The willingness to pay for dusky kob (*Argyrosomus japonicus*) restocking: using recreational linefishing licence fees to fund stock enhancement in South Africa

Ryan M. Palmer and Jen D. Snowball

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The economic feasibility of stock enhancement of *Argyrosomus japonicus* in South Africa was investigated using a willingness-to-pay (WTP) survey. The pilot study provides a unique example of the use of the contingent valuation method as a valuation tool for a proposed stock enhancement programme. An increase in the cost of a recreational fishing permit is used as a potential vehicle of payment. The median value of the maximum that fishers were willing to pay for a recreational fishing permit was R155 (South African Rand) for frequent fishers and R100 for non-frequent fishers. Analysis showed that a fee of more than R100 excluded up to 50% of anglers from the fishery, but that a fee of R100 excluded only 28% of recreational anglers and would generate an additional R12 million annually from the sale of recreational fishing permits. The estimated costs of set-up and running of a stock enhancement programme are substantially lower than this, suggesting that stock enhancement may be an economically feasible management option that deserves more investigation. The WTP method itself produces robust results and is likely to be an effective tool in the management of the marine environment.

Keywords: *Argyrosomus japonicus*, recreational line fishery, stock enhancement, willingness to pay.

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R. M. Palmer: Department of Ichthyology and Fisheries Science, Rhodes University, PO Box 94, Grahamstown 6140, South Africa, and South African Environmental Observation Network – Elwandle Node, Private Bag 1015, Grahamstown 6140, South Africa. J. D. Snowball: Department of Economics, Rhodes University, PO Box 94, Grahamstown 6140, South Africa. Correspondence to J. D. Snowball: tel: +27 46 603 8301; fax: +27 46 622 5210; e-mail: j.snowball@ru.ac.za.

Introduction

The spawner biomass per recruit of *Argyrosomus japonicus* in South African waters is estimated to be between 1 and 4.5% of pristine levels (Griffiths, 1997). Levels below the 20% threshold have frequently resulted in stock collapse (Griffiths, 1997) and are considered unsustainable. The species is currently managed by minimum size and daily bag limits for recreational anglers (from the shore and in estuaries: 1 fish per person per day >60 cm; from a boat at sea, Cape Agulhas to Umtamvuna River: 5 fish per person per day >50 cm, of which 1 fish may be >110 cm; from a boat at sea off KwaZulu-Natal: 5 fish per person per day >40 cm, of which 1 fish may be >110 cm). Although regulations were amended in December 2004 in an attempt to facilitate stock recovery, Griffiths (1997) suggests that with these present regulations, it may take >40 years for the stocks to recover.

The goals for managing the linefishery, articulated in the South African Marine Living Resources Act (Act No. 18 of 1998), include actively facilitating the recovery of overexploited linefish stocks and the maintenance of such stocks at optimum levels of production, goals unachievable under the current management system. Alternative management options, such as restocking programmes, are costly, and the question then arises of how such a venture might be funded. The economic feasibility of a stock enhancement programme is often evaluated by assessing its contribution to the fishery in terms of catch (Liao *et al.*, 2003). As the stock enhancement of *A. japonicus* would be aimed, primarily, at increasing the numbers of critically low stocks rather than enhancing the fishery for a species, our research investigates the willingness of resource users (the recreational anglers) to support the project through an increased cost of fishing permits.

The aim of this initial research was primarily to test the effectiveness of the willingness-to-pay (WTP) method as a valuation tool for a proposed stock enhancement programme. Although this pilot study used a limited sample (102 face-to-face interviews in the Western Cape of South Africa), results were robust enough to be used as an indication of the likely outcome of extending its scope in the future, and they present a unique application of the WTP method to a fishery enhancement programme.

For the purposes of this study, a recreational angler is defined as a holder of a valid recreational fishing permit. There are ~450 000 recreational linefishery permit holders in South Africa annually (Department of Environmental Affairs and Tourism: Chief Directorate Marine and Coastal Management, 2005). The cost of an annual recreational fishing licence in the year in which the study was conducted (2006) was R60 (ZAR, South African Rand; in 2006, ~R10= US$1). Although not the only aim of such a stock enhancement programme, stock recovery would

directly benefit recreational anglers. The proposed increased licence fee would therefore continue to work on the same principle as the present management system, whereby the user pays.

Briefly defined, stock enhancement of marine fish involves the spawning and rearing of larval fish under controlled conditions to their juvenile stage, and the release of these juveniles into the wild to augment depleted natural populations (Serafy *et al*., 1999), providing benefits to users and the public (Howell, 1998; Cowx, 1999). Stock enhancement is successfully used to manage many fish stocks in several countries, including red drum (*Sciaenops ocellatus*) in the United States (Serafy *et al*., 1999), Atlantic salmon (*Salmo salar*) in the United States and Europe (Ritter, 1997), and hatchery-reared chum salmon (*Onchorhynchus keta*) in Alaska, which have accounted for as much as 69% of the catch of that species (Knapp *et al*., 2007).

Material and methods

Contingent valuation is a method to estimate WTP—the most widely used method of estimating the non-market values of environmental attributes or amenities (Frykblom, 1997). It involves using data from a carefully designed questionnaire to estimate the amount that users may be willing to pay for a product or service that is not currently sold in the market. The method can be applied to public and private goods or to goods with mixed characteristics, as in this case. The WTP method asks respondents directly what they would be willing to pay in a hypothetical market situation to conserve or expand a good or resource (Carson *et al*., 2003). A face-to-face interview technique was used because it is generally accepted to be the most effective, facilitating explanation of the background information required and because respondents are more likely to respond to the questionnaire as well as to answer questions truthfully (Snowball, 2008). During December 2005 and January 2006, 102 recreational shore anglers were interviewed in Plettenberg Bay and Nature's Valley in South Africa's Western Cape. All anglers on the shore were approached, whether they were fishing in the estuary, in the surf, or from the rocks. Only anglers with current fishing permits were interviewed on the grounds that those not willing to pay for the existing licence would be unlikely to pay an extra amount for stock enhancement, so biasing the results. Although it is acknowledged that on-site sampling may bias results in favour of frequent fishers who were more likely to be on the shore at the time of the interview, the data collected showed a wide range of fishing frequencies. In an extended study, user bias could be controlled for by weighting the means by the inverse of the frequency of the fishing trips. In this study, however, frequency bias was reduced by sampling during the holiday season; the time of year that non-frequent fishers are more likely to fish. The data showed a representative sample with a similar number of frequent and non-frequent fishers having been interviewed.

The questionnaire consisted of six sections: (i) an introduction, giving background information and requesting participation; (ii) qualitative response opinion questions (agree, disagree, don't know); (iii) specific questions on kob fishing habits; (iv) the WTP scenario and questions (see the Extract); (v) qualitative reasons for being willing or unwilling to pay; and (vi) demographic information. As shown in the extract, the WTP scenario and questions were carefully designed to limit hypothetical bias: describing an item with which fishers were familiar and using a realistic payment vehicle (Carson and Mitchell, 1993).

Extract: the willingness-to-pay question from the survey

At present the spawner biomass per recruit of kob stocks has been reduced to <4% of pristine, indicating severe stock depletion, and the current management is not facilitating their recovery. Stock enhancement is a management method whereby kob will be bred in captivity in a hatchery until a certain size, then released into the wild to boost stocks. This will result in an increased population and eventually the full recovery of the species so that it may be harvested sustainably. The benefits to you as an angler would be that kob catches would become more frequent. Although the daily bag limit will not be increased, it may be attained more often. However, stock enhancement is an expensive management tool, so fishing licences would have to be increased.

Now I am going to suggest an amount by which licence fees would increase in order to pay for stock enhancement. The amount may sound much too low or much too high to you. It is just a starting point and you can tell me what the maximum amount you would be willing to pay would be.

Now, considering your annual income and expenses, would you be willing to pay an extra R45 per year to support stock enhancement? This means that the yearly licence fee would increase to R100.

☐ yes ☐ no

1. What is the maximum additional amount you would be willing to pay in increased licence per year?
2. How sure are you that you would really be willing to pay the amount that you mentioned? (read the options)

   ☐ not at all sure ☐ fairly sure ☐ very sure ☐ don't know

Results

The survey data showed two clearly distinguishable groups of anglers: those that fished fewer than 25 times per year (non-frequent fishers), and those that fished 25 or more times per year (frequent fishers).

The frequent fishers (42% of the sample) were more dependent on the fish that they were catching as food (subsistence), tended to fall into the low income and education categories, and were mostly (71%) local to the Plettenberg Bay area. Average spending on fishing equipment per trip was R63. Most non-frequent fishers (58% of the sample) were fishing mainly for recreation, and most (63%) were holidaymakers from outside the region. More respondents in this group were employed in high-income jobs and had better levels of education than frequent fishers. Average equipment spending per trip of this group was R333. Most anglers interviewed (89%) reported that they never or hardly ever reached their bag limit and agreed that regulation and other management methods were needed.

Some 75% of all the respondents were willing to pay more than the 2006 price for the recreational fishing permit to fund the restocking programme. Mean additional willingness to pay was R162 for the whole group, R183 for frequent, and R146 for non-frequent fishers. As expected, respondents with higher use values were willing to pay more for the goods.

Log-linear models, with the dependent variable being the WTP amount in ZAR, were run for all respondents, frequent fishers, and

non-frequent fishers (Table 1). A dummy variable, coded as 1 for frequent fishers and 0 for non-frequent fishers, was included in the model for all respondents and was positive and statistically significant, demonstrating a difference between the two groups and that the data split was justified. The general model specification was

$$\begin{aligned}\mathrm{Ln}(\mathrm{WTP}_i) = {} & \beta_1 + \beta_2\mathrm{Regs}_i + \beta_3\mathrm{Stocks}_i + \beta_4\mathrm{Recover}_i \\ & + \beta_5\mathrm{Comply}_i + \beta_6\mathrm{Job}_i + \beta_7\mathrm{Sex}_i + \beta_8\mathrm{Educ}_i \\ & + \beta_9\mathrm{Age}_i + \mu_i, \end{aligned} \quad (1)$$

where "Regs" was coded as 1 if respondents agreed that regulations were necessary, 0 otherwise; "Stocks" was coded as 1 if respondents were concerned about kob stocks; "Recover" was coded as 1 if respondents agreed that something should be done to facilitate stock recovery; "Comply" was coded as 1 if respondents reported complying with current regulations, 0 otherwise; "Job" was coded as 1 for a higher income job and 0 for lower incomes; "Sex" was coded as 1 if the respondent was male, 0 if female; "Educ" was coded as 1 if respondents had completed high school, 0 otherwise; and "Age" was coded as 1 if respondents were between 26 and 65 years old, 0 otherwise. All three models were statistically significant (all *F*-statistics significant at the 1% level) and, for cross-sectional data with small sample sizes, the model fitted the data fairly well. Only statistically significant variables are discussed in the text.

In the combined model ("all"), if respondents agreed that regulations were necessary, their average WTP increased by 33% (the percentage change in the dependent variable, WTP, in a log-linear model with dummy variables is calculated by taking the antilog of the coefficient, subtracting 1, and multiplying by 100). Demographics were also important: having a high-income job increased average WTP by 40% (as economic theory would predict: a positive relationship between income and WTP bids being an indication that respondents were considering their budgets and giving realistic answers); being male increased WTP by 33% and having completed high school increased average WTP by 40%.

When the sample was split between frequent and non-frequent fishers, clear differences emerged. In the frequent-fisher group, concern about the status of the *A. japonicus* stock increased average WTP by 88%. Having completed high school was also a highly significant and positive determinant of WTP. As found in other studies, higher levels of general education seem to be positively related to environmental awareness.

The non-frequent-fisher model fitted least well, probably because that group of fishers are more concerned with the recreational aspect of fishing than the status of *A. japonicus* stocks. The only statistically significant determinants were agreeing that regulations were important, which increased mean WTP bids by 39%, and having a higher income job, which increased WTP by 65%.

Table 1. Results of the log-linear WTP models.

Variable	All ($n = 102$)	Frequent ($n = 42$)	Non-frequent ($n = 60$)
C	3.690703***	3.949337***	3.712509***
Regs	0.282174*	0.205222	0.331178*
Stocks	0.171261	0.632081**	0.155866
Recover	−0.017562	−0.552469	0.003131
Comply	0.056222	0.180336	−0.117184
Job	0.334594**	0.212973	0.500348*
Sex	0.284506**	0.269374	0.313851
Educ	0.333552**	0.677811***	0.050657
Age	0.126604	0.083194	0.19111
Frequent	0.242838**	–	–
Adjusted r^2	0.276407	0.376851	0.20244
F-statistic	5.286793***	4.099355***	2.871951***

***Significant at the 1% level.
**Significant at the 5% level.
*Significant at the 10% level.

Set-up costs and WTP

The estimated initial set-up cost of the restocking programme would be in the order of R4 million, with annual running costs of between R1 million and R2 million (van Rooyen *et al.*, 2005). Running costs would depend on the number of fish being produced, assuming that fingerlings can be released at ~100 mm total length (Taylor *et al.*, 2005) after 3–4 months in the hatchery.

There are ~450 000 recreational fishing permit holders in South Africa annually (Department of Environmental Affairs and Tourism: Chief Directorate Marine and Coastal Management, 2005). However, as the licence fee increases, the number of licences bought is likely to decline (the law of demand: as price rises, quantity demanded falls). There is a trade-off between anglers' WTP for the recreational fishing permits and the funds generated (Figure 1). For example, a fee of R200 would generate the most income (R21.6 million), but 66% of anglers would be excluded as they would not be prepared to pay for a licence. An increase in price from R60 to R70 would result in a 24% decrease in the number of permits sold, but an increase from R70 to R100 would result in only a further 3% decrease in the number of anglers willing to pay for a recreational fishing permit. Thereafter, a substantial drop is observed, resulting in the exclusion of 50% of anglers from the recreational linefishery. On this basis, an increase in the licence fee to R100 per year would generate additional funds of almost R12 million a year—substantially more than that estimated to be required for the stock enhancement programme, even in the start-up year.

Discussion

An important concern regarding the WTP method is hypothetical bias—the fear that respondents would give unrealistically large WTP estimates—and the "free-rider" problem—that there are incentives for users to overstate their true WTP in order gain a "free ride" (Arrow *et al.*, 1993). However, extensive experimental

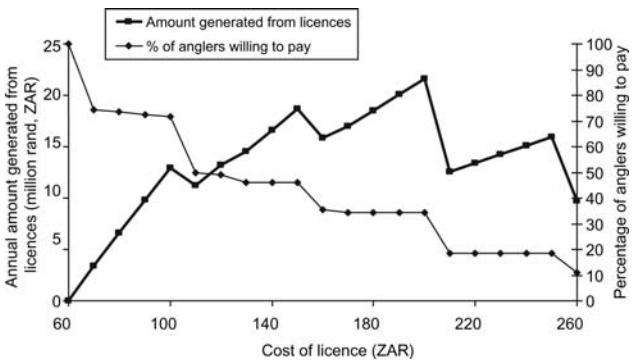

Figure 1. Cost–benefit of increased licences and the percentage of anglers willing to pay an increased licence fee.

research (Bohm, 1979; Botelho and Pinto, 2002; Murphy *et al.*, 2005; Snowball, 2008) has allayed fears of significant bias. Although it has been shown to exist, "free-rider" bias is usually small, resulting in WTP values between 1.26 and 1.30 times more than real market situations (List and Gallet, 2001), and can be circumvented by careful questionnaire design (Aadland and Caplan, 2003) and by testing for reliability and validity (Carson *et al.*, 2001).

Although some commentators argue that other forms of bias make WTP studies unreliable (Kahneman and Knetsch, 1992; Desvousges *et al.*, 1993; Diamond and Hausman, 1993), Carson and Mitchell (1993) concluded that it was the quality of the response to a WTP question that would determine the accuracy of the study. This is determined, in their view, by the survey design and administration or content validity: "Respondents must (i) clearly understand the characteristics of the good they are being asked to value; (ii) find the contingent valuation (CV) scenario elements related to the good's provision plausible; and (iii) answer the CV questions in a deliberate and meaningful manner".

Carson *et al.* (2001) identified several tests of validity and reliability for judging the success of a WTP survey. The first is construct validity, which tests the extent to which the findings are consistent with theoretical expectations. In this study, the expectation that WTP is positively related to income is borne out by the "jobs" variable, which was statistically significant and shows that, for the whole sample, having a higher income job increases mean WTP. In addition, the expectation that more frequent users of the resource would be willing to pay more than non-frequent users was shown: frequent fishers have a median WTP >50% higher than non-frequent fishers. Results of both these tests show the results of this study to be reasonable and that they can be used with a fair degree of confidence.

In conclusion, our study has illustrated the potential for the use of the contingent valuation method in determining the level of cost recovery, through fishing licences, of a proposed stock enhancement programme in a South African context. Such studies could prove to be a useful tool for fisheries managers. However, tests of reliability require the replication of the study at another time (temporal reliability) or with another sample population (geographical reliability; Carson *et al.*, 2001). Given that construct validity of the survey was fairly high, it is suggested that it would certainly be worth extending this pilot study to test the reliability of the survey instrument.

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