological conditions. There is evidence that the socio-economic background of landholders as well as attitudes influences adoption rates (Herr et al. 2005, Lockie and Rockloff 2004). There is also evidence that the type of mechanism design is important (Lockie and Rockloff 2004) and that considerations about risks and uncertainties can influence adoption rates (Herr et al. 2005).

The research reported in this paper has focused the tradeoffs that landholders in the Fitzroy catchment of the GBR intake area might consider in relation to supply of water quality mitigation actions. The use of two potential mechanisms to assess tradeoffs was tested with landholders in relation to supplying riparian protection actions. One mechanism was an experimental auction process where landholders submitted competitive bids in a workshop to supply mitigation actions. The other mechanism was the choice modeling technique, where landholders were asked to indicate their preferred choice from alternative supply strategies.

This paper is structured as follows. A brief overview of the background economic issues is provided in the next section, followed by a description of the case study site. The choice modeling study is reviewed in section four, and the experimental auction in section five. Final conclusions are drawn in section six.

2. Background economic issues.

The supply of mitigation actions and reduction strategies can be used to reduce pollution problems. However, the private incentives to provide these actions are typically lower than the social benefits that are generated, leading to undersupply. There is a role for government to correct this market failure. The use of competitive tender mechanisms can allocate public funding to increasing supply of water quality improvement actions (Latacz-Lohmann and Van der Hamsvoort 1997). The design of quantity-based trading mechanisms can allocate private funding for the same purpose. In both cases, the marginal net private benefits of supplying water quality improvement actions should increase, narrowing the difference between the marginal net private benefits and the marginal net social benefits of supply activities.

A difficulty for policy makers seeking to improve water quality is that they are often working without information about the costs and benefits of introducing improvement actions. The key information that is typically required is the private marginal costs of supplying improvement actions, and the marginal public benefits of achieving better water quality. The focus of this paper is the estimation of the private costs associated with the supply of water quality improvement actions.

Different economic tools are available to assess the potential costs of supplying different water quality actions. Farm production models can be used to assess the financial implications of different management actions. However, the effectiveness of these may be limited in relation to water quality improvements. This is because production models often do not account for heterogeneity between landholders, or include a number of non-financial factors that may drive landholder decisions.

Alternatives to modeling production enterprises are to ask landholders to state directly what their costs of potential supply might be, or to have them reveal the information though some form of an experiment. Stated preference techniques such as the contingent valuation method (Mitchell and Carson 1989) and choice modeling (Bennett and Blamey 2001) have been developed to assess stated preferences, while experimental economic techniques have been developed to assess in laboratory settings the types of tradeoffs that people might make.

Choice modeling is a stated preference valuation technique which has often been employed to estimate values for environmental tradeoffs (Bennett and Blamey 2001). The technique is adaptable for different purposes, and there is an emerging literature on the use of these conjoint-based mechanisms to analyse the potential supply of agricultural products or services (Lusk and Hudson 2004). In this project, the latter approach was followed, where choice modeling was employed to predict the tradeoffs that a landholder might consider when assessing the potential to supply mitigation actions (Rolfe, Alam, Windle and Whitten 2004).

There were two main reasons why it was appropriate to use a stated preference approach. The first was that because mitigation actions were not currently supplied in a market setting, some mechanism or tool to predict supply ex ante was needed. Choice modeling has strengths due to its flexibility in presenting landholders with tailored alternatives (Lusk and Hudson 2005). The second reason for nominating choice modeling is that this had more potential to identify differences in payment levels between individuals, expected because of variations in production systems, variations in individual characteristics, and differences in potential mechanism design. Allowing potential participants to 'state' the tradeoffs that they would consider had potential to be more accurate than a reliance on farm production models.

There are very limited applications of choice modeling (CM) to assess the potential supply of landholder actions, as the technique is more typically used to assess the demands of communities for environmental or social conditions. Windle and Rolfe (2005) report the use of CM to assess preferences of sugar cane farmers in central Queensland for diversification options. Lusk and Hudson (2004) reviewed the potential of stated preference techniques, including CM, to assess the supply by landholders for agricultural products. An application of CM to assess preferences for the supply of water quality actions is an extension of the type of analysis reported by Lusk and Hudson (2004) and Windle and Rolfe (2005). In those applications, landholders to indicate their preferred choice about different production options where the amount of potential income was an attribute of the choice set.

In an application of CM to water quality improvement actions, landholders could be asked to indicate their preferred choice between actions where the amount of potential income is an attribute of the choice set. However, it is challenging to define a standard set of actions that landholders might receive compensation for. In a typical stated preference experiment, a number of respondents are asked about their willingness to pay for a defined alternative. In dealing with potential water quality mitigation actions, the alternative to be supplied might vary between each landholder because of heterogeneity between properties. This variation in potential supply has to be accounted for in the design of the choice experiment.

Experimental economics is a mature field within the economics discipline, and there are a number of applications of experimental procedures to assess the potential supply of services or products in trading situations (Roth 2002). They can be also be used to test some of the design issues in competitive tenders that have been outlined by Klemperer (2002). Experiments typically take place in laboratory settings under very controlled procedures with the use of students or members of the public as participants (e.g. Cason, Gangadharan and Duke 2003).

The challenge in this project was to use experimental procedures to assess the potential supply of mitigation actions where the actions could not be defined as tightly as in a laboratory setting. Experimental economic procedures typically involve participants purchasing clearly defined items or services (single auctions) or purchasing and selling items or services (double auctions). In this case the situation to be modeled would involve participants selling a service where each participant may need to define the specific service.

Rolfe, McCosker Windle,and Whitten (2004) outline an experimental workshop approach to assess the likely behaviour of landholders to conservation tender schemes. These differ from laboratory experiments in that they are not as tightly controlled and do not extend over large numbers of bidding rounds. They do involve landholders and models of production enterprises, and so provide an alternative mechanism to assess the tradeoffs that landholders might face in adopting changed management practices. This has benefits in situations where there may be a number of non-productive factors that influence landholder choices. Production models, and experiments that rely on production models, may not be sufficiently robust to capture the full extent of incentives that are needed to change behaviour. The experimental workshops allowed landholders to state the tradeoffs that would be required, and thus did not involve as much prior modeling as a laboratory experiment would have done.

3. Case study description

The case study of interest was the management of riparian areas by landholders in the Fitzroy Basin. The basin drains an area of approximately 142,645 km^2 (approximately 10 percent of Queensland's land area) into the Great Barrier Reef (GBR) lagoon and is the largest of the river basins in the GBR catchment. In terms of area, rangeland grazing is the principal land use, covering 87.5% of the basin area and 94% of the area used for agriculture (Furnas 2003). As it occupies such a large area in the basin, it is the land use which has the most impact on water quality, and offers the most opportunity for providing mitigating actions.

Grazing activities are responsible for sediment and nutrient (nitrogen and phosphorus) emissions into waterways (Furnas 2003). While there are a number of management actions that can be used to minimize these emissions, the key actions relate to improvements in ground cover and management of riparian areas. The identification of appropriate standards, measurement and monitoring issues, and dealing with climate and ecosystem variability make ground cover standards a complex target to address. Management of riparian areas tends to be simpler because it often involves measures such as the exclusion of stock for limited time periods and the setting of minimum standards for pasture biomass.

While there is broad agreement about the types of management changes required to reduce adverse impacts on water quality, there is much less agreement about the impact of specific operations on water quality, the extent of management change needed, and the appropriate mechanisms to achieve that. Developments in the modeling of grazing enterprises and farming enterprises (e.g. McLeod et al. 2003) have helped to develop some of the linkages between management practices, production tradeoffs, and exports of suspended sediments. However, further work is needed to extend this modeling across different enterprise and land types in the Fitzroy.

While an understanding of direct production tradeoffs associated with management changes is valuable, the production model approach may not fully capture the diversity and range of opportunity costs involved. This is because those tradeoffs may vary substantially across individuals and enterprises, and because production models may not include the full range of opportunity and transaction costs that landholders consider when evaluating management changes. Surveys of landholders in GBR catchments focused on adoption of best management practices have been reported by Lockie and Rockloff (2004) and Herr et al. (2005). These confirm that while production tradeoffs are an issue of primary concern to landholders, there are a range of other factors that influence adoption rates. A simple focus on production tradeoffs will not adequately capture the incentives that landholders need to change behaviour.

In this paper, the use of choice modeling and experimental auctions to assess the full opportunity costs to landholders of changing management practices is reported. To simplify the task, the research has focused on the management of riparian areas by cattle graziers. Generic management actions of limited livestock exclusion and the maintenance of minimum biomass conditions have been chosen as the potential landholder initiatives of interest. The relevance of these measures to water quality improvements in the Fitzroy have been reviewed by Rolfe, Alam and Windle (2004).

Although the analytical task of estimating real opportunity costs of changing management practices was simplified by the selection of a discrete agricultural sector and management target, the case study application remained complex. One reason was that there is substantial diversity of riparian areas within the Fitzroy, which made it hard to identify generic impacts. For example, some of the key areas where management of riparian areas might have different opportunity cost implications across the Fitzroy included:

- There are a range of different stream orders involved, from small gullies that only carry water after rain to major river systems,
- Riparian areas can range from narrow streams with high banks to extensive braided systems that may be several kilometers wide,
- The areas range in soil type, productive capacity and level of pasture development,
- Some riparian areas are already fenced and have off-stream watering points, while others remain incorporated into major paddocks,
- It is not practical to fence some riparian areas where there are high-velocity floods,
- The standard of ground cover and biomass varies according to a range of natural and management factors.

These factors mean that riparian management and tradeoffs are likely to vary between each property, making it difficult to define standard policy alternatives for each participant to consider in a choice experiment. There are also problems of asymmetric information. Typically the landholder has the information about the riparian areas of interest, so an analyst wishing to compare policy alternatives needs to collect that information from each landholder.

Another issue which complicates the assessment of the opportunity costs of changed management actions is the identification of the necessary change. Economic theory suggests that MBIs will be more efficient when the incentives for landholders are related directly to the level of desired outcomes. Where improvements in water quality are being sought, these desired outcomes might be reductions in the exports of sediments and nutrients. However, the difficulties and costs of measuring and monitoring such changes mean that it is more practical to focus on input measures, such as stock exclusions and minimum levels of pasture biomass. These are more directly related to management outcomes, and are easier to measure and monitor.

The challenge of the research task was to apply the choice modeling and experimental auction techniques to these real-world situations where issues of complexity, limited knowledge and asymmetric information are major constraints.

4. The application of the Choice Modelling technique

Choice modeling operates by providing people in a questionnaire format with a series of choice tasks that represent the situation of interest (Rolfe, Bennett and Louviere 2000, Bennett and Blamey 2001). Respondents have to indicate their preferred choice in each of the choice sets, where the choice alternatives in each set are described by a common set of attributes. Each attribute can be represented by several different levels, so variation in the levels provides differences between the choice alternatives. One of the attributes is typically a payment mechanism, and the subsequent analysis of choice data allows tradeoffs to be identified between marginal changes in the payment requirements and marginal changes in the other variables.

The challenge in this case study was to frame the choice alternatives to landholders where there was asymmetric information about riparian management issues. It was difficult to define a constant set of alternatives for each respondent because of heterogeneity between properties. For example, a 50 metre buffer strip may have little impact on a property owner that has a narrow stream along one boundary, but would have a major impact on another property owner that has an extensive braided channel system running through the property. A detailed review of a number of the design issues is provided in Rolfe, Alam, Windle and Whitten (2004).

A pilot study with landholders in the Fitzroy basin explored issues of asymmetric information involved with the definition of riparian areas (Rolfe, Alam, Windle and Whitten 2004). In the pilot study, landholders were asked to provide followup information for each choice set so the specific riparian service being offered could be defined in each case. The collection of this level of information proved too complex for landholders to complete accurately (Windle, Rolfe, Whitten and Alam 2005), necessitating the adoption of a simpler frame for the survey. Here, the rationale for the design of the experiment is provided in relation to the framing of the choice sets, the framing of the payment mechanism, and the selection of the attributes and levels.

Framing the choice sets
To minimize issues of asymmetric information, the design task was to make a number of factors consistent across respondents and choice sets. This was done in a number of ways. First, respondents were asked to select a two kilometer section of waterway on their property that they would consider first if asked to better manage riparian areas. This established a consistent length of waterways across respondents.

Second, respondents were asked to provide details of the two-kilometer length of stream that they had selected. The information collected related to the physical characteristics such as stream order, country type and level of development, as well as management consequences, such as the need for fencing and artificial watering points. This addressed many of the issues of asymmetric information, allowing the supply options to be better compared between respondents in the subsequent evaluation.

Third, a standard set of management conditions and institutional arrangements were described for the potential purchase of environmental services. It was explained to the landholders participating that the aim of the survey was to identify the incentives needed to engage them in additional riparian management activities.

Fourth, other information about landholders was collected in a separate survey designed for this purpose. The type of information collected included socio-demographic data, general attitudinal data about land management and environmental factors, and more specific attitudinal data about incentive mechanisms and potential institutional arrangements. The collection of this data separately allowed the choice sets to be administered as a single exercise.

Framing of the payment mechanism

With stated preference techniques, the choices respondents face can be framed in either willingness to pay (WTP) or willingness to accept (WTA) formats. This means that in the case of riparian buffer management, landholders' preference for riparian buffer rehabilitation can be measured in two ways:

i) estimating landholders' WTP to avoid an obligation to rehabilitate and manage riparian buffers; and
ii) estimating landholders' WTA direct incentives for rehabilitating and managing riparian buffers.

For this study, the WTA format was adopted. This is because it would have been very difficult to frame a WTP scenario to landholders, given the current institutional structure and perceptions about property rights. It is expected that landholders will face some uncertainty in assessing the values of providing riparian buffers, which may lead to higher WTA estimates. However, this is a 'real world' condition, so the WTA format will be reflecting the levels of payment that landholders might need to enter into voluntary agreements. As landholders become more familiar with the supply of riparian buffers, their WTA bids may reduce.

Selection of attributes and levels

There are a wide range of potential attributes that can be used to describe riparian management alternatives. These can be summarized as:

- The type and size of the area of riparian vegetation to be managed,
- The management conditions that have to be met, and
- The institutional rules that frame the management agreements and conditions.

A key focus in the design of choice modeling experiments is to limit the complexity of the choice task and to include only the key attributes of interest. Given the importance of financial opportunity costs reported by Lockie and Rockloff (2004) and Herr et al. (2005), it was expected that the key attributes would be related to production tradeoffs, particularly those relating to the extent of the riparian area and some of the management conditions. Although other factors, such as institutional rules, may be important in some instances, they could effectively be controlled by holding them constant across choice sets.

Three attributes were chosen to represent the choice sets: a payment attribute, a buffer width attribute, and a management standard attribute relating to the minimum level of biomass. By having only three attributes, the choice task was made easier, and the number of responses needed to generate models with explanatory power was minimized. These are also the critical attributes from the policy perspective, as buffer width and biomass levels are likely to be major determinants of sediment and nutrient movement, and the payment vehicle is the link to opportunity costs. The description of the attributes and the levels used are provided in Table 1.

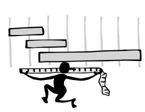
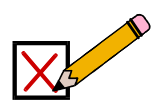
Table. Attribute key used in survey questionnaire and levels applied

Attribute	Base level	Alternative levels
Payment received ($/km/year)	$0	$100, $500, $1000
Width of buffer strip	Current level	10m, 50m, 100m
Minimum grass biomass (at the end of the dry season)	Current level	40%, 50%, 75%

Choice set design

Figure 1. Example choice set

Question 4a: Carefully consider each of the following options. Suppose these were the ONLY ones available, which would you choose?

	Payment received $/km/year	**Width of buffer strip**	**Minimum grass biomass**	**I would choose**
	$			
Option A	***$0***	***Current***	***Current***	☐
Option B	**$100**	**10 metres**	**40%**	☐
Option C	**$1000**	**100 metres**	**75%**	☐

The use of only three alternatives with three levels each meant that the full factorial contained only 27 choice sets. Two orthogonal fractional factorials of nine choice sets each were drawn and randomly paired[1] to create the choice experiments. This meant

[1] Lusk and Norwood (2005) report that valuation estimates from choice modeling experiments are robust to variations in experimental design parameters.

that each choice set contained two alternatives representing potential supply of riparian management actions, as well as a third ‘status quo’ alternative[2]. The presentation of the choice sets is shown in Figure 1.

Collection within a workshop setting

The surveys were administered to landholders in a workshop setting in Rockhampton, Queensland, in April 2005. Two separate workshops were run, with a total of 16 landholders participating. Landholders were drawn from a 120 kilometer radius of Rockhampton. Each workshop lasted for approximately three hours, and landholders were paid $100 for their time involved and their travel costs.

There were four main advantages associated with applying the CM exercise in a workshop format. First, the information that frames the policy context of the CM scenario could presented in an oral and visual format, which for many adults is an easier way of assimilating information than having to read it. Second, participants were able to ask questions and directly clarify any concerns. This allowed more complex tasks to be assigned than could be presented in a standard application. Third, the workshop setting was suited for the collection of different types of information, as required by the asymmetric information problems. Fourth, participants may have more tolerance for tasks in a workshop format where they are working with peers and are compensated for the time involved. It is therefore possible to ask each participant to complete a larger number of choice sets than would be possible in a questionnaire survey.

A further advantage of the workshop setting was that it was possible to run both the choice modelling and the experimental auction applications within a single workshop, facilitating the comparison between these approaches. As well, the collection of other data from participants about their background and their own property information was easier.

Choice modelling results

The choice data from the choice modeling survey was analysed with a multinomial logit model. A summary of the variables used to fit the choice model is shown in Table 2, while the model is reported in Table 3. The model fit is strong, and the attributes are signed as expected. Model coefficients show that respondents were more likely to select alternatives with higher payment levels, and less likely to select alternatives with increases in buffer width or minimum biomass conditions. The model also indicates that respondents with higher levels of education, and those with more extensive clearing on their property, were more likely to choose the status quo option and less likely to select a rebate option. Respondents with larger rivers on their property; those who focused more on environmental outcomes than production outcomes, and those with dependent children, were more likely to select a rebate option.

Table 2. Variables used in CM models

[2] Rolfe and Bennett (2006) note that while fewer alternatives generally reduce choice set complexity, three-alternative sets are preferable to two-alternative sets because the dichotomous formats appear to make respondents insensitive to attribute differences.

Variable	Description
Payment received ($/km/year)	Amount landholders would receive each year
Width of buffer strip	Required width (per km) of riparian buffer to maintain
Minimum grass biomass	Required minimum standard at the end of the dry season.
ASC	Alternative Specific constant which reflects the influence of all other factors on choice
Age of respondents	Measured in years
Education level	Categories 1-5 from primary only (1) to university degree (5)
River order	Categories 1-5 from major gully (1) to major river (5)
Extent of clearing	Categories 1-4 from mostly cleared on both sides (1) to hardly any clearing (4)
Focus between production and environmental goals	Categories 1-5 from focus completely on production (1) to focus completely on environment (5)
Dependent children	Yes (1) No (0)

Relative tradeoffs between attributes can be expressed in terms of part-worths (Rolfe et al. 2000, Bennett and Blamey 2001). Results from this model indicate that the cost per kilometer of providing each metre of buffer width is $3.70, and the cost per kilometer of providing each 1% increase in minimum biomass is $7.91.

Table 3. Multinomial logit model for general CM survey

	Coefficient	Standard Error	Part worth
Payment ($/km/year)	0.0028***	0.0005	
Width of buffer	-0.0104**	0.0040	$3.70 per metre
Minimum biomass level	-0.0226***	0.0084	$7.91 per 1%
Constant	6.9554**	2.8184	
Age of respondent	-0.0068	0.0193	
Education level	-1.9621***	0.5333	
River order	0.2555	0.2353	
Extent of clearing	-1.7134***	0.4260	
Focus between production and environmental goals	1.3387*	0.7825	
Dependent children	3.0950***	0.9990	
Model Statistics			
No Choice Sets	144		
Log L	-96.19325		
Adjusted Rho-square	0.37008		

*** significant at the 1% level; ** significant at the 5% level; * significant at the 1% level

While the choice models provide some information about the tradeoffs involved, they do not take full account of the heterogeneity between riparian areas. In particular, the total area of riparian zones (per kilometer), and the potential cost of capital works for fencing and off-stream waters were not included. In the next stage, the information from landholders was incorporated back into the choice sets to allow a more specific analysis of tradeoffs.

Identification of full tradeoffs

Data collected in the workshops allowed more precise information to be modeled about the type of riparian areas being offered, the capital improvements that were required, and the likely cost of those improvements. For example, respondents were asked about how much had been cleared within 100 metres of the stream bank, whether they had access to both sides of the stream or only one side, and what the country types were.

Information about capital costs was also gathered from direct questions in the workshop. To ensure minimum grass cover levels are maintained in riparian areas, these areas typically need to be fenced so that stock can be excluded, and additional water points may need to be provided. These are the two main capital costs to be incurred. Each landholder was asked to indicate for their identified riparian zone the additional fencing and water points needed, and their estimate of the cost involved. There was an average of 6.9 kilometres of fencing and three off-stream watering points indicated as necessary improvements. There was a considerable range of cost estimates between landholders, from $700/km to $3448/km for fencing (Figure 2) and from $243/km to $15,000/km for watering points (Figure 3).

Figure 2. Fencing costs ($/km)

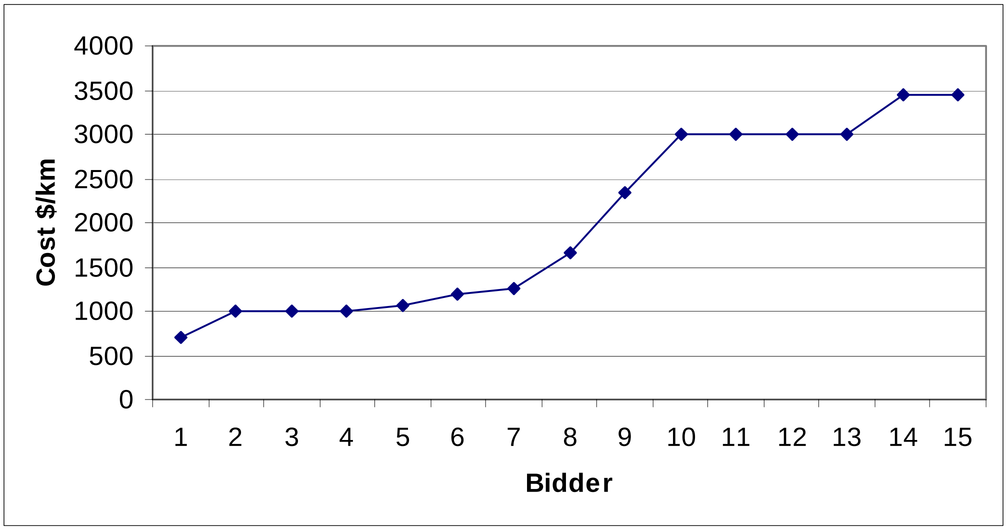
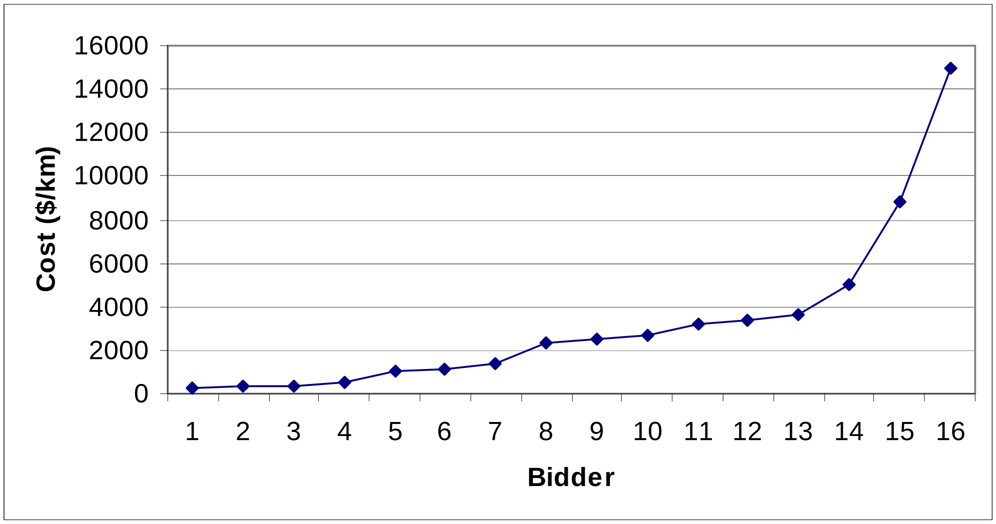


Figure 3. Cost of watering points ($/km)



Additional information was added to the choice sets for each individual in two main ways:

(a) estimates were made for the width of the riparian area nominated by each respondent according to country type and the location of riparian area within each property; the buffer width was then converted to area in each choice set, and

(b) the capital costs nominated by each individual necessary to implement their riparian management areas was amortised over 5 years at a 10% discount rate, and added to the payment levels for the relevant individuals in the choice sets.

The results of this extended analysis are reported in Table 4[3]. There is a high level of model fit, and the non-significance of the constant term suggests that other influences

[3] Note that the experimental design still applies to all respondents, but levels have now been adjusted to better match the tradeoffs they would have considered.

on bid values are slight. Landholders with higher levels of education and more cleared land are less likely to engage in conservation for payment options, while those who have dependent children are more likely to. Results suggest that landholders will require an average of $33/ha to manage riparian areas differently, and $8/km per 1% increase in the level of minimum biomass condition.

Table 4. Multinomial logit model for general CM survey

	Coefficient	**St Error**	**Part worth**
Payment ($/km/year)	0.0031***	0.0004	
Area of buffer	-0.1038**	0.0518	$33.24 per ha
Minimum biomass level	-0.0251***	0.0089	$8.04 per 1%
Constant	3.9706	2.7459	
Education level	-1.0981**	0.5245	
Extent of clearing	-1.0885***	0.4068	
Dependent children	1.5662**	0.6946	
Model Statistics			
No Choice Sets	144		
Log L	-88.41711		
Adjusted Rho-square	0.42718		

*** significant at the 1% level; ** significant at the 5% level;

5. The application of experimental auctions

An experimental auction approach to the prediction of supply functions was also trialed in the same workshops where the choice modeling surveys were collected. Experimental auctions involve a call for 'dummy' bids in a workshop setting for mitigation actions, similar to the operation of conservation tender schemes. The auctions are essentially a hybrid between an experimental economics approach and field trials, as they involve landholders engaged in limited number of hypothetical bidding rounds.

In this project, the experimental auctions were conducted with local landholders who were provided with dummy properties and were asked to indicate on a property map a riparian area that they were prepared to manage in a prescribed manner. They were also asked to enter a bid that reflected the cost to them of altering their management regime and providing the required conservation services. This process was aimed at collecting information that provided more specific insights into the design and operation of a particular MBI mechanism.

There were four different dummy properties designed for the workshop, each with the same attributes, but varied to create apparent differences. Each property map had:

- a large river and a smaller creek indicated on the map,
- an area of braided streams – typical in parts of the Fitzroy basin,
- three main vegetation types: alluvial, box-ironbark, and hill country – each separated into timbered and non-timbered areas,
- fenced paddocks,
- water points, and
- house and yards.

The key advantages of using dummy properties is that landholders do not have to provide the case studies, only the most relevant attributes can be included, and attributes can be set consistently between participants. An example of a property map used in the workshop is provided in Figure 4.

The following baseline management conditions were specified:

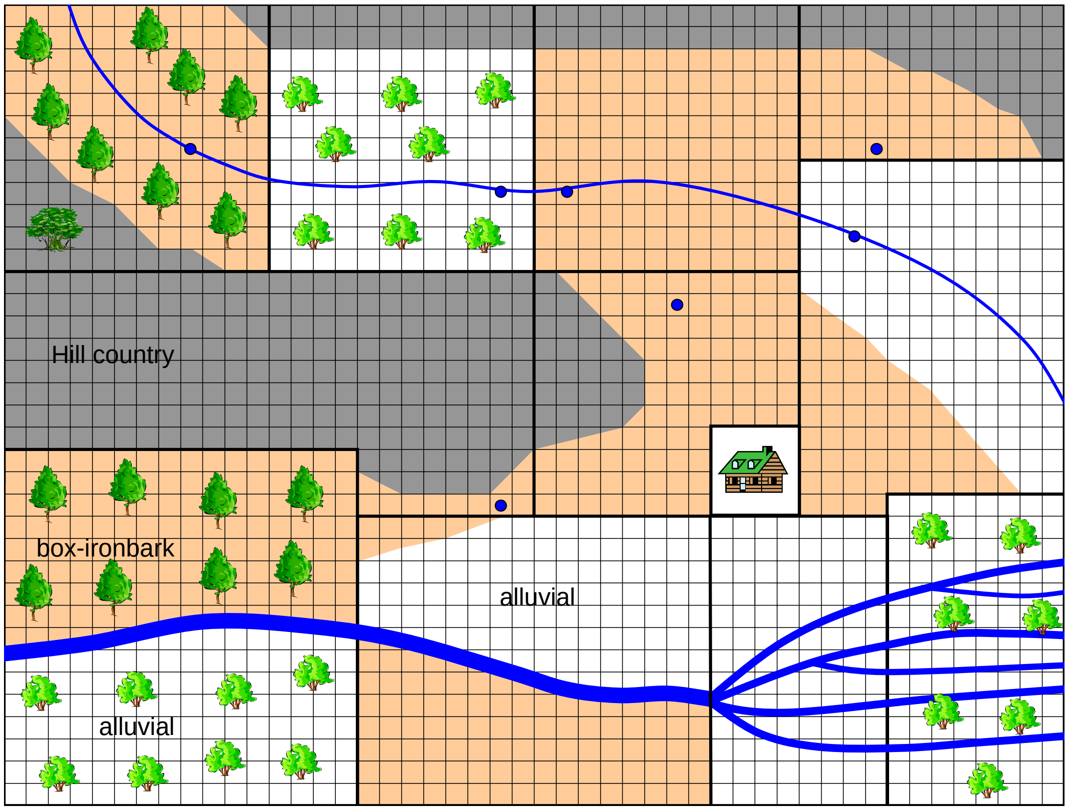
- Commitment to retain a minimum 40% grass cover at the end of the dry season (photo standards were provided)
- Fire was allowed but the area must be destocked until minimum biomass is reached.
- No additional exotic plant species can be introduced deliberately.

While minimum conditions were specified to ensure particular environmental outcomes, they still allowed landholders flexibility over their production outcomes, and cattle could still be grazed in designated areas. In addition, landholders were advised that any agreements would:

- be for a 5 year period with annual payments,
- be in the form of a contract, and

- include a monitoring process based on an annual visit, with two weeks notice.

Figure 4. Example of a dummy property used for the experimental auction

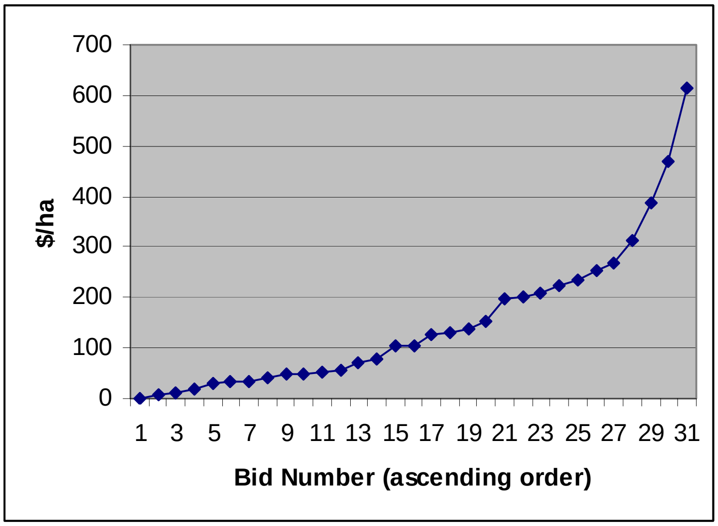


Landholders in the workshop were asked to treat the dummy properties as their own operation, using their knowledge to estimate how it should be managed. To generate bids in the workshop, participants were asked to mark on the maps the area of riparian buffer they were prepared to manage in this way and the bid amount (cost to them of the altered management regime). The use of grid squares (200m x 200m = 4 hectares each) helped to calculate areas, lengths and widths of riparian strips. Small prizes were awarded for the most cost effective bids, to provide participants with an incentive to keep their bids as competitive as possible.

A simple metric was developed based on the river type and whether the buffer area was timbered or non-timbered. This allowed estimates of the environmental benefits of the buffer to be generated in terms of the amount of sediment averted from entering the watercourse. These environmental benefits were then compared to the opportunity costs, represented by the nominated bids, to identify the most cost effective options presented by workshop participants.

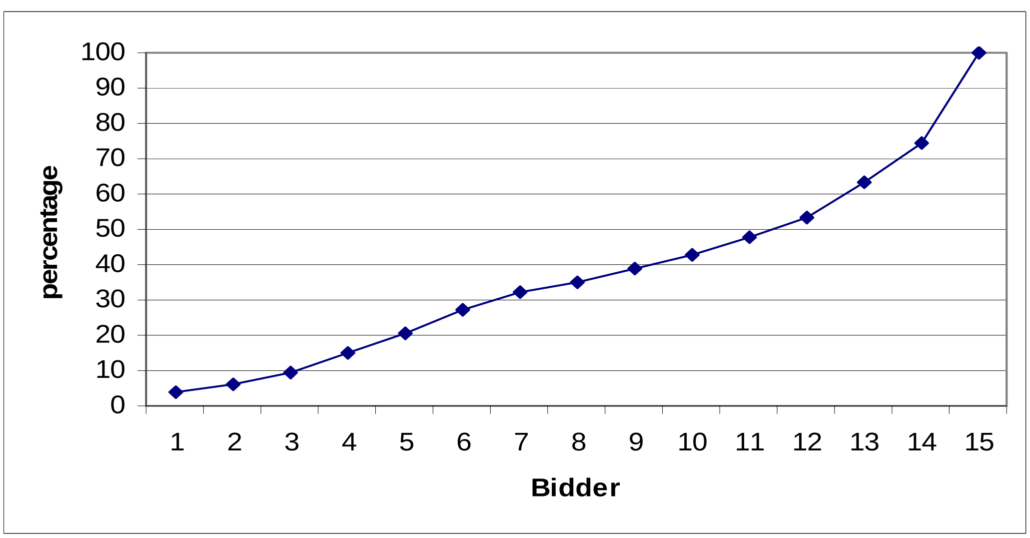
In the first round of bidding respondents were asked to focus on their opportunity costs and to assume any capital costs would be funded separately. In the second round of bidding participants were asked to base their bids on both capital and variable costs, i.e. they asked for an initial payment (fixed costs) and an annual payment (variable costs). Analysis of the opportunity costs across both workshop rounds, simply in terms of the riparian area identified, indicate that there is a broad range of relative bid values (Figure 5). The average bid value was $150/ha/year, but this reduced to $106/ha/year if the highest four bids were excluded.

Figure 5. Relative bid values - opportunity cost only



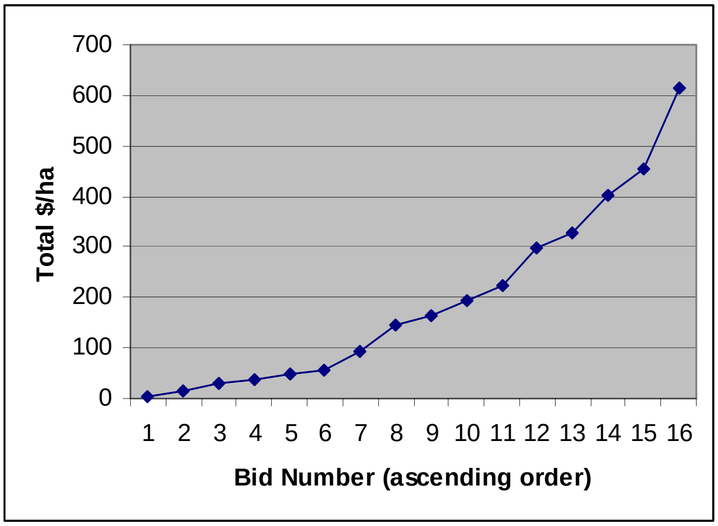
The varying importance of the capital cost component across landholders is shown in the following diagram. This indicates that it would be difficult to control for capital costs or to ignore its influence. It also demonstrates that programs which concentrate on capital costs without opportunity costs may have limited participation.

Figure 6. Fixed costs as a percentage of total costs



Bid values were higher when capital costs were considered. For comparative purposes, these were amortised over five years with a 10% discount rate. The results indicate that there is a broad range of relative bid values which partly represent the variation in fixed and variable costs (Figure 7). The extent of the range indicates that it is much more efficient for some landholders to implement mitigation actions com pared to others.

Figure 7. Relative bid values - fixed + variable cost



Regression models on the bid amounts have also been fitted. A regression model for the opportunity costs is shown in Table 5. The results indicate that landholders would require more money to manage riparian zones better if they have dependent children, and if the area is bigger. The size of the constant term means that there are a range of other influences on the size of the opportunity costs. The results also indicate that the amount of payment required falls for older landholders and as riparian zones get wider. The latter may be because of perceptions that management may be easier with larger zones compared to narrow riparian strips.

Table 5. Explanators for bid value.

	Unstandardized Coefficients		Sig.
	B	Std. Error	
Constant	20130.91	6626.78	.005
Have dependent children	18217.78	4627.24	.001
Area of riparian zone (ha)	16.85	3.97	.000
Width of buffer strip (m)	-17.12	8.36	.050
Age of respondent	-240.42	146.49	.112

Dependent variable = bid value. Adjusted R-square = .526

6. Conclusions.

The two experiments reported in this paper have approached issues of asymmetric knowledge about potential supply of riparian mitigation actions in two different ways. One approach involved the use of choice modelling where landholders could state their preferences for supply options, while the other involved the use of experimental workshops where landholders revealed their bids in a more controlled setting.

High levels of heterogeneity in mitigation actions and costs complicate the assessment. To minimise estimation problems, it was important to control as many factors as possible. Very different approaches were taken to achieve this. In the choice modelling experiment, set actions were identified from each landholder, and specific information collected along with a generic set of choice sets. The choice sets were then adjusted for individual circumstances, so the resulting models were calibrated to specific riparian options. With the experimental workshops, control was achieved by using a standard set of model properties. This minimised heterogeneity associated with locations, although heterogeneity between individuals and the type of actions that they would voluntarily engage with.

The same landholders were involved in both experiments, allowing some broad comparisons to be generated. The results from the choice modelling experiment were more deterministic, with a larger number of explanatory variables being significant in the model, and a relatively low value for the constant (which captures the influence of other factors). While the models from the experimental workshop were weaker, the provision of draft actions on maps from landholders and the two-way learning process involved means that this technique also had strengths.

The specific values that were generated are also relevant at a policy level. The opportunity cost tradeoffs identified for the area of riparian zone to be managed was estimated at $33/ha with the choice modelling technique, and $17/ha with the experimental workshop technique. However, while additional information was available from the choice modelling technique about tradeoffs for minimum biomass levels, the experimental workshops could not extend to this level of analysis.

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