# 14 Auctioning biodiversity conservation contracts: an empirical analysis

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## 1 Introduction

A century ago in Australia, food and fibre were scarce relative to the supply of habitat. Today the opposite could be argued. Governments now face the problem of encouraging landholders to provide public goods, such as habitat conservation, in the face of an economic environment that facilitates the production of private goods. Governments, both in Australia and overseas, have used a wide range of policy mechanisms to influence private land management including fixed-price grants, tax incentives and voluntary schemes. Latacz-Lohmann and Van der Hamsvoort (1997) propose, however, that auctioning conservation contracts as a means of creating markets for public goods has many theoretical advantages. They argue that competitive bidding, compared with fixed-rate payments, can significantly increase the cost-effectiveness of conservation contracting because of the cost revelation advantages of bidding processes.

In this chapter we explain how the now extensive economic literature on auction and contract design, and new approaches to measuring habitat quality, can be incorporated into a practical field trial conducted under the name of BushTender©. Results from two pilots conducted in two different regions of Victoria, Australia, are presented and discussed.

The first BushTender© pilot was conducted in two areas of Northern Victoria and the second in three areas within West and East Gippsland (see Figure 14.1). Although we report the results of two BushTender pilots, there have been several other applications of this approach in Victoria and more recently across Australia. These other applications focus on a variety of environmental goods and services including riverine habitat, native grasslands and carbon sequestration, and more recently a large pilot incorporating multiple environmental outcomes (carbon, dryland salinity, water quality, stream flow and terrestrial biodiversity) has been completed. Following these pilots, the Victorian Government has endorsed BushTender as a state-wide policy programme for habitat.

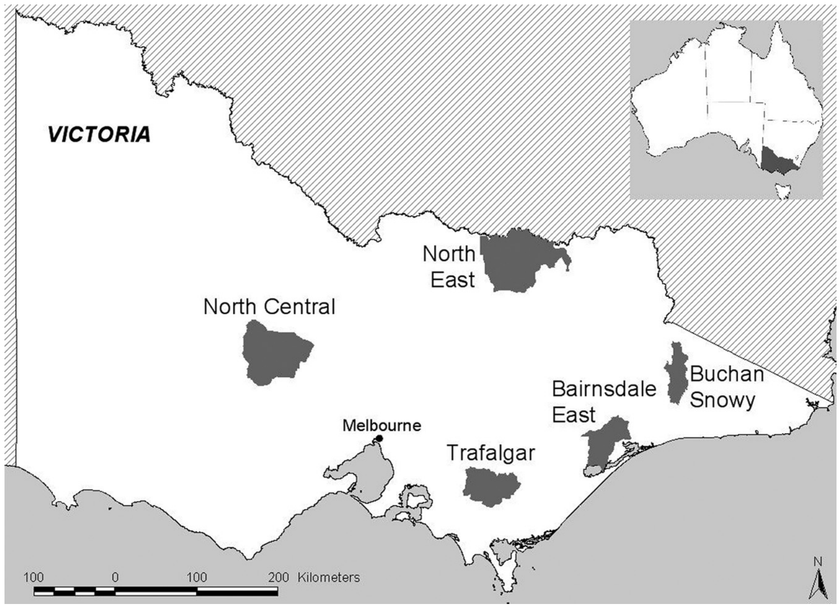


Figure 14.1. BushTender© pilot areas in Victoria, Australia

## 2 Conservation of biodiversity on private land

### *2.1 The problem of habitat loss on private land*

There are over a million hectares of native vegetation remaining on private land in Victoria. Crowe *et al.* (2006) report that managing native vegetation on private land is important for the conservation of native flora and fauna. Twelve per cent of Victoria's remaining native vegetation is on private land, 60 per cent of which is a threatened vegetation type (i.e. its conservation status is either endangered, vulnerable or depleted); and private land supports 30 per cent of Victoria's threatened species populations. There are also important land and catchment protection reasons for improving the management of vegetation on private land including the benefits for salinity, water quality, soil erosion and greenhouse emissions.

Conserving biodiversity on private land has been an important, but elusive, objective for government agencies. Despite government programmes, many important biodiversity assets on private land remain subject to degradation due to land-use practices such as livestock grazing, firewood collection and weed and pest invasion. Generally, it has not been feasible to include remnant vegetation on private land in the national reserve system through land purchase. Remnants are often of small scale and are spatially dispersed so that incorporating them into the public reserve system would involve high maintenance and protection costs and would not take advantage of local knowledge, expertise and resources. Public reservation will not protect all, or even most, biodiversity and 'off reserve' conservation will be required to protect biodiversity.

### *2.2 Nature conservation programmes*

#### *2.2.1 Australia*

In Australia, both State and Commonwealth Governments allocate large budgets to environmental and natural resource management. The Australian National Audit Office report on the Natural Heritage Trust in 2000–01 shows that this programme will have committed approximately US$2 billion to environmental works by June 2007 (Australian National Audit Office 2001). A further US$1.1 billion has been allocated to the National Action Plan for Salinity and Water Quality over a seven-year period by State and Federal Governments (Australian National Audit Office 2001). These and other environmental and natural resource management programmes employ a combination of intervention mechanisms including community and catchment-based planning, voluntary programmes, fixed-price subsidies and grants, education programmes and capital works programmes.

Although there is general acknowledgment that these programmes have altered community awareness about environmental issues, there is not a widespread belief that they have cost-effectively achieved significant on-ground outcomes. For example, the Australian National Audit Office (2001) commented on the Natural Heritage Trust by saying that the programme has been successful in raising awareness, but that it has not been so successful in achieving long-term landscape outcomes, and that cost-sharing, monitoring and administration has been poor. Thus, while achieving attitudinal shift, these programmes have been less effective at delivering and demonstrating improvements in the environment.

In Australia, State governments have substantial legislative responsibility for private land. Legislation controlling clearing of native vegetation – such as Victoria's Planning and Environment Act 1987 – is used in most states. Different states also offer financial incentives, such as assistance for fencing of remnants and weed and pest control (Denys Slee and Associates 1998). State governments sometimes make targeted purchases of land to address critical gaps in the reserve system, and revegetation programmes operate through grants to community groups. A range of voluntary programmes is supported by State governments. For example, a Victorian programme called Land for Wildlife aims to establish non-binding agreements with landholders for biodiversity conservation. The states, or state-based organisations, also offer programmes such as the Voluntary Conservation Agreement Programme in Queensland and Conservation Agreements (administered by the Trust For Nature) in Victoria (Denys Slee and Associates 1998). These schemes are legally binding and often have offsetting concessions such as rate relief, cash offsets or fencing concessions.

### *2.2.2 International experiences*

In other countries, environmental agencies have implemented a number of policy mechanisms to deal with nature conservation on private land. The US has employed essentially two approaches: farmland protection easements and mechanisms that involve payments to landholders. The latter includes the Conservation Reserve Programme (CRP) and the Wetlands Reserve Programme (WRP) which are funded under the US Farm Bill. These programmes evolved partly from concerns over soil erosion and partly as assistance programmes for farmers. Predecessors to the CRP, such as the Soil Bank Programme, were introduced to divert land from crop production in order to reduce commodity inventories as well as to establish protective cover for land taken out of production (Wiebe, Tegene and Kuhn 1996). The CRP commenced in 1985 with broad environmental objectives and with a requirement that funds be allocated on a competitive basis. Currently, farmers bid for public funds based on an environmental benefits index (EBI), which scores landholders based on six environmental factors (wildlife; water quality; erosion; enduring benefits; air quality; and conservation priority areas) and a cost factor. The United Stated Department of Agriculture (USDA) selects contracts based on the EBI, but it has a reserve price based on the rental value of land adjusted for its productive capability. Other programmes, such as the USDA's Water Quality Incentive Program (WQIP), involve stewardship payments and the provision of technical information about surface and groundwater management. The WQIP uses fixed payments to landholders (Cooper 1997).

In Canada a Permanent Cover Program (PCP) has been introduced to encourage soil conservation and other environmental outcomes on farmland. The PCP employs a fixed payment approach with participating landholders required to engage in long-term contracts (including a buy-out option). Payments are determined on the basis of the length of the contract and the area involved.

Fraser and Russell (1997) provide an overview of agri-environmental schemes in the UK, three of which are relevant to nature conservation on private land: Environmentally Sensitive Areas (ESAs); the Conservation Stewardship Scheme (CSS); and the Nitrate Sensitive Areas (NSAs). The ESA and the NSA target farmers in specific geographic areas. The ESA focuses on the 'maintenance or enhancement of the environmental and landscape quality' and the NSA focus is on reducing the presence of nitrates in water. Both schemes offer fixed payments for undertaking certain actions. Wynn (2002) analysed the ESA scheme in Scotland and found that it did not target farms with high biodiversity, nor focus on low-cost producers. Wynn notes that better targeting would increase the cost-effectiveness of the scheme. The CSS targets environmental features, not geographic areas. The CSS offers a fixed payment for pre-specified actions, although, not all farmers who submit an offer are accepted. Instead, the CSS agency chooses farmers who offer the best quality management plans.

## 3 The economics of nature conservation on private land

### *3.1 Missing markets*

It is widely acknowledged that existing markets and institutions misallocate resources to environmental goods and services. While markets are generally efficient in allocating resources to commodity production, they may be ineffective or nonexistent with respect to creating 'environmental value'.

Ideas about why markets are missing or inefficient have changed over time. Coase (1960) argued that when property rights are clearly defined, market players will bargain to achieve an efficient solution (create a market), assuming that transaction costs are zero. However, when transaction costs are positive, the institutional arrangement that minimises these costs should be preferred. Thus the boundaries of the firm, and by extension, the market, are found by finding the organisational form that minimises transaction costs.

The role of information in markets was first highlighted by Akerlof (1970). Subsequently, many economists have refined our understanding of how the distribution of information affects market players, and how these players may or may not respond to the problem (see, for example, Laffont 1990). It is now appreciated that information problems can destroy markets in extreme cases, or render markets inefficient because transaction costs diminish scope for value creation. The literature on information economics has forced economists and policy-makers to reassess policy mechanisms employed for many public policy problems. Likewise, there are new insights into policy mechanism design that arise from the application of information economics to environmental problems.

Using an information perspective, it can be seen that the problem with environmental goods is with the revelation of preferences for these goods (willingness to pay). The free rider problem associated with public goods hinders accurate revelation of preferences. One of the key solutions to this problem in the past has been via government stepping in and acting as demander on behalf of society. There has been much debate about what information should inform government allocation decisions, with many economists advocating valuation techniques such as contingent valuation. Whatever the manner in which demand-side preferences are expressed, we will argue in Section 5 that good information about the supply side (the focus of this chapter) is a complement to more efficient decisions regarding the creation and protection of environmental goods.

There are also important information effects that can be observed with respect to the supply side. Latacz-Lohmann and Van der Hamsvoort (1997) explain how information asymmetry affects the functioning of markets for environmental goods and services associated with private land. They note that there is a clear presence of information asymmetry in that: ‘farmers know better than the program administrator about how participation (in conservation actions) would affect their production plans and profit’ (Latacz-Lohmann and Van der Hamsvoort 1997: 407). Likewise, environmental experts, not landholders, hold information about the significance of environmental assets that exist on farm land. Further, landholders may not have all the relevant information about government priorities and are unlikely to understand how this information might influence subsequent contracts. Hence, although flat-rate Pigouvian taxes and subsidies may ‘correct’ market failures in circumstances where information asymmetry is not evident, other policy mechanisms will be needed when information is hidden. Latacz-Lohmann and Van der Hamsvoort (1998) conclude that: ‘some institution other than a conventional market is needed to stimulate the provision of public goods from agriculture’ (p. 334). They argue that auctions are: ‘the main quasi-market institution used in other sectors of the economy to arrange the provision of public-type goods by private enterprises’ (p. 335).

Auctioning conservation contracts is, therefore, a means of creating missing markets for nature conservation. The basic proposition is that markets for nature conservation are missing because of the asymmetric information problem and that policy mechanisms can be designed to reveal hidden information needed to develop meaningful transactions (markets) between government and landholders. It is contended that this process will facilitate price discovery and allow resources to be allocated where this has been difficult and inefficient in the past. The following sections draw on auction and contract design literature to identify the key features of this approach.

### *3.2 Auction design*

Formal analysis of auctions in the economic literature is relatively new. While a complete literature review on the many design aspects of auctions is beyond the scope of this chapter, a broad understanding of the underpinnings of current theory is instructive. Early work on auctions stems from the seminal papers of Friedman (1956) for the case of a single strategic bidder, and Vickrey (1961) for the equilibrium game theoretic approach. The development of appropriate game theoretic tools has made auction theory an increasingly researched topic. The three broad models studied are: the independent private value model of Vickrey (1961), the symmetric common value model of Rothkopf (1969) and Wilson (1969, 1977) and the asymmetric common value model of Wilson (1969). Several survey articles summarise the auction design literature (see McAfee and McMillan 1987; Wolfstetter 1996; and Klemperer 2002).

#### *3.2.1 Sealed bids*

The possibility of collusion between landholders bidding in an auction is always an important consideration in the choice of auction format. Repeated open, ascending and uniform-price auctions are generally more susceptible to collusion than a sealed-bid approach (see Klemperer 2002). Moreover, where bidders are risk averse, as we might well expect with private landholders, a first-price sealed-bid auction will facilitate lower bids because landholders can reduce commodity and weather related income variability by adding a regular income stream from conservation payments (Riley and Samuelson 1981).

#### *3.2.2 Single round*

Latacz-Lohmann and Van der Hamsvoort (1997) argue that a single round of bidding is preferred to multiple rounds because landholders are assumed to have independent private values rather than common values. In a private values model agents know their own valuations with certainty but make predictions on the values of others. While in the common values world, players have identical valuations but form their estimate on the basis of private information. In a common values world, agents will be able to learn about the 'common value' of the asset through the bidding strategies of all the other agents (as each agent has private information on the value of the asset). Thus, multiple rounds of bidding can facilitate information aggregation in the market and enable bidders to get a better sense of the true (common) value of the asset. Absent some mechanism for the efficient aggregation of such information, common value auction formats suffer from the 'winner's curse' (where the item is sold to the person with the most 'optimistic' private estimate of the true common value). However, where values are private and specific to each individual, information aggregation does not yield superior outcomes. Variation from farm to farm with respect to soil quality, rainfall, production systems etc. suggests that each landholder would base their bid on private, rather than common, information about opportunity costs and would be unlikely to alter this bid when given information about other landholders' valuations. In some contexts, we may expect affiliated values where there are both private and common value components in the bidding behaviour. This requires further attention in auction and policy design.

#### *3.2.3 Discriminative price*

Where bidders draw valuations from different distribution functions, Myerson (1981) argues that optimal auction design is achieved by awarding contracts to the lowest bidders. Note that the performance of the auction format can be thought of from two perspectives. First, as in the Myerson (1981) case, which format maximises the value created, and second, how value is divided between the buyer and the sellers.

These questions lead to consideration of whether a one-price or price discriminating auction should be employed. Though the theory on optimal bidding strategies in a discriminatory price auction versus a one-price auction is inconclusive, it is worth noting that if both formats are successful in achieving truthful revelation, a discriminatory price auction is analogous to a first degree price-discriminating monopolist. As such, there will be a change in the distribution of value, not the quantum of value created. Similarly, in the context of an auction of nature conservation contracts, the discriminatory price auction would, subject to the caveat highlighted above, achieve the same outcome as the one price approach, but at lower cost. Cason and Gangadharan (2005) examine the use of one-price versus discriminative-price auctions in an experimental setting. They find that bidding does change, and that the discriminative auction is more cost-effective. However, their assessment does not explicitly examine which auction format is superior with respect to economic efficiency.

#### 3.2.4 Hidden information

Cason *et al.* (2003) used laboratory experiments to examine bidder behaviour in an auction when the value of their output was known, compared with when it was not. These experiments indicate that when bidders did not know the value of output, their bids tended to be based on the opportunity costs of land-use change. By contrast, when bidders were given information about the significance of their biodiversity assets, they tended to raise bids and appropriate some information rents.

#### 3.2.5 Budget constraint and no reserve price

A reserve price strategy is a key element of auction design. While a reserve price will be less important where there is a budget constraint (see Myerson 1981; Riley and Samuelson 1981), this will not hold for repeated auctions. In repeated auctions it would be possible to transfer funds between rounds to maximise the nature conservation outcomes presented in other regions, or in subsequent auctions. An appropriately designed reserve price strategy would have implications for inter-temporal resource allocation as well as providing a means of spatially allocating conservation funds.

#### 3.2.6 Auction design in BushTender©

The key design elements chosen for BushTender© auctions include: first-price, sealed bid, single round, price minimising and price discriminating format. A budget constraint applied to the auction and a reserve price was not formulated *a priori*. In the pilot auction, the exact value of the landholder's biodiversity asset was withheld from the landholder to improve the auction's cost-effectiveness. There are, however, other considerations that may influence this strategy. These are discussed later in the chapter (see section 5).

### 3.3 Contract design

There are many design issues that arise in the development of contracts between government (the principal) and landholders (agent) for the purpose of conserving biodiversity on private land. From contract theory, the main problems of contract design relate to incentives and asymmetric information. Specifically these problems are manifested as adverse selection, moral hazard and observability. Other problems of contract design include commitment, credibility and incomplete contracts (Salanie 1997).

Adverse selection refers to situations where agents have private information on their types that would be valuable to the principal in terms of contract design. In the case of nature conservation contracts, the opportunity cost of land-use is hidden from the principal but will be important in the selection of successful contracts and in the price associated with conservation services offered. The problem with adverse selection here is the payments of information rents to induce the agent to reveal private information (Salanie 1997).

Moral hazard refers to the problem of hidden actions. It arises where the principal is unable to observe the actions of an agent who in this case carries out the requirements of a conservation contract on farms that are often in remote locations. It leads to consideration of contracts that mitigate against agents 'shirking' their commitments (Laffont and Martimort 2002).

Even if contracts can be designed to prevent adverse selection and moral hazard, outcomes may still be unobservable. Observability is a problem with nature conservation contracts because it is difficult to measure and monitor the status and resilience of habitat for native plants and animals. For example, monitoring the impact of changes to land management in terms of the improvement in the stock and quality of fauna and flora would be very costly and subject to dispute. The level of observability has implications for monitoring and enforcement of contracts and their subsequent incentive effects on agents' behaviour (Laffont and Martimort 2002). An alternative strategy would be to specify a contract on the basis of inputs, such as fencing, weed control and understorey protection, that can be expected to improve habitat quality. These inputs are known to improve habitat status and resilience, but the transformation function that maps these actions (inputs) into outcomes is not known with certainty, even if the actions were carried out diligently. Further, the effect of unexpected events, such as drought and floods, could not reasonably be predicted by the agent (landholder), nor the principal (government).

These two problems (unobservability of outcomes and imperfect knowledge about the transformation function) were considered by Ouchi (1979), and explained in the context of the public sector by Wilson (1989). Williamson (1985) has characterised this as the problem of 'measurement'. The principal-agent literature has considered one or both of these problems to varying degrees (see, for example, Holmstrom and Milgrom 1991, 1994). This literature has recommended a host of ways to deal with these difficult problems, including: organising activities inside the firm; using fixed pay arrangements (again inside the firm); and contracting on the basis of inputs.

#### *3.3.1 Contract design in BushTender©*

Conservation contracts for the pilot were developed based on inputs rather than outcomes, individual management agreements, menus of actions, progress payments and a monitoring and enforcement strategy. Input contracts were chosen because there were no low-cost means of measuring outcomes on which to base (enforce) these contracts. Because environmental benefits vary from site to site (non-standard benefits), individual management agreements specifying a schedule of management commitments were employed with progress payments made on the basis of agreed actions. This allowed the government scope to identify what actions were valuable, from a nature conservation perspective, and for landholders to choose a menu of actions that they preferred. For example, on some sites regenerating understorey was an imperative, whereas on others agreeing to not collect firewood (this action disturbs habitat) was relatively important.

Landholders were required to self-report on an annual basis. If a landholder did not report, or the report flagged non-performance, a counselling process was initiated before financial penalties were employed. If compliance was not forthcoming, payments were withheld, or in the worst-case scenario the contract was terminated.

This type of contract has implications for risk bearing. Specifically, the government agency bears most of the risk associated with structural parameters where contracts are specified in terms of inputs. This was considered sufficient for the pilot, where the main purpose was to test the auction mechanism and the supporting information systems. However, improvements in knowledge (for example, new technology that allows lower-cost monitoring of species prevalence) may enable a government agency to base at least part of its payments on output.

### *3.4 Ecological service assessment*

Before transactions can occur between environmental agencies and landholders, certain information will be needed to avoid the lemons problem noted by Akerlof. Two types of information will assist government to distinguish between different bids and different conservation actions that might be taken – information about the significance of habitat and information about service (habitat improvement).

#### *3.4.1 Biodiversity significance*

Landscapes that have been modified for agricultural purposes will not necessarily retain a representative mix of habitat types. One way of expressing the conservation value of different types of habitat is with a Biodiversity Significance Score (BSS) where $BSS_i$ represents the biodiversity value of landholder i's remnant vegetation. The Biodiversity Significance Score draws on information about the scarcity of vegetation types and its Ecological Vegetation Classification[1] (NRE 1997).

### 3.4.2 *Habitat improvement*

There are a number of actions that landholders can take to improve the condition of habitat on private land. These include fencing to exclude stock from remnant vegetation, controlling environmental weeds and pests and minimising habitat disturbance by not harvesting firewood. The value of these habitat management actions, in terms of the improvement in habitat condition, can be expressed as a Habitat Services Score (HSS) where $HSS_i$ represents the change in quality of habitat from landholder i's habitat management actions. Parkes *et al.* (2003) developed a new metric called a 'habitat hectare' (referred to in section 4.2) to express the change and quantity and quality of habitat improvement.

Information about significance and habitat improvement was summarised in a Biodiversity Benefits Index (BBI) for each landholder i:

$$BBI_i = \frac{BSS_i \cdot HSS_i}{b_i} \tag{1}$$

In equation 1, ($b_i$) represents the nominal bid submitted by i to protect and enhance the remnant vegetation offered into an auction.

## 4 **Results**

Following advertisement of the auction, expressions of interest, assessment of proposed sites by ecologists and measurement of BBI, landholders submitted bids based on agreements that stipulated their selected actions. Bids were then ranked in ascending order according to BBI and contracts were written with the successful bidders up to a budget constraint. Tables 14.1 and 14.2 summarise the number of participants and sites assessed in the auctions.

Information about bids in the auctions is shown in Tables 14.3 and 14.4. Bids relate to either individual sites or, where landholders had multiple sites, they were given the option of submitting a combined bid for all their sites. A number of landholders chose to submit a combined bid. Joint bids between two or more landholders were not allowed in these trials.

[1] Ecological Vegetation Classes indicate whether vegetation is presumed extinct, endangered, vulnerable, depleted etc.

Table 14.1 *Northern Victoria BushTender© pilot – participation*

| Pilot phase | North Central | North East | Total |
|---|---|---|---|
| Expressions of interest (in pilot areas) | 63 | 63 | 126 |
| Properties assessed | 61 | 54 | 115 |
| Sites assessed | 104 | 119 | 223 |
| Hectares assessed | 1833 | 2006 | 3839 |

Table 14.2 *Gippsland BushTender© pilot – participation*

| Site assessment | Trafalgar | Bairnsdale East | Buchan Snowy | Total |
|---|---|---|---|---|
| Expressions of interest (in pilot areas) | 55 | 35 | 11 | 101 |
| Properties assessed | 37 | 22 | 9 | 68 |
| Sites assessed | 68 | 52 | 15 | 135 |
| Hectares assessed | 531 | 1134 | 702 | 2367 |

Table 14.3 *Bids for the Northern Victoria pilot*

| | North Central | North East | Total |
|---|---|---|---|
| Number of bidders | 50 | 48 | 98 |
| Number of bids | 73 | 75 | 148 |
| Number of sites | 85 | 101 | 186 |
| Number of successful bidders | 37 | 36 | 73 |
| Number of successful bids | 47 | 50 | 97 |
| Number of successful sites | 61 | 70 | 131 |
| Area under agreement (ha) | 1644 | 1516 | 3160 |

Table 14.4 *Bids for the Gippsland pilot*

| | Trafalgar | Bairnsdale East | Buchan Snowy | Total |
|---|---|---|---|---|
| Number of bidders | 27 | 19 | 5 | 51 |
| Number of bids | 43 | 25 | 5 | 73 |
| Number of sites | 48 | 42 | 9 | 99 |
| Number of successful bidders | 16 | 14 | 3 | 33 |
| Number of successful bids | 19 | 16 | 3 | 38 |
| Number of successful sites | 21 | 30 | 6 | 57 |
| Area under agreement (ha) | 262 | 906 | 516 | 1684 |

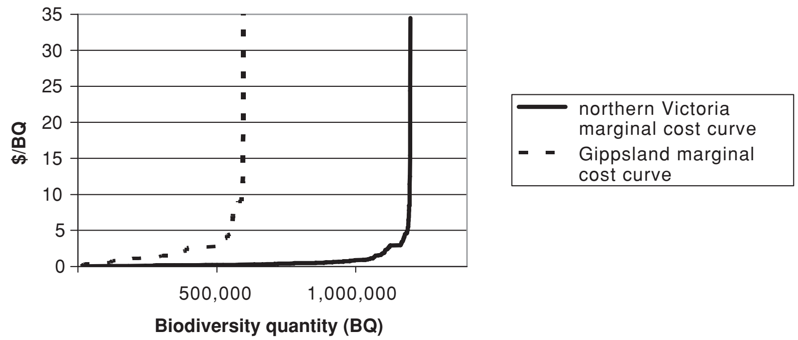


Figure 14.2. Supply curves from BushTender

## *4.1 Analysis of bids*

Drawing on information from the bids, Figure 14.2 illustrates the cost of generating additional units of biodiversity. We will henceforth refer to the curves in Figure 14.2 as supply curves for biodiversity.[2] The horizontal axis depicts the total quantity of biodiversity supplied (BQ). This measure is adjusted for biodiversity quality and is the numerator of the BBI as given in (1): the biodiversity significance score times the habitat services score. The vertical axis displays the (bid) price per unit BQ. As shown in Figure 14.2, the supply curves for biodiversity are relatively flat over much of the quantity range, but then transform to relatively steep as the quantity of BQs rises. All auctions of conservation contracts tend to generate supply curves that display the same general profile. This occurs because supply prices are derived by combinations of the distribution of opportunity costs and the distribution of habitat gains. Regional differences in opportunity cost tend to shift the supply curve but not to change its general characteristics. The steeply rising section of the supply curve tends to be due to declining biodiversity benefits of bids rather than rising offer prices.

Although it is difficult to compare the results from the auction with other mechanisms, it has been possible to examine how a hypothetical fixed-price scheme would perform compared with the discriminative price auction used in the pilot. To make this comparison, we must assume that the fixed-price scheme would operate as a one-price auction and

[2] The bids shown in Figure 14.2 are inclusive of any 'information rents' that bidders may have included in their bid price. We assume here that opportunity costs and information rents make up bids. This is different to the characterisation of Latacz-Lohmann and Van der Hamsvoort (1998), who differentiate the supply curve on account of it being exclusive of rents.

Table 14.5 *Comparison of fixed-price scheme to discriminating auction*

| | Northern Victoria | Gippsland |
|---|---|---|
| *Comparison holding biodiversity quantity constant* | | |
| Actual Budget (US$) | 325,817 | 629,403 |
| Budget required in fixed-price scheme (US$) | 2,113,600 | 1,632,900 |
| Proportionate increase in cost of Fixed-price scheme | 6.5 | 2.6 |
| *Comparison holding budget constant* | | |
| Actual BQ | 1,165,019 | 530,099 |
| BQ of fixed-price scheme | 874,412 | 371,679 |
| Percentage fall in quantity from fixed-price scheme | 25 | 30 |

that bidder behaviour would not change in both auctions.[3] We justify this assumption by first recognising that landholders' behaviour would change with different schemes but theory or empirical evidence does not allow us to assume how the supply (bid) curve would change. In a fixed-price scheme, an agency would pay each successful landholder the same price: the price of the marginal offer. This is the price that an agency would need to offer to all landholders to generate the same supply of biodiversity made available from the price discriminating auction.

The results of this hypothetical comparison are given in Table 14.5. For the Northern Victoria pilot, a fixed-price scheme would require a budget of approximately US$2.1 million (over six times more than the budget allocated through the auction) to elicit the same quantity of BQ units as the discriminative price auction. Looked at another way: for the same budget of around US$325,000, a fixed-price scheme would give an agency approximately 25 per cent less biodiversity. A similar analysis for the Gippsland pilot shows that a fixed-price approach would require over 2.5 times the funding allocated through the auction.

Different contracts were employed in the two pilots reported. For the Northern Victoria pilot, landholders were offered a menu of actions but once actions were selected, standard contracts were used each with a three-year time span. In the Gippsland pilot a menu of contracts was offered including three- or six-year contracts, with the further option of ten-year or permanent protection following the active management period. The options chosen by landholders are summarised in Table 14.6.

[3] Assuming that the hypothetical fixed-price scheme is a one-price auction is probably going to overstate the benefits of a fixed-price scheme, but understate its administrative costs. This would be because most fixed-price schemes do not quantitatively score biodiversity outcomes, do not conduct landholder visits and do not advise on a range of possible landholder actions.

Table 14.6 *Management agreements taken up in Gippsland pilot*

| Successful contract type | per cent |
|---|---|
| Three years | 2.5 |
| Three years plus 10 years' protection | 0 |
| Three years plus permanent protection | 0 |
| Six years | 49 |
| Six years plus ten years' protection | 28 |
| Six years plus permanent protection | 20.5 |

Table 14.7 *Area of habitat secured under contracts: Northern Victoria*

| | Conservation significance | | | | |
|---|---|---|---|---|---|
| | Very high | High | Medium | Low | Total |
| Area secured under management agreements (in hectares) | 666 | 1540 | 934 | 20 | 3160 |
| Vegetation quality under management agreements (in habitat hectares) | 371.3 | 831.7 | 509.1 | 6.4 | 1718 |
| Habitat hectare rating | 0.56 | 0.54 | 0.55 | 0.32 | 0.54 |
| Change in quality (in habitat hectares) | 22.8 | 92.6 | 53.4 | 0.1 | 168.8 |

### 4.2 *Improvements in habitat quality and quantity*

Tables 14.7 and 14.8 summarise the expected improvements in habitat quality procured through the auctions reported. These data indicate that conservation contracts were allocated over 3,160 hectares of land in Northern Victoria and 1,684 hectares in Gippsland. For the pilot in Northern Victoria, the existing stock of vegetation was assessed at 1,718 habitat hectares which is expected to increase by 168.8 habitat hectares due to the interventions specified in contractual agreements with landholders. Habitat hectares is a metric developed by ecologists to measure the quality of vegetation relative to its pristine condition (see Parkes *et al.* 2003). A score of 1 represents pristine condition. As shown in Tables 14.7 and 14.8, the habitat hectare score in the Northern Victoria pilot averaged 0.54 and in Gippsland 0.69. The expected increase in habitat quality in the Gippsland pilot was 217.9 habitat hectares compared with the existing assessment of vegetation quality of 1,158 habitat hectares.

Table 14.8 *Area of habitat secured under contracts: Gippsland*

| | Conservation significance | | | | |
|---|---|---|---|---|---|
| | Very high | High | Medium | Low | Total |
| Area secured under management agreements (in hectares) | 610 | 231 | 744 | 99 | 1684 |
| Vegetation quality under management agreements (in habitat hectares) | 423.4 | 164.6 | 516 | 53.9 | 1158 |
| Habitat hectare rating | 0.69 | 0.71 | 0.69 | 0.54 | 0.69 |
| Change in quality (habitat hectares) | 81.4 | 37.7 | 113.2 | 13.3 | 217.9 |

### *4.3 Awareness and participation in the auction*

Following the pilot auctions, surveys (380 samples) were conducted of participants and non-participants to collect information about: attitudes towards the auction; attitudes toward environmental issues; landholder demographics and enterprise characteristics (see Ha *et al.* 2003). Logistic regressions were used to model awareness and participation (see Appendix).

In general, we conclude that landholders' actions (whether they were members of environmental groups or participate in environmental activities) is the only consistent factor influencing awareness and participation. Demographic variables were important in both regions but there are no consistent trends across the two regions. Male and older participants displayed higher levels of awareness. Enterprise orientation was significant in determining awareness in one but not both regions. From the Gippsland results, it would seem that those who thought that BushTender was a 'good idea', and landholders who believe native vegetation management is the responsibility of landholders, were more likely to participate. Other physical and demographic variables showed inconsistent trends across both the pilot regions. These data suggest that awareness and participation in auctions (at least in the two regions investigated) does not seem to be consistently influenced by the characteristics of landholders.

## 5 Discussion and conclusions

The pilot auction has shown that it is possible to create at least the supply side of a market for nature conservation: with a defined budget, prices can be discovered and resources allocated. Characterising nature

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conservation on private land as a problem of asymmetric information has improved our understanding of why this and related environmental markets are missing or ineffective and has introduced an alternative policy mechanism to those currently available. Auctioning nature conservation contracts offers many advantages over planning, command and control, voluntary approaches and fixed-price policy mechanisms.

The standard approach of dealing with missing markets by adopting coarse policy tools such as taxes, regulation and voluntarism has been questioned in the context of the information problems inherent in environmental landscapes. Policy mechanisms, such as auctions, that reveal and aggregate relevant information efficiently are likely to yield efficiency advantages and have implications for other environmental problems.

Many important design issues have been addressed in the process of implementing the auction. Besides choices about auction format, contract design and the specification of biodiversity preferences, many practical choices arise concerning communication with landholders, skills required to successfully run an auction and timing of activities. These factors all influence the performance of the auction.

Perhaps the most important finding from the pilot auction of nature conservation contracts is that where there are heterogeneous agents and non-standard environmental benefits, an auction offers significant cost savings over fixed-price schemes, such as subsidies and tax concessions. This comparison is made on cost-effectiveness, rather than economic efficiency grounds. For the budget available and the bids received, it has been shown that a price discriminating auction would reduce by a large proportion the cost of achieving the same biodiversity improvement using a fixed-price approach. Moreover, a fixed-price approach – such as a fixed price per metre of fencing – essentially reveals the wrong information from the parties involved. It requires landholders to reveal the actions that they believe will improve the environment (when this information is perhaps held by environmental agencies); and agencies to reveal price that will be paid for these actions (when this information is often held by landholders).

The attraction of an auction of nature conservation contracts rests in the value of information revelation. The pilot auction was designed to reveal specific but previously hidden information from the agency responsible for nature conservation and from landholders. As part of the auction, the government agency had to derive a metric expressing the impact of land use change on the stock of biodiversity. The agency had to consider how to score the improvement in biodiversity associated with changes in land management (the Habitat Services Score) and the relative conservation status of different areas of vegetation (the Biodiversity Significance

Score). This information would significantly improve priority setting for nature conservation, whatever the mechanism employed.

Because the auctions were one-off pilots, it was not possible to observe their impact on other markets in the economy. However, there would be dynamic effects that could be important if such institutions became fully embedded in the economy. For example, land markets would reflect native vegetation 'value' in addition to production and location effects.

### *5.1 Future directions*

Although the auctions described above were successful and popular with landholders, there remain many interesting design and implementation issues that deserve further consideration.

#### *5.1.1 Repeated auctions*

The pilot auctions were constructed essentially as a 'one-shot game' between the government and private landholders. Design of a sequential auction, however, would be more complicated than the pilot because landholders could be expected to learn through rounds of the auction. Under these circumstances, landholders could change their bidding strategies and possibly raise the cost of nature conservation to the agency. For example, Riechelderfer and Boggess (1998) found that bidders in the Conservation Reserve Program – which is a sequential auction – revised bids from previous rounds by offering bids at the reserve price. The reserve price in this case was set as a per-hectare rate and when landholders learned this reserve price, they anchored their bids accordingly.

#### *5.1.2 Multiple environmental outcomes*

Another interesting development would be to design auctions capable of dealing with multiple environmental outcomes from landscape change where these outcomes are complementary and/or competing. Revegetation of parts of the landscape may, for example, improve habitat quality and address land degradation. Auction theory is starting to make inroads into questions of how complementarities make market design difficult. Milgrom (2000) shows that complements to some bidders but not to others pose a threat to the existence of equilibria. Roth (2002) also notes that this problem arises in labour markets, such as the medical internship placement system, where couples prefer co-placement.

A second generation auction that includes multiple environmental goods and services (water quality, stream flow, land salinisation and terrestrial biodiversity), involving combinations of policy mechanisms (auctions and tradeable permits for carbon) has now been piloted in Victoria. This pilot (EcoTender) has raised a number of further considerations particularly with respect to the way scientific information is included in auctions, buyer aggregation procedures, methods of determining preferences for environmental goods and services and the way that other environmental markets – such as tradeable permit systems – interact with auction mechanisms in the future (see Strappazzon *et al.* 2003).

### *5.1.3 Information hidden versus information revealed*

One of the most interesting design issues with the pilot auction of conservation contracts was the extent to which information was made known to landholders prior to formulation of their bids. In the pilots reported above, some of the information about the biodiversity metric was withheld from landholders: they knew the Habitat Services Score but not the Biodiversity Significance Score. While this strategy was empirically supported on cost-effectiveness criteria by laboratory experiments (see Cason *et al.* 2003), other considerations suggest that full disclosure of information about biodiversity significance may be appropriate. In the short-run, withholding some information limits the scope for landholders to extract information rents from the auction. Clearly, if landholders knew that they had the only remaining colony of some plant or animal, they would be able to raise their bid well above opportunity cost, compared with a situation where this information were not known. The alternative strategy also has merit in that (i) the information rents that accrue to landholders would influence land markets and encourage investment in nature conservation; and (ii) landholders would know exactly what scarce biodiversity assets they have and could self-select into the auction process improving the matching between government priorities and the bidders in an auction.

### *5.1.4 Reserve prices and demand valuation*

The purpose of the auctions to date has been to develop an understanding of the cost of obtaining the next units of biodiversity (the supply side of the market). However, government will always have to make decisions about budgetary expenditure in the light of information about both costs and benefits – the demand-side of the equation. This raises the question of whether society is prepared to pay for the next unit of biodiversity and at what price. Viewed in this way, a reserve price strategy requires a government to bring together notions of both supply (opportunity cost) and demand (willingness to pay).

As stated in 3.1 it is notoriously difficult to elicit truthful revelation of non-priced values. However, allocating a budget to a biodiversity auction implies that there will be some bids that are rejected, and hence there will be an implicit valuation of a contract price that is too high.

The best way to consider the demand side of biodiversity is still very contentious. Myriad articles have been written on how to explicitly value goods such as biodiversity. Some have argued that the aim of explicitly valuing biodiversity is futile and that governments – as representatives of society – should make choices about variables such as the biodiveristy budget, and this is the most satisfactory way of resolving the dilemma. Whatever prevails, it is clear that an approach such as BushTender helps to reveal information about the supply price of the next unit of biodiversity, determined on a competitive basis. This information could be used to populate part of the information space in which resource allocation decisions are made.

Reserve prices will also become more important as subsequent auctions are run. In this case, governments would face the decision of purchasing within the current auction where marginal costs rise (as demonstrated in figure 14.2) or differing purchases to subsequent auctions to take advantage of better conservation contracts.

#### *5.1.5 Funding models*

The BushTender approach opens up several avenues for increased funding for biodiversity services. The first is that government may be more likely to fund conservation activities if the outcomes are more visible, reportable and cost-effective. The auction approach is rich in terms of the data that it provides to decision-makers and should therefore make it easier to convince decision-makers about its value. In other words, it provides the potential buyers with a more accurate description of the type and quantity of product that can be procured with a given budget.

Governments in Australia are beginning to see this approach as a useful tool and are starting to allocate funds to it. For example, the Victorian Government has recently endorsed BushTender as an official government programme with an on-going financial commitment. A number of projects funded under the Commonwealth's programme of US$3.9 million on Market Based Instruments were influenced by the BushTender approach. Another application has occurred with the national biodiversity stewardship component of the Commonwealth of Australia's Biodiversity Hotspots programme.

#### *5.1.6 Information to facilitate cross-programme comparisons*

Other indirect benefits could arise from the application of auctions and other market approaches to environmental management. For example, information about the marginal cost of habitat conservation would assist public sector decision-makers in allocating resources between conservation investments on public (eg. national parks) and private land. Similarly, the emergence of more formalised and quantitative methods of expressing relative preferences for alternative environmental actions may facilitate development of more robust offset and trading schemes.

### *5.1.7 Site synergies*

Auctions employ contracts to facilitate transactions with individual landholders. However, the aim of habitat conservation schemes may at times involve many landholders whose actions are interdependent (site synergies). Currently, the index for biodiversity developed for BushTender attempts to take site synergies into account by using a 'landscape context' scoring element. Further research is needed to refine ways of representing habitat interdependencies. There may also be benefits from further research into alternative auction format and contract design problems. With respect to auction format, there appears scope to consider and pilot a combinatorial auction that would assist bidders to interact and discover efficient package of contracts.

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## Appendix

### *Modelling*

We modelled the data on awareness and participation using logistic regressions as we were modelling a binary dependent variable in both cases. For awareness, we are analysing the factors that influence awareness of the BushTender scheme. For participation, we are analysing the factors that determine the decision to participate.

We choose variables by essentially first testing if the variable is a significant explanator of the dependent variable in question in a univariate regression. All variables are then included in an initial model which is refined using significance tests until a minimum Akaike information criterion value is reached. See Ha *et al.* 2003 for more details.

Table 14.A1 *Northern Victoria awareness model*

| Dependent variable: awareness of BushTender© scheme (380 observations) | |
|---|---|
| Variable | Coefficient |
| *Action variables* | |
| Actively increasing or managing remnant vegetation by: | |
| – cleaning up or maintaining area | 0.837** |
| – establishing soil erosion measures | 1.625** |
| – undertaking good farm practices | 2.852** |
| – controlling and/or monitoring rabbits | 1.591* |
| Member of either: Alpine Valley, Land for Wildlife, VSS, Grasslands Society, Meat and Livestock Corporation, Target 10, Women in Agriculture, Landcare, Sustainable Grazing Systems, North Eastern Stud Breeders, Olive Growers Association, Agricultural Society and other agricultural groups | 1.431*** |
| Respondent or spouse is a member of an organisation concerned with land protection or the environment | 1.224*** |
| In the past three years participated in either a Heartlands, Country Fire Authority, 20/20, fencing, soil erosion, salinity control, native planting, Bushcare, Project Platypus, Hindmarsh Biolink, duck boxes, organic farming, Murray River Action Group, wildlife monitoring/rescue, local groups, Target 10, roadside management, other or unknown environmental groups | 1.011*** |
| Regularly reads the Chronicle | −2.117** |
| Native vegetation, bushland or unimproved pasture is used for: | |
| – grazing of livestock | −0.698*** |
| – weed control | 0.937*** |
| *Perception variables* | |
| The amount and quality of native vegetation within 10–15 km of property is very good | −0.665** |
| Decline of wildlife due to habitat loss | 0.969* |
| *Demographic variables* | |
| The respondent is male | 0.742*** |
| Respondent's spouse is aged sixty years or more | 0.884*** |
| *Constant* | −1.799*** |
| Akaike Information Criterion (AIC) | 1.116 |
| McFadden R-squared ( per cent) | 24.4 |

Note: All estimates rounded to the nearest third decimal place unless otherwise shown
'*', '**', '***' denotes estimate significant at the 90, 95 and 99 per cent level respectively
'^' denotes estimate was insignificant at the 95 per cent level

Table 14.A2 *Gippsland awareness model*

| Dependent variable: awareness of BushTender© scheme (380 observations) | |
|---|---|
| Variable | Coefficient |
| *Action variables* | |
| Actively increasing or managing remnant vegetation by: | |
| – fencing off vegetation areas | 0.564* |
| – protecting remnant vegetation | 0.597** |
| Member of: | |
| – Landcare | 1.167*** |
| – Land for Wildlife | 1.25^ |
| Participated in an environmental programme run by: | |
| – Landcare | 0.923* |
| – Land for Wildlife | 2.211* |
| Participated in an environmental programme in the last 3 years | −0.84** |
| Native vegetation, bushland or unimproved pasture is used for sheltering stock | 2.215*** |
| *Perception variables* | |
| Strongly disagree that it is difficult to find useful information on native vegetation and biodiversity | 0.818** |
| Believe that landowners should take more responsibility for managing native vegetation on their properties | |
| – disagree | 1.626*** |
| – neither agree nor disagree | −1.738*** |
| Observed decline in local vegetation due to other reasons | 0.973^ |
| Observed decline in wildlife due to urban sprawl | −1.661^ |
| *Physical variables* | |
| Type of farm enterprise: | |
| – Sheep | 0.676* |
| – Beef | 0.491* |
| – Cropping | −3.294** |
| Trafalgar locality | −0.621** |
| Proportion of property that is improved pasture ( per cent) | −0.001^ |
| *Demographic variables* | |
| Respondent's education: | |
| – formal training in agricultural or land management | 0.715** |
| – post-graduate qualification | 1.932*** |
| Respondent is male | 0.737** |
| Years in locality | −0.032*** |
| Respondent's age is less than 30 | −1.887*** |
| Spouse has attained a trade qualification | −1.033** |
| *Constant* | −0.466^ |
| Akaike Information Criterion (AIC) | 1.078 |
| McFadden R-squared ( per cent) | 31.7 |

Note: All estimates rounded to the nearest third decimal place unless otherwise shown
'*', '**', '***' denotes estimate significant at the 90, 95 and 99 per cent level respectively
'^' denotes estimate was insignificant at the 95 per cent level

Table 14.A3 *Northern Victoria participation model*

| Dependent variable: participation in BushTender© scheme's expression of interest stage (167 observations) | |
|---|---|
| Variable | Coefficient |
| *Action variables* | |
| Heard about BushTender© from a radio programme | −2.53** |
| Respondent or spouse is a member of an organisation concerned with land protection or the environment | 1.224*** |
| Regularly reads industry journals | −2.064* |
| Native vegetation, bushland or unimproved pasture is used for planting trees or shrubs | 0.518^ |
| *Perception variables* | |
| Respondent does not think about native vegetation management and biodiversity very much | −1.176** |
| *Constant* | −0.96** |
| Akaike Information Criterion (AIC) | 1.208 |
| McFadden R-squared ( per cent) | 16.4 |

Note: All estimates rounded to the nearest third decimal place unless otherwise shown
'*', '**', '***' denotes estimate significant at the 90, 95 and 99 per cent level respectively
'^' denotes estimate was insignificant at the 95 per cent level

Table 14.A4 *Gippsland participation model*

Dependent variable: participation in BushTender© scheme's expression of interest stage (189 observations)

| Variable | Coefficient |
|---|---|
| *Action variables* | |
| Heard about BushTender© from a radio programme | −4.53** |
| Involved with Land for Wildlife as a: | |
| – programme participant | 5.883*** |
| – member | 3.101** |
| Actively increasing or managing native vegetation by: | |
| – fencing off native areas | 1.987*** |
| – controlling weeds | 1.113^ |
| Native vegetation, bushland or unimproved pasture is used for livestock grazing | −1.754** |
| *Perception variables* | |
| BushTender© involves the community, which is a: | |
| – very good idea | 3.942*** |
| – good idea | 3.961*** |
| Strongly agree that is its own responsibility to manage native vegetation and biodiversity | 1.953** |
| Strongly agree that enthusiastic when it comes to native vegetation and wildlife protection | −2.073** |
| Amount and quality of native vegetation within 10–15 km of property is good | −1.515** |
| Strongly disagree to learning more about native vegetation and biodiversity management | −5.559** |
| Thinks BushTender© is a good idea | −2.818*** |
| Somewhat agree that had a positive impact on the quality and quantity of native vegetation on my property | −1.882** |
| Local vegetation is very good for other reasons | 7.116*** |
| Somewhat agree that it is very difficult to find useful information on native vegetation and biodiversity | 2.457*** |
| *Physical variables* | |
| Trafalgar locality | −3.44*** |
| Proportion of property that is unimproved pasture ( per cent) | 0.026* |
| *Demographic variables* | |
| Spouse has attained tertiary education | 1.168^ |
| Years in locality | −0.044** |
| Children are involved in land management decisions | 2.872** |
| *Constant* | −0.539^ |
| Akaike Information Criterion (AIC) | 0.69 |
| McFadden R-squared ( per cent) | 62.1 |

Note: All estimates rounded to the nearest third decimal place unless otherwise shown
'*', '**', '***' denotes estimate significant at the 90, 95 and 99 per cent level respectively
'^' denotes estimate was insignificant at the 95 per cent level