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Valuing recreational fishing in Tasmania and assessment of response bias in contingent valuation*

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We report results from contingent valuation studies in each of two Tasmanian fisheries that estimate the value of a day's recreational fishing. Published studies estimating the economic value of recreational fishing in Australia and New Zealand are limited, although the economic and social benefits associated with this activity are sizable and the importance of understanding the behaviour of recreational fishers for the sustainable management of aquatic resources is well recognised. In our contingent valuation surveys, we use a double-bounded version of the dichotomous choice question, which improves the statistical efficiency of the estimates relative to those based on a single dichotomous choice question. We test and control for response bias, in the form of anchoring and a shift effect, that may occur in data collected using a double-bounded dichotomous choice (DBDC) elicitation format. We highlight the importance of identifying and correcting for response bias in DBDC models on a case-by-case basis. Our estimation results show that there is no significant difference in the willingness to pay for a day of recreational fishing across individuals who caught different number of fish in either fishery. This suggests that high and low catch fishers placed the same value on a day's fishing.

Key words: anchoring, contingent valuation, recreational fishing, response bias, shift effect.

1. Introduction

Worldwide recreational fishing provides sizeable economic and social benefits, and in some fisheries recreational catch comprises a significant proportion of total extractive resource use (McPhee *et al*. 2002; Post *et al*. 2002; Campbell and Murphy 2005). However, many marine systems that support important recreational fisheries are under pressure from a wide range of processes, including overfishing by both commercial and recreational sectors,

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habitat degradation, and changes in species abundance and distribution and ecosystem function (Jackson *et al.* 2001; Cooke and Cowx 2004; Worm *et al.* 2006). It is increasingly acknowledged that the sustainable management of marine resources to meet the broad range of demands placed upon them requires managers to understand the way in which recreational fishers make decisions about their interactions with marine systems as well as how changes in the economic and ecological environments impact their behaviour and welfare (McPhee *et al.* 2002; Post *et al.* 2002; Cooke and Cowx 2004, 2006; Cooke and Schramm 2007).

In Australia, according to the most comprehensive survey of recreational fishing to date (Henry and Lyle 2003), 3.36 million people had engaged in recreational fishing at least once in the 12 months prior to May 2000, with a total catch of approximately 136 million aquatic animals. Furthermore, it is estimated that Australian recreational fishers spent $1.85 billion for services and items attributed to recreational fishing in the 12 months between May 2000 and April 2001 (Campbell and Murphy 2005). Given the size of the recreational fishing sector in Australia, it is recognised that there is a need to explicitly consider the recreational fishing sector in the management of aquatic resources (DAFF 2011). However, research into recreational fisheries remains relatively underdeveloped and our understanding of the behaviour of recreational fishers under alternative management strategies, as well as the link between characteristics of the fishing experience and fishers' welfare, are limited. Improving our understanding of recreational fishing is important to address key management issues, such as the allocation of fishing rights across sectors, the implementation of harvesting controls (such as fishing seasons and gear restrictions) and of spatial closures including marine reserves (Ditton 2004).

The main objective of this article is to address the need for increased research into recreational fishing in Australia through the use of contingent valuation, a stated preference non-market valuation technique. There is a large amount of existing research estimating the economic value of recreational fishing activities in North America (Johnston *et al.* 2006); however, the number of published studies focusing on Australian and New Zealand recreational fishing is much more limited.[1] In this article, we estimate recreational fishers' willingness to pay (WTP) for their most recent day's fishing in two important Tasmanian recreational fisheries, the inshore saltwater and rock lobster fisheries. Recreational fishing activity is particularly important in Tasmania, where the participation rate of 29 per cent in 2000 was the second highest in the country (Henry and Lyle 2003). We also estimate the effects of various individual characteristics of the fisher, the fishing method and catch,

[1] Some exceptions include Wheeler and Damania (2001) for New Zealand marine fishing, Kerr (1996) and Kerr and Greer (2004) for New Zealand freshwater fishing, Rolfe and Prayaga (2007) for freshwater dams in Queensland and Prayaga *et al.* (2010) for recreational fishing on the Great Barrier Reef. We also note that there are a number of unpublished studies.

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as well as fishers' subjective assessment of the motivation and quality of the fishing experience, on the inter-person difference in WTP for the most recent day's fishing.

Consistent with the recommendations of the National Oceanic and Atmospheric Administration panel (Arrow *et al.* 1993), we use a dichotomous choice format for the contingent valuation question. In the survey, recreational fishers who had participated in fishing activities in the previous 12 months were invited to indicate whether or not they would have chosen to spend the last day's fishing had it cost them a specified amount (i.e. bid) more than it actually did. In contrast to previous contingent valuation studies of recreational fishing in New Zealand and Australia (Wheeler and Damania 2001; Rolfe and Prayaga 2007), we use a double-bounded version of the dichotomous choice question format, in which a follow-up dichotomous choice question is asked after the first valuation question (Carson *et al.* 1986).[2] A positive response to the initial bid is met with a second valuation question in which the bid amount is larger than the initial bid, while a negative response results in the respondent being asked a follow-up question in which the bid amount is smaller than the initial bid. By asking respondents the follow-up valuation question, the statistical efficiency of the estimates based on a single dichotomous choice question can be improved (Hanemann *et al.* 1991).

The use of the double-bounded dichotomous choice (DBDC) contingent valuation format is not uncontested, and several studies have found a consistent difference in estimated marginal effects of particular variables, as well as mean WTP estimates, between single- and double-bounded models (e.g. Hanemann *et al.* 1991; Kanninen 1995; Flachaire and Hollard 2006). Kanninen (1995) shows that this difference cannot be fully attributed to bias in the estimation methods or bid design and suggests that the difference might be explained by respondents' behavioural response bias instead. Respondents may, for example, adjust their WTP in light of some piece of information or anchor, which may or may not be associated with the contingent valuation survey (Boyle *et al.* 1985; Green *et al.* 1998). Respondents may also answer the valuation question according to perceived social norms (Kahneman and Knetsch 1992).

A second objective of the article is to address these behavioural issues in DBDC contingent valuation surveys. We employ estimation models that have been developed in previous studies to control for possible response bias. Herriges and Shogren (1996) develop an anchoring model, allowing the possibility that respondents may anchor their WTP to an initial bid amount that is randomly assigned to them. Alberini *et al.* (1997) propose an alternative model that incorporates incentive effects as a form of response bias, in which respondents' WTP when answering the second valuation question is structurally shifted from the true WTP (i.e. shift effect). Possible behavioural explana-

[2] By contrast, the previous studies use the single-bounded dichotomous choice format where the 'yes/no' valuation question is asked only once.

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tions for this form of response bias include yea- (nay-) saying where respondents may have a tendency to agree (disagree) according to their perceptions of the expectations of the interviewer. In the presence of anchoring and/or shift effect, the responses to the first and second valuation questions are made based on different WTPs. Because such data do not reflect respondents' true preferences, parameter and WTP estimates are subject to bias. To avoid such bias, we provide a careful diagnosis of possible anchoring and shift effect by estimating four econometric models and then performing appropriate model selection.

The remainder of this article is organised as follows. In section 2, we provide an overview of the socio-economic characteristics of the Tasmanian recreational fishery and of the surveys and data used in this study. In section 3, we describe the DBDC contingent valuation format used in our survey and summarise responses to the valuation questions. The econometric models, estimation method and model selection process are then outlined. We also report and discuss the estimation results in this section. We conclude in section 4.

2. Descriptions of fisheries and of fisher surveys

2.1. Tasmanian recreational fishery: overview

The most recent survey of recreational fishing in Tasmania was conducted in 2007/08 and provides a comprehensive description of the fishery in terms of fisher demographics, participation, catch and effort (Lyle *et al.* 2009). Recreational fishers are more likely to be male (with a participation rate of 38 per - cent for males, compared with 18 per cent for females) and to be between the ages of 30–44 years. Regional participation rates vary between 24 and 33 per cent depending on area of residence, with an overall participation rate in 2007 of 26 per cent amongst Tasmanian residents.

Recreational fishing makes an important contribution to social and economic activities in Tasmania. According to Lyle *et al.* (2009), approximately 128 000 Tasmanian residents participated in recreational fishing between December 2007 and November 2008, accounting for around 640 000 person days of fishing effort. Although the median number of days fished per person is five, individual activity levels are highly skewed, with just 20 per cent of fishers accounting for 56 per cent of the total state-wide effort. In an earlier survey, the total attributable fishing expenditure in Tasmania over the 12-month period between May 2000 and April 2001 was estimated at $51.86 million (Henry and Lyle 2003).

Recreational fishing activities in Tasmania involve a variety of fishing techniques and equipment targeting a diverse range of fish and invertebrates in freshwater, estuarine and marine environments. In this study, based on habitat, method and target species, we have disaggregated fishing activity into seven major categories: dive fishing (non-rock lobster), freshwater fishing,

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gamefish fishing, inshore saltwater fishing, net fishing, offshore bottom fishing and rock lobster fishing. Our valuation exercise focuses on two of the most important fisheries, the inshore saltwater fishery and the rock lobster fishery, both of which interact and compete with commercial fisheries.

2.2. Survey descriptions

The survey instrument used in this study for both fisheries was a structured questionnaire that was composed of five parts and was administrated by telephone. The first section provided an introduction and background to the survey, while the following two sections asked questions about respondents' general attitudes toward fishing and details of their fishing activities over the previous 12 months. The fourth section required a series of questions about the respondents' experience on their most recent day's fishing and posed two dichotomous choice contingent valuation questions. The final section of the survey collected demographic information from each respondent.

The survey group for the inshore saltwater fishery was chosen from a sample of fishers who had participated in the 2007/08 recreational fishing survey (Lyle *et al.* 2009). Initial selection into the recreational fishing survey was based on a stratified random telephone survey of households. At the completion of the recreational fishing survey in December 2008/January 2009, all respondents were asked if they would be willing to participate in a follow-up valuation survey. Those who indicated that they would be interested and had performed some fishing during 2007/08 were included in the sample group for the follow-up valuation survey that was conducted in mid-2009. This group consisted of 604 households but became a net sample of 486 households after removing non-contacts and ineligible responses, in which the individual answering the survey was < 18 years of age. Of these, 480 households fully responded, with 314 reporting that their most recent day's fishing included activities that met the definition of the inshore saltwater fishery and who were therefore considered within the scope of the study. After excluding respondents who provided inconsistent responses or gave answers protesting the valuation component of the survey, the usable sample was reduced to 293 households.

In the case of the rock lobster fishery, the survey group was selected from fishers who had participated in a survey of the 2008/09 recreational rock lobster fishery (Lyle and Tracey 2010). Initial selection in the rock lobster survey was based on a random sample drawn from the Tasmanian recreational rock lobster licensing system. The valuation survey was conducted after the completion of the 2008/09 survey from late 2009 to early 2010, with 674 license holders being identified in the sample group. Discounting non-contacts and ineligible respondents, 97.3 per cent of the net sample fully responded. Of the 622 fully responding license holders, 423 had fished for rock lobster during the 2008/09 fishing season and were considered in scope. After removing protesters to the valuation questions and responses for which daily cost infor-

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mation was contradictory, a usable sample of 384 rock lobster fishers was available for the contingent valuation exercise. As initial sampling was based on random selection and survey response rates were high for both the inshore saltwater and rock lobster fisheries, the samples can be considered representative.

2.3. Fisheries descriptions and summary statistics

2.3.1. Inshore saltwater fishery

The inshore saltwater fishery is defined as line fishing in marine waters within five kilometres from the coast targeting a range of inshore marine and estuarine fish species. As such, the inshore saltwater fishery attracts both shore and boat-based fishing and may be associated with a range of other fishing activities (e.g. dive collection or potting for rock lobster and netting). A disproportionately high amount of fishing effort in this fishery is concentrated in the waters off Tasmania's south-east coast, reflecting the relatively sheltered waters and ready access points, close proximity to the largest population centre in Tasmania and a diverse array of fish species and habitats within the south-east. Despite the diversity of species, flathead (*Platycephalus* spp.) accounted for 76 per cent of the recreational scalefish caught within the inshore saltwater fishery, exceeding the commercial catch by a factor of four based on estimated landed weights (Lyle *et al.* 2009).

The summary statistics of the data collected in our inshore saltwater fishery survey are provided in Table 1. On their most recent day's fishing, 68 per cent of respondents indicated that they were targeting a single species, with 48 per cent nominating flathead as their sole target species, whereas 23 per cent and 10 per cent were either targeting multiple species or nominated no specific target species. In total, respondents reported having caught about 30 different species of fish on the last day's fishing. In terms of motivational factors, 28 and 38 per cent of respondents reported that either 'enjoying the outdoors' or 'spending time with family and friends' was their main motivation for going fishing on that day. Only 22 per cent of respondents said that the main motivation was catch-related ('catching fish to eat' or 'catching fish for sport').

2.3.2. Rock lobster fishery

Southern rock lobster (*Jasus edwardsii*) is the target species in the Tasmanian rock lobster fishery, being highly prized by recreational fishers as well as supporting a major commercial fishery (Lyle *et al.* 2005). Lobsters are targeted using three capture methods; dive collection, lobster pots and lobster rings (hoop nets). Recreational access to the fishery is largely boat based and participants require method-specific licenses. The popularity of lobster fishing in Tasmania has increased markedly in recent years. Since the present licensing system was introduced in 1995, the number of

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Table 1 Summary statistics of inshore saltwater fishery survey sample

Variable	Description	Mean	SD
Male	Gender (male = 1, female = 0)	0.79	0.41
Age†	Age (< 20 = 1, 20–29 = 2,…, 60–69 = 6, > 69 = 7)	5	1.34
Fulltime‡	Currently working full time (yes = 1, no = 0)	0.6	0.49
Income†	Income (< \$20k = 1, \$20k–\$40k = 2,…, \$80k–\$100k = 5, > \$100k = 6)	3	1.33
Days	The number of days spent fishing in the last 12 months	14.67	18.31
Fh_Caught	The number of flathead caught on the last day of fishing	7.37	10.95
As_Caught	The number of Australian salmon caught on the last day of fishing	0.53	1.98
Oth_Caught	The number of other species caught on the last day of fishing	1.59	3.98
Fh_Target‡	Specifically targeted flathead	0.48	0.50
As_Target‡	Specifically targeted Australian salmon	0.09	0.28
Oth_Target‡	Specifically targeted other species	0.11	0.31
Mix_Target‡	Targeted multiple species	0.23	0.42
Non_Target‡	Did not target any species	0.10	0.29
Hours	The amount of time spent fishing on the last day of fishing	4.47	1.34
Boat‡	Fished from boat	0.65	0.48
Shore‡	Fished from a shore	0.23	0.42
Jetty‡	Fished from a jetty	0.13	0.33
Importance†	How important fishing was on that fishing day (most important = 3,…, less important = 1)	3	0.62
Conditions†	Overall fishing condition (excellent = 5,…, terrible = 0)	4	1.85
OtherPersons	The number of other persons in the fishing party	2.03	1.81
Children‡	Respondent went fishing with his/her children	0.38	0.49
MotivEat‡	The main motivation for going fishing was to catch fish for eating	0.19	0.39
MotivOut‡	The main motivation for going fishing was to enjoy the outdoors	0.28	0.45
MotivPeople‡	The main motivation for going fishing was to spend time with friends/family	0.38	0.49
MotivSport	The main motivation for going fishing was to catch fish for sport	0.03	0.18
MotivOther‡	The main motivation was some reason(s) other than those given by the interviewer	0.12	0.12
Cost	Total amount spent for the last day of fishing	42.79	41.97

Notes: †These variables are measured on Likert-type scales and the median values, instead of the mean values, are reported. ‡These variables are dummy variables that take the value 1 when respondents answer yes, 0 otherwise.

licensed fishers increased from around 8500 to over 21 000 in 2009 (Lyle and Tracey 2010).[3]

The summary statistics of the data collected in our rock lobster fishery survey are provided in Table 2. Lobster pots were the most commonly used fish-

[3] Concurrent with this rise in popularity, six comprehensive biennial catch and effort surveys of the recreational lobster fishery have been conducted since 1996. See Lyle and Tracey (2010) for the most recent survey report. A recent socio-economic evaluation of Tasmanian lobster fishers has also been completed (Frijlink and Lyle 2010).

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Table 2 Summary statistics of rock lobster survey sample

Variable	Description	Mean	SD
Male	Gender (male = 1, female = 0)	0.92	0.27
Income†	Income (< \$20k = 1, \$20k–\$40k = 2,…, \$80k–\$100k = 5, > \$100k = 6)	3	1.46
Experience	The number of years of experience in rock lobster fishing in Tasmania	20.77	15.02
Plan10‡	Plan to go lobster fishing in 10 years time	0.79	0.41
RLmain‡	Rock lobster fishing/diving is the main fishing activity	0.17	0.37
BoatOwn‡	Own any boat(s) used for fishing/diving	0.77	0.42
Kept	Number of rock lobster kept on the last day of fishing	1.01	1.53
Release	Number of rock lobster released on the last day of fishing	0.42	1.14
Dive‡	Fishing method on the last day of fishing was 'dive'	0.28	0.45
Pot‡	Fishing method on the last day of fishing was 'pot'	0.64	0.48
OtherFishing‡	Did other types of fishing	0.67	0.47
Trip‡	The last day of fishing was part of a multi-day trip	0.61	0.49
Importance†	How important fishing was on that fishing day (most important = 3,…, less important = 1)	3	0.64
Quality†	Overall fishing quality based on the number of lobsters and fish caught (excellent = 5,…, terrible = 1)	3	1.15
OtherPersons	The number of other persons in the fishing party	2.52	1.89
Children‡	Respondent went fishing with his/her children	0.18	0.38
MotivEat‡	The main motivation for going fishing was to catch fish for eating	0.14	0.35
MotivOut‡	The main motivation for going fishing was to enjoy the outdoors	0.15	0.36
MotivPeople‡	The main motivation for going fishing was to spend time with friends/family	0.30	0.46
MotivRelax‡	The main motivation for going fishing was to relax	0.10	0.31
MotivCatch‡	The main motivation for going fishing was for enjoyment of catching lobsters	0.14	0.35
MotivOther‡	The main motivation was some reason(s) other than those given by the interviewer	0.16	0.37
Cost	Total amount spent for the last day of fishing	81.55	94.40

Notes: †These variables are measured on Likert-type scales and the median values, instead of the mean values, are reported. ‡These variables are dummy variables that take the value 1 when respondents answer yes, 0 otherwise.

ing method on the most recent day's fishing (64 per cent) followed by dive collection (28 per cent). Less than 5 per cent of respondents reported using other fishing methods, including rings and/or combined fishing methods during their last day's fishing for lobster. On average, the number of rock lobsters caught on the last day's fishing was low (1.31 lobsters per person), and 56 per cent of respondents did not catch any lobster.

As a measure of commitment to the rock lobster fishery, respondents were asked whether they expected to still be fishing for rock lobster in 10 years time, nearly 80 per cent suggested they would continue fishing for rock lobster, whereas only 17 per cent of the sample indicated that rock lobster fishing is their main fishing activity and 67 per cent combined rock lobster fishing with other types of fishing on the last fishing day. As with the inshore

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saltwater fishery, the most prominent motivational factor for going lobster fishing was to spend time with friends and family. By contrast, the catch-related motivation was stronger in the rock lobster fishery than in the inshore saltwater fishery. In total, 28 per cent of the sample indicated the main motivation for going lobster fishing was either to catch them for eating or to enjoy catching lobsters.

3. Estimating willingness to pay for a day of recreational fishing in Tasmania

3.1. Double-bounded dichotomous choice method

We adopt a double-bounded dichotomous choice (DBDC) contingent valuation method to estimate respondents' WTP for the last day of fishing in the Tasmanian inshore saltwater and rock lobster fisheries. In DBDC contingent valuation, a dichotomous choice valuation question is asked twice. The format of the valuation question is similar to that used by Cameron and James (1986) and Wheeler and Damania (2001) where the payment vehicle is respondents' personal expenses on the consumable items in the last day's fishing.[4] This payment vehicle is chosen for its simplicity and because it avoids the need to introduce a license fee or tax, both of which may elicit protest bids from respondents.[5] Moreover, respondents are familiar with their expenses on these items so that the tradeoffs presented in the valuation question are realistic.

To place the valuation questions within the context of their fishing activity, respondents were first asked about their annual fishing activity, the most recent fishing trip and their personal expenses on the consumable items on that day. The dichotomous choice valuation questions were then asked as below:

> Bearing in mind that you may have many calls on your income, if it had cost you an extra $\$XX$ on these items for this day's fishing would you still have gone fishing on that day?(Q1)
>
> … would you have still gone fishing on that day if it had cost you an additional $\$YY$?(Q2)

where $\$XX$ is an initial bid and $\$YY$ is the second bid. The survey was pretested and a range of values was chosen for the initial bid $\$XX$, namely 10, 20, 30, 40, 50 or 60. These values were randomised according to a uniform probability distribution and a unique set of valuation questions was gener-

[4] Those include, for example, bait, fuel for boat/car, food and fishing tackle (but exclude major items such as rods and reels).

[5] Remaining protest bids were identified by including a 'not willing to answer' option for the valuation questions, and asking respondents who answered {no, no} to explain this response.

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ated in which $\$YY$ was calculated as either double or half of $\$XX$, respectively, depending upon whether a participant responded in the affirmative or negative to the initial bid. Consequently, there are four possible combinations of responses to the DBDC valuation question: {yes, yes}, {yes, no}, {no, yes} and {no, no}.

Figures 1 and 2 summarise respondents' answers to the valuation questions for the inshore saltwater fishery (Figure 1) and the rock lobster fishery (Figure 2) disaggregated over the initial bid amounts. The figure shows that, for both fisheries, the proportion of responses in the {yes, yes} category decreases with increases in the initial bid. The absence of {no, no} and the low incidence of {no, yes} responses among people receiving an initial bid of \$10 also suggests that the range of bids has been reasonably well chosen in both fisheries. The proportion of respondents answering no to the first valuation question is higher in the inshore saltwater fishery than that in the rock lobster fishery for all initial bids.

While respondents' true WTP cannot be observed directly from Figures 1 and 2, we observe their binary responses to different bid amounts. Given the observed responses to the valuation questions, we can estimate respondents' true WTP for the last fishing day, using a statistical procedure developed by Cameron and James (1987) originally for the single-bounded model.

3.2. The econometric models: anchoring bias and shift effect

We assume that the respondent *i*'s true WTP (WTP_i^*) can be specified as a linear combination of *k* independent variables, such that:

$$\mathrm{WTP}_i^* = x_i'\beta + \varepsilon_i \tag{1}$$

where x_i is a $k \times 1$ vector of the independent variables, β is a $k \times 1$ vector of the corresponding coefficients and ε_i is an error term that is normally distributed with zero mean and variance σ^2.

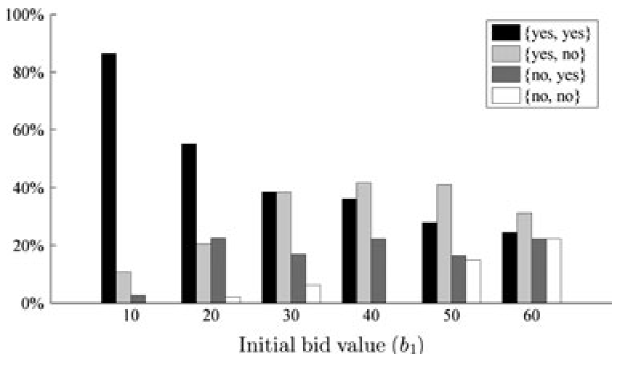

Figure 1 Distribution of responses to contingent valuation questions for each initial bid: inshore saltwater fishery.

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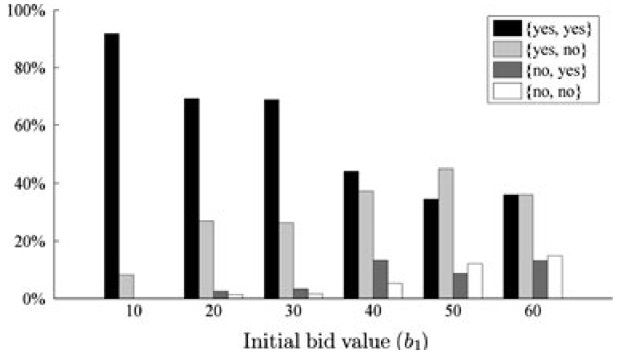

Figure 2 Distribution of responses to contingent valuation questions for each initial bid: rock lobster fishery.

The individual i's response to each valuation question is defined as follows. If the respondent's WTP is greater than the bid value, the respondent answers yes and no otherwise, that is

$$\text{If}\begin{cases} \text{WTP}_{ji} \geq b_{ji} \\ \text{WTP}_{ji} < b_{ji} \end{cases}, \text{ then } \begin{cases} y_{ji} = 1 \\ y_{ji} = 0 \end{cases}, \ i = 1,\ 2,\ \ldots N \text{ and } j = 1,\ 2$$

where WTP_{ji} is the respondent i's WTP used to answer the j-th valuation question, b_{ji} is the bid amount and y_{ji} is the indicator variable ($y_{ji} = 1$ denotes 'yes' and $y_{ji} = 0$ is 'no') for the j-th valuation question.

An important issue that has been discussed in the contingent valuation literature is whether asking a follow-up valuation question (Q2 above) will improve the estimate of the WTP. It is generally accepted that the dichotomous choice contingent valuation format is preferred to the open-ended question format (Arrow *et al.* 1993). However, debate continues about whether gains in statistical efficiency associated with a multiple bid format offset the bias that can result from various forms of response bias (Hanemann *et al.* 1991; Cameron and Quiggin 1994; Flachaire and Hollard 2006). For example, respondents may use information provided as part of the valuation exercise to re-evaluate their attitude towards the good or service being valued. Consequently, the answers to the first and second valuation questions would be based on different WTPs, that is $\text{WTP}_{1i} \neq \text{WTP}_{2i}$ (Boyle *et al.* 1985). Respondents may also modify their WTP so as to give responses that they believe are in some sense socially desirable (Kahneman and Knetsch 1992; Kanninen 1995).

This article focuses on response bias in the form of anchoring and a shift effect. Anchoring is a situation where respondents anchor their WTP to a bid amount that is randomly drawn in the survey so that it should not affect respondents' answers to the valuation question (Herriges and Shogren 1996). The shift effect is present when respondents' WTP is systematically shifted

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from their true WTP and responses to bid amounts do not thus reflect the true WTP (Alberini *et al.* 1997). Previous studies consistently find evidence of both the anchoring and shift effects in DBDC contingent valuation surveys and suggest that both the estimates of the mean WTP and the marginal values associated with particular variables are biased when these effects are not appropriately controlled in the estimation (Herriges and Shogren 1996; Alberini *et al.* 1997; DeShazo 2002; Whitehead 2002; Chien *et al.* 2005; Flachaire and Hollard 2006).

In this study, four econometric models are estimated to test and control for possible anchoring bias and/or shift effect in the DBDC contingent valuation. The four estimated models are the following: (i) the conventional double-bounded model that incorporates neither the anchoring nor shift effect; (ii) the anchoring model that accounts only for a potential bias due to anchoring behaviour; (iii) the shift effect model that accounts only for a structural shift in respondents' WTP; and (iv) the anchoring and shift effect model that controls for both the anchoring bias and shift effect simultaneously.

3.2.1. Conventional double-bounded model

The conventional double-bounded model assumes that the respondent i uses their true WTP (WTP_i^*), to answer both the first and second valuation questions, that is

$$\mathrm{WTP}_i^* = \mathrm{WTP}_{1i} = \mathrm{WTP}_{2i} \tag{2}$$

3.2.2. Anchoring model

Herriges and Shogren (1996) develop a framework that explicitly models and estimates the effect of anchoring within the double-bounded model. Their model assumes a particular form of anchoring in which respondents' WTP when answering the second valuation question is a weighted average of their true WTP (WTP_i^*) and the first bid amount (b_{1i}), such that:

$$WTP_{2i} = (1-\gamma)WTP_{1i} + \gamma b_{1i} \,\text{where}\, \mathrm{WTP}_i^* = \mathrm{WTP}_{1i} \tag{3}$$

where $0 \leq \gamma \leq 1$ is the anchoring parameter that measures the degree of anchoring. When $\gamma = 1$ the respondent totally replaces the true WTP with the initial bid amount; whereas there is no anchoring behaviour when $\gamma = 0$.

3.3.3. Shift effect model

Alberini *et al.* (1997) propose a model which assumes that respondents' WTP when answering the second valuation question is exogenously shifted from the true WTP, such that:

$$\mathrm{WTP}_{2i} = \mathrm{WTP}_{1i} + \delta \,\text{where}\, \mathrm{WTP}_i^* = \mathrm{WTP}_{1i} \tag{4}$$

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where δ is the shift parameter. When the shift parameter is negative ($\delta < 0$), respondents systematically devalue their WTP following the first valuation question. By contrast, a positive estimated shift parameter ($\delta > 0$) represents a form of 'yea-saying' or acquiescence behaviour (Kanninen 1995), in which respondents overestimate their WTP for the second valuation question as a result of a tendency to respond positively regardless of the bid level.

3.3.4. Anchoring and shift effect model

Whitehead's (2002) model allows for the possibility that responses to the DBDC contingent valuation may simultaneously reflect an anchoring bias and a shift effect, such that:

$$\mathrm{WTP}_{2i} = (1-\gamma)\mathrm{WTP}_i^* + \gamma b_{1i} + \delta \text{ where } \mathrm{WTP}_i^* = \mathrm{WTP}_{1i} \tag{5}$$

The conventional double-bounded model in (2), the anchoring model in (3) and the shift effect model in (4) represent restricted versions of the anchoring and shift effect model in (5). The anchoring model is retained by imposing the restriction of $\delta = 0$ on (5), and we have the shift effect model when $\gamma = 0$. When both parameters are $\gamma = 0$ and $\delta = 0$, then the model in (5) becomes the conventional double-bounded model. By estimating the four models, respectively, model selection can be performed based on hypothesis testing on whether $\gamma = 0$ and $\delta = 0$.

3.3. Estimation

We estimate the four econometric models by maximum likelihood using the log-likelihood function as below:

$$\begin{aligned}\ln l = \sum_{i=1}^{n} \big(& y_{1i}y_{2i}\ln[\Pr(\text{yes, yes})] + y_{1i}(1-y_{2i})\ln[\Pr(\text{yes, no})] + \\ & (1-y_{1i})y_{2i}\ln[\Pr(\text{no, yes})] + (1-y_{1i})(1-y_{2i})\ln[\Pr(\text{no, no})]\big)\end{aligned}$$

The probabilities that respondent i answers {yes, yes}, {yes, no}, {no, yes} and {no, no} are defined as:

$$\Pr(\text{yes, yes}) = \Pr(y_{1i}=1, y_{2i}=1) = \Pr(\mathrm{WTP}_{2i} > b_{2i})$$

$$\Pr(\text{yes, no}) = \Pr(y_{1i}=1, y_{2i}=0) = \Pr(b_{2i} > \mathrm{WTP}_{2i} > b_{1i})$$

$$\Pr(\text{no, yes}) = \Pr(y_{1i}=0, y_{2i}=1) = \Pr(b_{1i} > \mathrm{WTP}_{2i} > b_{2i})$$

$$\Pr(\text{no, no}) = \Pr(y_{1i}=0, y_{2i}=0) = \Pr(b_{2i} > \mathrm{WTP}_{2i})$$

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The probabilities for the anchoring and shift effect model in (5) can be computed as:

$$\begin{aligned}\Pr(\text{yes},\text{yes}) &= 1-\Phi\left(\left[\frac{b_{2i}-\gamma b_{1i}-\delta}{1-\gamma}-x_i'\beta\right]\Big/\sigma\right)\\ \Pr(\text{yes},\text{no}) &= \Phi\left(\left[\frac{b_{2i}-\gamma b_{1i}-\delta}{1-\gamma}-x_i'\beta\right]\Big/\sigma\right)-\Phi\left(\left[b_{1i}-x_i'\beta\right]/\sigma\right)\\ \Pr(\text{no},\text{yes}) &= \Phi\left(\left[b_{1i}-x_i'\beta\right]/\sigma\right)-\Phi\left(\left[\frac{b_{2i}-\gamma b_{1i}-\delta}{1-\gamma}-x_i'\beta\right]\Big/\sigma\right)\\ \Pr(\text{no},\text{no}) &= \Phi\left(\left[\frac{b_{2i}-\gamma b_{1i}-\delta}{1-\gamma}-x_i'\beta\right]\Big/\sigma\right)\end{aligned} \tag{6}$$

where $\Phi(\cdot)$ is the standard normal cumulative density function. The probabilities for the conventional double-bounded model, anchoring model and shift effect model are computed by imposing restrictions on (6), as discussed previously. Because the cumulative density functions are non-linear in the parameters, we bootstrap the standard errors of the parameters estimated and a confidence interval for the mean WTP with 1000 replications.

3.4. Model selection and estimation results

We select a preferred model for each fishery on the basis of testing whether $\gamma = 0$ and $\delta = 0$ in the combined model, which accounts for both an anchoring bias and shift effect occurring simultaneously. Table 3 summarises the estimation results for the inshore saltwater fishery for the four econometric models. In the combined model, the anchoring and shift parameters (γ and δ) are statistically significant at the 1 per cent and 5 per cent level of significance, meaning that estimates from the models that do not control for both forms of response bias simultaneously are potentially biased. We therefore select the anchoring and shift effect model as the preferred model and interpret the estimation results on the basis of this model.

Table 4 summarises the estimation results of the four econometric models for the rock lobster fishery. The preferred model for the rock lobster fishery is not as clear as that for the inshore saltwater fishery. While only the shift effect parameter is significant (at the 1 per cent level) in the combined model, the anchoring and shift effect parameters are both significant (at the 5 per cent and 1 per cent level, respectively) when tested independently in the anchoring model and the shift effect model. Because the inclusion of an irrelevant variable leads to an efficiency loss in the estimation, we select the shift effect model in (4) as the preferred model for the rock lobster fishery.[6]

[6] We note that, among the four econometric models, the signs for the estimated coefficients are the same (except for Male).

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Table 3 Estimation results for inshore saltwater fishery

Independent variable	Econometric model			
	Conventional double-bounded	Anchoring	Shift effect	Anchoring and shift effect
	Estimate (standard error)†‡			
Constant	26.17 (17.12)	20.74 (35.58)	24.57 (17.54)	17.12 (31.51)
Male	10.50 (6.83)	16.31 (12.79)*	10.34 (6.59)	16.64 (12.67)*
Age	−2.08 (2.30)	−3.52 (4.40)	−2.05 (2.32)	−3.63 (4.21)
Fulltime	12.27 (7.30)	19.21 (14.10)	12.11 (7.10)	19.58 (13.56)*
Income	2.08 (2.54)	3.11 (4.73)	2.06 (2.42)	3.17 (4.63)
Days	0.07 (0.14)	0.05 (0.25)	0.07 (0.14)	0.05 (0.26)
Fh_Caught	−0.01 (0.27)	0.02 (0.48)	0.00 (0.25)	0.03 (0.45)
As_Caught	−0.57 (1.74)	−1.10 (3.57)	−0.59 (1.80)	−1.21 (3.24)
Oth_Caught	0.58 (0.75)	1.08 (1.44)	0.56 (0.73)	1.09 (1.39)
Fh_Target	−11.42 (7.09)	−16.35 (13.00)	−11.16 (6.78)**	−16.38 (12.94)
As_Target	−3.63 (9.61)	−4.18 (18.00)	−3.75 (9.68)	−4.44 (18.68)
Oth_Target	−12.85 (9.29)	−16.33 (15.81)	−12.75 (8.57)	−16.49 (16.58)
Non_Target	−14.72 (9.04)	−22.07 (17.48)	−14.46 (8.98)	−22.31 (15.98)*
Hours	−0.05 (1.81)	−0.84 (3.30)	0.01 (1.90)	−0.81 (3.10)
Boat	9.72 (6.43)	17.14 (13.54)*	9.52 (6.38)	17.55 (13.06)*
Importance	2.25 (4.40)	5.18 (10.87)	2.07 (4.45)	5.15 (7.94)
Conditions	1.45 (1.32)	1.85 (2.32)	1.43 (1.30)	1.85 (2.29)
OtherPersons	7.63 (1.94)**	11.71 (6.00)**	7.50 (2.03)**	11.89 (4.96)**
Children	−10.41 (5.73)*	−15.15 (11.54)	−10.26 (5.86)*	−15.38 (11.45)
MotivOther	−16.74 (7.98)*	−26.71 (18.52)*	−16.80 (8.38)*	−27.94 (16.23)*
Cost	0.17 (0.17)*	0.24 (0.26)*	0.16 (0.07)**	0.24 (0.14)*
σ	33.13 (2.18)**	51.00 (20.21)**	32.70 (2.14)**	52.05 (17.10)**
γ	–	0.39 (0.16)*	–	0.42 (0.16)**
δ	–	–	3.35 (1.75)*	3.73 (1.72)*
log-likelihood	−317.62	−314.68	−315.71	−312.30
Observations	293	293	293	293
Mean willingness to pay	65.21	81.15	62.78	78.18
95% confidence interval†	[60.48, 70.04]	[66.31, 116.05]	[57.90, 67.85]	[63.04, 108.38]

Notes: †Standard errors and 95% confidence interval are bootstrapped with 1000 replications. ‡**1% level of significance, *5% level of significance.

Using the anchoring and shift effect model, we estimate that the mean WTP, in excess of actual costs, for the last day of fishing in the inshore saltwater fishery as $78.18, with a 95 per cent confidence interval of [$63.04, $108.38]. The shift effect model estimated for the rock lobster fishery indicates that the mean WTP for the last day of lobster fishing is $87.43 with a 95 per cent confidence interval of [$81.37, $94.03]. Therefore, the mean WTP in excess of actual costs for the last day of lobster fishing was greater than that for the inshore saltwater fishery, although the difference was not statistically significant.

Our analysis enables us to distinguish the importance of fishers' valuation of the last day's fishing with various personal characteristics and that day's catch and non-catch related variables. In the inshore saltwater fishery, male respondents showed a significantly higher WTP for the last day of fishing than female

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Table 4 Estimation results for rock lobster fishery

Independent variable	Econometric model			
	Conventional double-bounded	Anchoring	Shift	Anchoring and shift
	Estimate (standard error)†‡			
Constant	43.85 (19.07)**	55.19 (33.50)*	46.98 (19.01)*	57.46 (31.91)*
Male	0.18 (8.80)	−1.35 (16.24)	0.15 (9.09)	−1.08 (14.84)
Income	4.73 (2.07)*	7.06 (5.84)*	4.95 (2.23)*	6.95 (4.24)*
Experience	0.16 (0.21)	0.19 (0.43)	0.17 (0.20)	0.20 (0.34)
Plan10	13.76 (6.56)*	21.21 (15.04)*	14.13 (6.76)*	20.34 (13.34)*
RLmain	1.69 (6.78)	2.16 (12.14)	1.51 (7.07)	1.79 (10.61)
BoatOwn	8.31 (6.36)	10.15 (11.16)	8.31 (6.35)	9.82 (10.43)
Kept	−1.77 (2.14)	−2.24 (4.16)	−1.82 (2.20)	−2.23 (3.65)
Release	0.43 (2.61)	0.93 (4.35)	0.46 (2.69)	0.87 (4.10)
Dive	−15.11 (13.01)	−22.34 (21.21)	−15.34 (13.66)	−21.28 (19.22)
Pot	−9.75 (11.91)	−12.57 (19.05)	−9.35 (12.32)	−11.46 (16.92)
OtherFishing	−1.96 (6.57)	−3.22 (12.17)	−2.10 (6.36)	−3.17 (10.71)
Trip	2.39 (5.88)	1.41 (10.91)	2.06 (5.69)	1.15 (9.90)
Importance	−7.02 (4.36)*	−11.33 (9.04)*	−7.26 (4.44)*	−10.85 (8.03)*
Quality	5.80 (2.68)**	8.55 (5.64)*	5.92 (2.72)*	8.22 (5.21)*
OtherPersons	1.90 (2.14)	3.10 (4.14)	2.04 (2.14)	3.07 (3.55)
Childeren	−5.93 (7.56)	−6.89 (13.21)	−6.07 (7.74)	−6.92 (12.39)
MotivOther	1.51 (8.78)	2.05 (16.42)	1.53 (8.61)	1.98 (13.83)
Cost	0.11 (0.05)**	0.18 (0.10)**	0.11 (0.05)**	0.17 (0.09)**
σ	40.48 (2.56)**	63.44 (25.68)**	41.60 (2.51)**	60.83 (20.05)**
γ	–	0.41 (0.18)*	–	0.36 (0.19)
δ	–	–	−5.29 (1.98)**	−4.82 (2.00)**
log-likelihood	−356.31	−353.76	−352.95	−351.10
Observations	384	384	384	384
Mean willingness to pay	82.79	110.16	87.43	111.72
95% confidence interval†	[77.48, 88.85]	[84.56, 171.54]	[81.37, 94.03]	[85.81, 167.03]

Notes: †Standard errors and 95% confidence interval are bootstrapped with 1000 replications. ‡**1% level of significance, *5% level of significance.

respondents. The WTP was also likely to be higher if the respondent was working on a full-time basis and fished from a boat. Interestingly, whether the main motivation for going fishing was associated with consumptive purpose (i.e. catch fish for eating or for sport) or non-consumptive purpose (i.e. spend time with family and/or friends, or to spend time outdoors) did not differentiate respondents' WTP in either fishery. However, fishers in the inshore saltwater fishery who had less specific intentions and motivations showed significantly lower WTP than those who targeted particular species and had clearly articulated consumptive and/or non-consumptive motivations. For example, a fisher who did not target any species was willing to pay less for the last day's fishing than one who targeted a specific species or who targeted multiple species.

While results show that WTP for the last day of fishing was higher in both fisheries the larger the size of the fishing party, the effect was significant only

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in the case of the inshore saltwater fishery. In neither fishery did the presence of children in the fishing party affect mean WTP. Previous studies have found that respondents with greater experience or skill in the fishery value the day's fishing more highly (Oh *et al*. 2005; Oh and Ditton 2008). While this is not evident in our results, lobster fishers who anticipated a commitment to participate in the fishery over the next decade were willing to pay over $14 more for the day's fishing experience.

Interestingly, in the rock lobster fishery, WTP was significantly lower for fishers for whom lobster fishing was a more important element of the day's fishing activity than for those for whom it was less important. Given the relatively low average levels of catch in this fishery, this may capture fisher's disutility with reduced catch per unit of effort where they were focused on rock lobster fishing as a major component of the day's activity.

In both fisheries, the most recent day's fishing costs have a small but significantly positive effect on mean WTP. To the extent that this variable can be interpreted as a proxy for the price of inputs used to produce the fishing day, this result is consistent with complementarity between inputs purchased in the market and the fishing day being valued (Cameron and James 1986)

Particular care needs to be taken in interpreting estimation results for the effect of the catch variable(s) in our models. In our valuation question, respondents were asked whether they would still have elected to have gone on their last day's fishing if the cost of that day had been higher, but the experience, including the number of fish caught, had remained the same. Consequently, the coefficients of the catch variables measure the inter-person difference in WTP across respondents who caught different number of fish, *ceteris paribus*. In our analysis, variables related to the number of fish caught and/or kept in both fisheries were not significant. In effect, high and low catch fishers placed the same value on a day's fishing, *ceteris paribus*. The significant positive coefficient of the quality variable in the rock lobster model, which is based on fishers' evaluation of their satisfaction with the number of lobster caught and/or kept, suggests that satisfaction with the catch on the last day is evaluated relative to individual fisher expectations. Importantly, the estimated coefficient on the catch variable in our models cannot be interpreted as implying a zero marginal effect of fish caught on fishers' WTP for the day's fishing experience. In other words, our survey data does not tell us whether the individual *i*'s WTP would increase or decrease if the person could catch one more fish in the last day's fishing.

4. Concluding remarks

This article reports results from two contingent valuation studies that estimate recreational fishers' WTP for their most recent day's fishing in the Tasmanian inshore saltwater and rock lobster fisheries. Our estimation results suggest that the value of recreational fishing in the Tasmanian inshore saltwater and rock lobster fisheries cannot be adequately captured by measuring the

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number of fish caught or the expenditure on a day's fishing activity. The variation in the value of fishing across respondents also depends on a range of factors, including the motivation and quality of fishing experience and demographic characteristics of fishers. These results are consistent with the findings in other valuation studies for marine and freshwater recreational fishing in Australia and New Zealand (e.g. Wheeler and Damania 2001; Kerr and Greer 2004; Rolfe and Prayaga 2007; Prayaga *et al*. 2010).

Importantly, the mean WTP estimates reported in this study (Tables 3 and 4) should not be interpreted as the total mean WTP for the last day of fishing because our estimates represent only one part of the total WTP. Total WTP for individual *i*'s last day of fishing consists of, at least, three parts: the amount actually spent for the day's fishing on the consumable items (e.g. bait, fuel for boat/car and food); the fixed cost already incurred for the day's fishing (e.g. rods and reels, boat and insurance); and the unobserved amount that they are willing to spend in excess of this for access to the day's fishing. WTP estimated in this study and reported in Tables 3 and 4 is the last of these, in addition to the expenditure on consumable items and fixed costs, for the last day's fishing. Further, the average total expenditure on the consumable items in the last day of fishing was \$42.79 in the inshore saltwater fishery and \$81.55 in the rock lobster fishery (Tables 1 and 2). Given these values, we re-calculate the mean WTP for the last day of inshore saltwater fishing as \$120.97 and \$168.98 for the last day of rock lobster fishing. Because the data for the fixed cost incurred for the day's fishing is not available, however, these mean WTP estimates are conservative estimates of the total loss of welfare a fisher would experience were they not to have had access to the last day's fishing.

In our analysis, we pay particular attention to the possibility of response bias occurring in the data collected using a DBDC question format. We estimate four econometric models which are nested within each other and test for the presence of anchoring bias and structural shift effects. Our estimation results ($\hat{\gamma} = 0.42$) suggest that respondents in the inshore saltwater fishery systematically anchor their WTP to the initial bid when answering the second valuation question. Furthermore, we identify a statistically significant shift effect in the survey responses for both fisheries. However, while results ($\hat{\delta} = 3.73$) indicate that respondents in the inshore saltwater fishery tend to inflate their WTP in response to the second valuation question, we identify a significant systematic negative shift effect $\hat{\delta} = -5.29$ among responses in the rock lobster fishery. We therefore select the anchoring and shift effect model for the inshore saltwater fishery and the shift effect model for the rock lobster fishery as preferred models. Empirically, the combined effect of failing to properly account for these respondent behaviours in our study could have resulted in either over- or underestimating mean WTP by about 20–27 per cent compared with the corrected model. This highlights the importance of identifying and correcting for response bias in the DBDC model on a case-by-case basis. We also suggest that double-bounded

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contingent valuation response data should be interrogated for alternative specifications of anchoring behaviour as noted by recent studies (e.g. Aprahamian *et al*. 2008; Flachaire and Hollard 2008).

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