Conservation values and management preferences for the Ningaloo Marine Park: a discrete choice experiment

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Abstract

The creation of a marine reserve network is an active area of policy in Australia. Successful policy hinges on community support, which requires an understanding of what drives improvements in social welfare. Here, a discrete choice experiment is used to estimate ecological values for the Ningaloo Marine Park. A novel aspect of this research is that it not only considers the values people hold for conservation outcomes, but also their preferences for how those outcomes are achieved. By considering management process within the choice model, we gain a richer understanding of the relationship between social welfare and marine conservation. The results indicate that management process does have an impact on individuals' preferences for conservation.

Key words: Discrete choice experiment, management preferences, Ningaloo Marine Park

JEL code: Q51 – Valuation of Environmental Effects

Introduction

Marine reserves are used world-wide to protect marine ecosystems. In Australia, current policy supports the creation of a nation-wide marine reserve network (DEWHA 2010a). Policy success relies, in part, on community support, which results from net improvements in social welfare. Thus, it is important to understand the drivers for such improvements. Marine reserves generate welfare through commercial enterprises, recreational activities and their intrinsic non-use values. To understand recreational and non-use values, non-market valuation approaches are useful. In particular, stated preference techniques are the only means by which we can quantify non-use values in economic terms (see Bennett and Blamey 2001).

Stated preference techniques are often applied in a manner that conforms to standard neoclassical utility theory, where it is supposed that individuals only value the *outcome* of a proposed policy or program, and not the *process* by which that policy is implemented (Bulte *et al.* 2005). Here, we use process to mean the management approach used to implement a policy that will deliver a particular outcome. For example, in a discrete choice experiment (DCE), attribute levels usually consist of various policy outcomes, and the policy process is (at most) defined implicitly and not factored into the estimation of willingness to pay (WTP).

The above conformity is correct to an extent: strictly speaking, utility is associated with the final policy outcome; however, the level of utility may be influenced by the policy process used. Evidence has emerged in the economics literature to support the concept that utility for an outcome is affected by a number of precursors. Bulte *et al*. (2005) find that the cause of an environmental problem influences individuals' WTP to fix it. Bosworth *et al*. (2010) discover that people are willing to pay more to reduce mortality via prevention over treatment. Johnston and Duke (2007) test the hypothesis that policy processes are utility-neutral in a DCE on agricultural land preservation. They find that in many cases the inclusion of process as an attribute level significantly changes respondents' WTP, suggesting that the inclusion of process levels in DCEs can improve the accuracy of policy information. The rejection of neutral utility applying to policy process is a result supported by Czajkowski and Hanley (2009) who use labelled alternatives to describe management processes for increasing National Park area.

Conceptually, there are a number of reasons why people may react to policy processes in a DCE framework. Where a process is not well defined, even implicitly, individuals could make unobservable assumptions about the type of process to be used in policy implementation. They may also form assumptions about how successful different management processes will be in generating an outcome. Where a process is adequately defined, individuals may hold preferences for the management process that are independent of the associated outcome.

It is perhaps more obvious that individuals who hold use values for a particular asset may react to policy process. For example, consider someone who enjoys recreational fishing: this individual may value marine reserve conservation for a variety of use and non-use related outcomes; although, we might expect them to react to management approaches that restrict their ability fish, given the consequences on their use values. However, even in the case of pure existence values policy process could affect utility. Consider, for example, a policy designed to protect an endangered species through the eradication of feral animals. A non-user may still care about the manner in which the feral animals are eradicated.

In a context where an environmental improvement could be achieved via various management processes, useful advice for policy could be gained by including these processes in a DCE framework: it could inform decision makers not only of the value of the environmental improvement, but also of the preferred way to achieve it. This innovative stated preference approach is worthy of application in an emerging area of policy, such as marine reserve economics, where it could greatly contribute to policy design.

Indeed, Rolfe and Windle (2011) use a DCE to value the Great Barrier Reef in eastern Australia, where different management policies were introduced for the protection of the Great Barrier Reef as labelled alternatives. They compare WTP for three different management labels with an additional label that represented a combination of the three types of management. They find that value estimates are not significantly different between the combined policy approach and the average of the three separate management forms.

Building on Rolfe and Windle (2011), it would be useful to investigate, in the context of marine conservation, whether individuals' preferences vary depending on whether management is specified or not. Further, Rolfe and Windle (2011) address WTP at broad level management of the entire marine park. It is possible that a suite of smaller scale management processes targeted at particular attributes within a marine reserve may generate different results. For example, as the specifics of a management approach become more clearly defined, individuals may have a stronger realisation of resulting personal impacts.

Here, we apply a DCE to the Ningaloo Marine Park on the north-west coast of Western Australia, to estimate how much the West Australian community is willing to pay to protect a suite of ecological attributes. Within the DCE, a split sample design is used to estimate WTP for conservation outcomes achieved by varying management processes, and WTP for the same outcomes without management specified. The paper is organised as follows: first, the methodology is described with respect to case study and attribute selection, experimental design, and hypotheses to be tested; second the results of the hypothesis testing are discussed along with the definition of a final model and associated WTP estimates; and last, the results are interpreted in terms of their implications for policy.

Methods

Case study and attribute selection

The Ningaloo Marine Park contains the Ningaloo Reef, the world's largest fringing coral reef adjacent to a continental land mass. Recently listed as a World Heritage Area, one of the criteria addressed in the listing relates to the significance of its biodiversity values, indicating the importance of conserving its ecology into the future (DEWHA 2010b). As such, the DCE considers the values of four ecological components of Ningaloo – coral, fish, marine turtle and whale shark populations. It was anticipated that non-use values would be associated with the attributes. Spurgeon (2004) recommends that there needs to be a greater focus on estimating marine non-use values as these are poorly understood.

These particular ecological attributes were selected based on their functional importance or iconic status within the marine park. The coral, target fish stocks (i.e. the finfish in the marine park that are most commonly sought after and caught by recreational fishers) and marine turtles are identified as Key Performance Indicators in the marine park's management plan, meaning that they are recognised as being important in terms of ecosystem function (MPRA 2005). The fourth attribute, whale sharks, is representative of iconic megafauna. The conservation outcomes associated with the attributes were specified as a percentage increase in population size, defined in more detail below (see Table 1).

The literature has approached the inclusion of management processes in two ways: by including process as an attribute level (e.g. Johnston and Duke 2007), or by including it as a labelled alternative (e.g. Rolfe and Windle 2011). Here, the focus on numerous ecological attributes makes labelling difficult. For a label to be appropriate, the same management process would need to be effective in generating an improvement in conservation outcome for each attribute considered in the policy program. In this instance, given that effective management differed across attributes, it was more appropriate to integrate the management processes as attribute levels.

As such, the attribute levels were defined using two integrated components: conservation outcome levels, and management process levels. For each of the coral, fish and turtle attributes, the conservation outcome levels were defined as either a 0%, 5%, or 10% increase to their population (see Table 1). For whale sharks, the levels were 0%, 2% and 5% increases to their population[1].

Each attribute was assigned two different management processes by which equivalent conservation outcomes could be achieved. The processes were based on possible future management strategies,

[1] It was assumed less likely that we could influence the conservation levels of migratory whale sharks as strongly as other attributes given that they spend a large proportion of their time outside of the marine park area in International waters.

or strategies that could alleviate particular threats to the attribute. They were not uniform across the attributes, but were similar in that one of the processes (management type T1) was more restrictive on human use of the marine park than the other (type T2).

The conservation and management levels were then coupled together, so that each percentage improvement in conservation was achieved by one or the other of the two management processes. Table 1 shows these couplings, resulting in five distinct levels for each attribute. Note that the quantity of management increases along with increasing conservation outcome. Thus, the policy process is defined thoroughly to show: (1) the type of management approach; (2) the quantity of management applied; and (3) the resulting quantity of the conservation outcome. Where there is no improvement in conservation (i.e. the 0% level) management is unnecessary, and therefore not described.

Table 1: Ecological attributes and their levels comprised of a conservation outcome and management process.

Attribute[a]	**Attribute reference**[b]
Coral (KPI)	
0% more coral	Baseline
5% more coral due to 5% new no go zones (T1)	Coral1
5% more coral due to 7% increase in sanctuary zones (T2)	Coral2
10% more coral due to 10% new no go zones (T1)	Coral3
10% more coral due to 12% increase in sanctuary zones (T2)	Coral4
Target fish stocks (KPI)	
0% more fish	Baseline
5% more fish due to 2 month seasonal closure (T1)	Fish1
5% more fish due to 10% increase in sanctuary zones (T2)	Fish2
10% more fish due to 3 month seasonal closure (T1)	Fish3
10% more fish due to 15% increase in sanctuary zones (T2)	Fish4
Marine turtles (KPI)	
0% more turtles	Baseline
5% more turtles due to 50km beach closure (T1)	Turtle1
5% more turtles due to 3 extra fox bait zones (T2)	Turtle2
10% more turtles due to 100km beach closure (T1)	Turtle3
10% more turtles due to 6 extra fox bait zones (T2)	Turtle4
Whale sharks (iconic megafauna)	
0% more whale sharks	Baseline
2% more whale sharks due to 25% reduction in whale shark tours (T1)	Wshark1
2% more whale sharks due to Government donating $1,000,000 to their international conservation (T2)	Wshark2
5% more whale sharks due to 50% reduction in whale shark tours (T1)	Wshark3
5% more whale sharks due to Government donating $2,000,000 to their international conservation (T2)	Wshark4

[a] Attribute levels shown here are for the management sample. In the outcome-only sample, there are three levels representing the conservation improvements only. In the regression output reported in Table 5, the outcome-only variables are coded as for the baseline and levels associated with management T1 (e.g. for Coral: baseline, Coral1, Coral3).
[b] Attributes are dummy coded.

Where respondents received the version of the survey with no management process specified, the attribute levels comprised only of the three conservation outcome levels. For example, the coral attribute had levels of 0%, 5% and 10% increases in population size.

A payment vehicle was defined as an annual cost, taking on levels of $0, $20, $40, $60 and $80, collected as an environmental levy on general income tax. The $0 level was only ever associated with the status quo option in the choice scenario, where the conservation of all ecological attributes reflected a 0% level.

Survey and experimental design

Two versions of the survey were created: the 'management' survey, where management processes were specified; and the 'outcome-only' survey, where management process was not specified. The two versions were otherwise identical.

Each survey included a section on the valuation of Ningaloo Marine Park, and a section on the valuation of a second marine park – the proposed Ngari Capes Marine Park – in the southwest of Australia[2]. The sequence in which respondents saw each marine park was randomised to account for ordering effects. Within each marine park section, respondents were presented with the choice scenarios and supporting attribute descriptions and instructions. Information was also collected about the respondents experience with the marine park and its attributes, along with debriefing questions relating to the DCE. Following the two valuation exercises, socio-demographic information was collected.

The choice scenarios consisted of four alternatives: three conservation programs and a status quo. Caussade *et al*. (2005) investigate the amount of variance associated with different numbers of alternatives, and suggest that four alternatives per choice scenario is optimal for reducing variance. The DCE adhered to a best-worst choice-sequence format (Carson and Louviere 2011); however, only the best choice data are analysed here. Figure 1 provides an example of how the choice scenarios appeared with and without management processes specified.

Two D-efficient, main effects designs were generated for the split samples, using the Discrete Choice Experiments software (Burgess 2007). The management design consisted of 25 choice scenarios, blocked by a factor of five, with an efficiency measure of 99%. The outcome-only design was generated with 15 choice scenarios, blocked by a factor of three, with an efficiency measure of 96%. The blocking of the design meant that respondents in both samples received five choice questions in the survey.

The survey was administered via an online internet panel between July and August 2008 to a sample of the West Australian population. Internet surveys have emerged as a convenient sampling method, and evidence suggests that there are no significant differences in WTP estimates derived from web-based and traditional mail-out surveys (Windle and Rolfe 2011; Olsen 2009).

[2] Refer to McCartney (2011) for more information regarding the Ngari Capes case study.

	OPTION 1 Status quo	OPTION 2	OPTION 3	OPTION 4
Conservation of coral reef	0% more coral	10% more coral due to 12% new no go zones	5% more coral due to 7% new no go zones	0% more coral
Conservation of target fish stocks	0% more fish	10% more fish due to 15% increase in sanctuary zones	5% more fish due to 2 month seasonal fishing closure	10% more fish due to 3 month seasonal fishing closure
Conservation of turtle populations	0% more turtles	10% more turtles due to 6 extra fox bait zones	10% more turtles due to 100km beach closure	0% more turtles
Conservation of whale shark population	0% more whale sharks	0% more whale sharks	2% more whale sharks due to Government donating $1,000,000 to their international conservation	5% more whale sharks due to 50% reduction in whale shark tours
Cost to you per year	$0	$20	$60	$80
Most preferred option:	☐	☐	☐	☐
Least preferred option:	☐	☐	☐	☐

	OPTION 1 Status quo	OPTION 2	OPTION 3	OPTION 4
Conservation of coral reef	0% more coral	10% more coral	5% more coral	0% more coral
Conservation of target fish stocks	0% more fish	10% more fish	5% more fish	10% more fish
Conservation of turtle populations	0% more turtles	10% more turtles	10% more turtles	0% more turtles
Conservation of whale shark population	0% more whale sharks	0% more whale sharks	2% more whale sharks	5% more whale sharks
Cost to you per year	$0	$20	$60	$80
Most preferred option:	☐	☐	☐	☐
Least preferred option:	☐	☐	☐	☐

Figure 1: Example choice scenarios for the management and outcome-only surveys.

Respondent characteristics

A total of 340 individuals responded to the management survey, with 260 completing the survey in full (completion rate of 76%). For the outcome-only survey, 225 individuals responded, with 151 completing the survey (67%). Note that an accurate response rate is not able to be estimated given that bulk invitations were sent to panellists (over 8000 across both surveys) and it isn't possible to determine how many individuals read the email before the survey quota was closed off. Of the completed responses, a total of 407 provided usable data for estimation (after removing anomalies in data recording): 255 for the management sample; 152 for the outcome-only sample. Age and gender statistics for each sample are shown in Table 2, compared with the West Australian population in 2006 (Australian Bureau of Statistics 2006).

Table 2: Gender and age distributions of the management and outcome-only samples, and West Australian population (WA).

Demographic category		Management sample	Outcome-only sample	WA population (2006)
Gender				
	Male	53%	53%	50%
	Female	47%	47%	50%
Age				
	18-30 yrs	11%	9%	23%
	31-45 yrs	31%	32%	30%
	46-60 yrs	39%	44%	27%
	61-75 yrs	18%	15%	14%
	Over 75 yrs	2%	0%	7%

Research hypotheses

There are a number of hypotheses to consider in terms of testing for statistical differences between the management and outcome-only samples. Noting that there is a different arrangement of attributes, and therefore parameters, between the management and outcome-only samples, it is useful to first define the utility function for each.

A generalized sub-utility function for an attribute in each data set can be defined as follows:

$$U_{Management} = \alpha_1 C_1 T_1 + \alpha_2 C_1 T_2 + \alpha_3 C_2 T_1 + \alpha_4 C_2 T_2 \quad (1)$$

$$U_{Outcome-only} = \gamma_1 C_1 T_3 + \gamma_2 C_2 T_3 \quad (2)$$

where:

C_1 = 1 if attribute conservation = level 1; 0 otherwise

C_2 = 1 if attribute conservation = level 2; 0 otherwise

T_1 = 1 if attribute management type = level 1; 0 otherwise

T_2 = 1 if attribute management type = level 2; 0 otherwise

T_3 = 1 if management type is unspecified; 0 otherwise

There are four possible constraints that can be imposed on the attributes. First, we can constrain management type T1 to be equal to management type T2 in the management sample, that is:

$$H_o^1: \quad \alpha_1 = \alpha_2; \quad \alpha_3 = \alpha_4$$

If H_o^1 is not rejected, it implies that individuals hold homogeneous preferences for management type. We can then explore a second constraint that assumes homogenous preferences for management across both samples, which would imply that individuals only hold preferences for conservation outcomes. That is, one can restrict all three of the management types (T1, T2, T3) to be equivalent:

$$H_o^2: \quad \alpha_1 = \alpha_2 = \gamma_1; \quad \alpha_3 = \alpha_4 = \gamma_2$$

If H_o^1 is rejected, then individuals hold heterogeneous preferences for specified management types. We can then investigate the possibility that respondents in the outcome-only sample are making unobserved judgement as to the form of management process that would be used to achieve the conservation outcome. One could argue that, in the absence of an explicit description of the management process, respondents may assume it to be equivalent to one of the management processes defined in the management survey (i.e. management type T1 or T2), or something different altogether. Referring to equations (1) and (2), the following restrictions can be tested:

$$H_o^3: \quad \alpha_1 = \gamma_1; \quad \alpha_3 = \gamma_2$$

$$H_o^4: \quad \alpha_2 = \gamma_1; \quad \alpha_4 = \gamma_2$$

The null hypotheses H_o^3 and H_o^4 set management type T3 (unspecified) equal to management types T1 and T2, respectively.

Note that all of these hypotheses could be applied to each individual attribute, given that the specific management processes differ by attribute – what may be true for one attribute could be different for another. However, this presents many permutations to investigate. Instead, we test these hypotheses concurrently across all ecological attributes in the data set. This is justified on the basis that there is a similarity for type T1 and T2 management processes across attributes, with the processes being more or less restrictive on human use of the marine parks, respectively.

Concurrently, it is also possible to test whether we can restrict the alternative specific constant (ASC), which represents the status quo option, across the two data sets:

$$H_o^5: \quad ASC_{management} = ASC_{outcome-only}$$

By testing whether the ASCs are significantly different from one another, we can establish whether the inclusion of management process changes an individual's preferences for opting in or out of conservation programs.

Results

This section presents the results in a series of steps. First, mixed logit models are developed for the purpose of comparing the management and outcome-only samples. Log likelihood statistics are reported for these models which investigate the hypotheses developed above. Then, using the resulting model from these investigations, individual characteristic heterogeneity is explored in detail. Data were analysed with Stata 12.0 (Statacorp 2011).

Mixed logit models, as proposed by McFadden and Train (2000), were used in the initial stages of estimation to capture heterogeneity in the sample. The management and outcome-only samples were modelled separately with random parameter specifications on all attributes and the ASC. In each case, the majority of the standard deviations of the random parameters were not significant with respect to the attributes. Iterative models were then estimated applying random specifications to each attribute in turn. There was little consistency across attributes, and between the management and outcome-only models, as to which parameters should be random[3]. On the other hand, the ASC had a consistently significant standard deviation.

As such, for the purpose of comparing preferences for management processes across the two samples, we proceed using mixed logit models with random ASC parameters for both the management and outcome-only samples. The log likelihood statistic for the management model was -1223.96; and -666.37 for the outcome-only model.

The first step in exploring how individuals reacted to management process was to test hypothesis H_O^1. Within the management data set, a constraint was placed on the parameters to set management types T1 and T2 equal to each other, implying that preferences for management are homogeneous. A likelihood ratio test was used to determine whether this restriction was acceptable, returning a ratio statistic of 15.80 (Table 3). This suggests that we cannot accept the restriction, and H_O^1 is rejected. The rejection of this hypothesis also voids the test for H_O^2. Therefore, we conclude that individuals do not hold homogeneous preferences for management process.

In testing hypotheses H_O^3 and H_O^4, we must apply a restriction that sets the unspecified management type T3, from the outcome-only model, equal to one of the specified management types in the management model. Effectively, this restricts the two samples into one model. In applying this test, in the first instance, it is useful to allow scale to vary across samples. That is, in the probability function for mixed logit estimation, the scale parameter (λ) is inversely proportional to the standard deviation of the error term (see Train 2009). As a result, attribute coefficients are scaled according to the variance of unobserved utility. Therefore, when comparing samples, differences in marginal utility could be due to differences in sample variance. These differences can be controlled for using the grid search method, whereby relative values for λ are identified for each sample and coefficients are rescaled accordingly (see Swait and Louviere 1993).

Using this approach, hypothesis H_O^3 was tested, where the unspecified management T3 is set equal to T1. The outcome-only sample was rescaled (λ(O)=1.20), and a likelihood ratio test does not reject the hypothesis with a ratio of 10.91 (Table 3). It was possible that we could then restrict the samples

[3] Note that the specification of mixed logit models often requires researcher judgement, as well as quantitative testing, as the appropriate placement of random parameters can be unclear (Johnston and Duke 2007).

further, to hold scale equal (i.e. λ(O)=1). Once again the likelihood ratio test statistic accepts this restriction (Table 3).

An equivalent test was performed to test whether the unspecified management T3 is similar to T2, that is, for hypothesis H_o^4. Table 3 reports a likelihood ratio test statistic of 19.10, with the outcome-only sample rescaled (λ(O)=1.12), rejecting the null hypothesis that T2=T3.

These results imply that individuals from the outcome-only sample behave as if they have preferences that are similar to the preferences that respondents from the management sample have for management type T1. We are able to constrain T1 and T3 to be equal, and we do not need to control for scale effects in doing so. Using this model, with T1=T3, a further restriction was imposed to establish whether the ASCs from each sample could be constrained to one ASC. Noting that choice frequencies for the ASC were similar with respondents selecting the ASC 13% and 11% of the time for the management and outcome-only samples, respectively, the likelihood ratio test for H_o^5 reports a ratio statistic of 3.49, thus the hypothesis of equivalent ASCs is not rejected (Table 3).

Table 3: Likelihood ratio test statistics for the research hypotheses applied to the management and outcome-only samples.

Test	Unrestricted log likelihood[a]	Restricted log likelihood	Likelihood ratio test statistic[b]	d.f.; χ^2 critical value (p=0.05)	Restriction outcome
H_o^1	-1223.96	-1231.86	15.80	8; 15.51	Reject
H_o^3; if λ(O)=1.20	-1890.33	-1895.79	10.91	8; 15.51	Accept
H_o^3; if λ(O)=1	-1895.79	-1896.46	1.35	1; 3.84	Accept
H_o^4; if λ(O)=1.12	-1890.33	-1899.88	19.10	8; 15.51	Reject
H_o^5; if T1=T3	-1896.46	-1898.21	3.49	2; 6.00	Accept

a Where hypotheses test for a restriction that combines the management and outcome-only samples in some manner, the unrestricted log likelihood is calculated as the additive management + outcome-only log likelihoods of the separate models.
b Calculated as: 2(unrestricted model log likelihood – restricted model log likelihood).

The hypothesis testing presents us with a combined management and outcome-only model that restricts management type T1 equal to the unspecified management type T3, and contains one random ASC parameter to represent both samples. Henceforth referred to as the combined model, the data was explored further to consider heterogeneity in marginal utilities as a result of individual characteristics. A number of individual characteristics were found to be significant inclusions, as defined in Table 4, with interactions apparent on the ASC and the coral, turtle and whale shark attributes.

With the inclusion of these interaction terms, the standard deviation of the ASC parameter became insignificant. A likelihood ratio test comparing the mixed logit model (with random ASC; log likelihood: -2191.86) with a multinomial logit model containing an equivalent set of non-random parameters (log likelihood: -2191.86) provides a ratio statistic of 0.00, confirming that the random parameter specification is no longer required. It is likely that the individual characteristics in the combined model explain heterogeneity associated with the ASC sufficiently. The multinomial logit regression results for the combined model are presented in Table 5.

Table 4: Explanatory individual characteristic variable descriptions for the combined model, with sample means noted.

Variable	Description	Mean
Aware	Aware that the area is designated as a marine park: 0=no; 1=yes	0.84
WA park	Have visited other West Australian marine parks before: 0=no; 1=yes	0.43
Certain	Certain of responses given in choice questions: 0=no; 1=yes (where 1 = 7 or more on a scale from 1-10)	0.67
Policy	Believe results will influence policy: 0=no; 1=yes (where 1 = 7 or more on a scale from 1-10)	0.34
Group	Belong to an environmental group: 0=no; 1=yes	0.5
Child	0=no children; 1=children	0.74
Visit	Have visited Ningaloo Marine Park before: 0=no; 1=yes	0.37
Seen coral	Have seen live coral before: 0=no; 1=yes	0.86
4WD	Have been on Ningaloo beach before with four wheel drive: 0=no; 1=yes	0.5
Walk	Have been walking on Ningaloo beach before: 0=no; 1=yes	0.33
Seen wshark	Have seen live whale sharks before: 0=no; 1=yes	0.30

The ASC is positive in the combined model, implying that there is a preference to select the status quo over a conservation program (Table 5). However, several variables that are interacted with the ASC weaken the inclination to opt for it. In particular, individuals who are aware the area is a marine park are less likely to select the ASC than other individuals, *ceteris paribus*, as are individuals who are confident either in their choice responses or in the ability of the study results to influence policy. Individuals belonging to environmental groups, who likely have a stronger pro-conservation attitude, prefer to opt for conservation programs over the status quo, all else constant. In a few cases, individuals held stronger preferences for maintaining the current situation, all else held equal. These included: individuals with children, who could be more concerned about financial constraints; individuals who have visited other marine parks in Western Australia, perhaps indicating a substitution effect; and individuals who have visited Ningaloo before, which may reflect a reduction in option value as they have already experienced the marine park.

Despite the popularity of the status quo option, the marginal utilities for the ecological attributes are positive in the majority of cases, indicating that people do want to conserve (Table 5). There is, however, a particular exception to this rule that relates to individuals' reactions to management process. Two individual characteristics help to explain heterogeneity in preferences for the turtle attribute: whether the individual has been either four wheel driving or walking on the Ningaloo beach before. In the case of the four wheel drivers, marginal utility for turtle protection is in fact negative, *ceteris paribus*. Noting that management type T1 for turtle conservation is a beach closure, which would preclude these individuals from their activity of choice, explains this reaction with respect to the attribute levels that prescribe to this management (i.e. Coral1*4WD and Coral3*4WD). For the attribute levels that prescribe to the alternate management type T2, the interaction with four wheel drivers is only significant at the highest level of conservation.

Interestingly, for individuals who walk on the beach at Ningaloo, the preference for turtle conservation is stronger despite the conflict with the beach closure management type T1 (Table 5). Walking does not require the same lengths of beach as four wheel driving, and is a more passive activity, perhaps reflecting upon the individuals' conservation attitudes.

Table 5: Multinomial logit results for the combined model.

Variables	Coefficient mean	Standard error
ASC	1.872***	0.263
ASC*aware	-0.774***	0.183
ASC*WA park	0.589***	0.150
ASC*certain	-0.516***	0.152
ASC*policy	-1.357***	0.212
ASC*group	-2.150**	1.052
ASC*child	0.540***	0.179
ASC*visit	0.657***	0.195
Coral1	0.676***	0.193
Coral2	0.646***	0.252
Coral3	0.685***	0.194
Coral4	0.710***	0.277
Coral1*seen coral	0.654***	0.200
Coral2*seen coral	0.537**	0.268
Coral3*seen coral	0.838***	0.201
Coral4*seen coral	0.977***	0.289
Fish1	0.916***	0.089
Fish2	0.871***	0.113
Fish3	1.087***	0.090
Fish4	1.012***	0.107
Turtle1	0.878***	0.103
Turtle2	0.544***	0.138
Turtle3	0.846***	0.104
Turtle4	0.688***	0.129
Turtle1*4WD	-1.331***	0.329
Turtle2*4WD	-0.646	0.420
Turtle3*4WD	-1.889***	0.364
Turtle4*4WD	-1.107***	0.391
Turtle1*walk	0.483***	0.186
Turtle2*walk	0.549**	0.242
Turtle3*walk	0.922***	0.186
Turtle4*walk	1.008***	0.219
Wshark1	0.727***	0.101
Wshark2	0.871***	0.128
Wshark3	0.822***	0.101
Wshark4	0.851***	0.125
Wshark1*seen wshark	-0.364**	0.155
Wshark2*seen wshark	-0.538**	0.209
Wshark3*seen wshark	-0.517***	0.156
Wshark4*seen wshark	-0.473**	0.204
Wshark1*group	0.810**	0.400
Wshark2*group	1.325***	0.470
Wshark3*group	0.617	0.384
Wshark4*group	0.422	0.461
Cost	-0.016***	0.001

Notes: n = 407; number of observations = 2035; log likelihood = -2191.86.
***, **, * denotes significance at the 99%, 95% and 90% level of confidence respectively.
The ASC is the status quo parameter.

Turning to the partworths, or WTP estimates, we see again the negative relationship between four wheel drivers and turtle conservation (Table 6). WTP is not significantly different to zero in almost all cases where an individual is a four wheel driver. The one exception is where WTP is highly significant at the 99% level of confidence – but is negative. This particular case relates to individuals who four wheel drive and don't walk on the beach at Ningaloo, for the maximum level of turtle conservation under management type T1. This management process applies the largest quantity of beach restriction – a 100km closure. WTP for turtle conservation is otherwise positive.

Table 6: Partworths for the combined model, and probability that willingness to pay for the highest level (5% for whale sharks, 10% for other attributes) of conservation is greater than the lower level (2% for whale sharks, 5% for other attributes).

	$/year/individual		**Probability**
Increase in coral populations	**5%**	**10%**	**P(10% > 5%)**
T1: No go zone management; and T3: Unspecified			
- Have not seen live coral before	44***	44***	0.962
- Have seen live coral before	86***	98***	0.013
T2: Sanctuary zone management:			
- Have not seen live coral before	42**	46**	0.830
- Have seen live coral before	76***	109***	0.000
Increase in fish populations			
T1: Seasonal closure management; and T3: Unspecified	59***	70***	0.029
T2: Sanctuary zone management	56***	65***	0.228
Increase in turtle populations			
T1: Beach closure management; and T3: Unspecified			
- Have not walked on or used a 4WD on beach before	57***	54***	0.726
- Have walked on, but have not used a 4WD on beach before	88***	114***	0.004
- Have used a 4WD on, but have not walked on beach before	-29	-67***	0.179
- Have walked on and used a 4WD on beach before	2	-8	0.712
T2: Fox baiting management:			
- Have not walked on or used a 4WD on beach before	35***	44***	0.325
- Have walked on, but have not used a 4WD on beach before	70***	109***	0.005
- Have used a 4WD on, but have not walked on beach before	-7	-27	0.544
- Have walked on and used a 4WD on beach before	29	38	0.759
Increase in whale shark populations	**2%**	**5%**	**P(5% > 2%)**
T1: Tour reduction management; and T3: Unspecified			
- Have not seen whale sharks before and are not a member of an environmental group	47***	53***	0.310
- Have seen whale sharks before, but are not a member of an environmental group	23**	20**	0.696
- Member of an environmental group, but have not seen whale sharks before	99***	93***	0.767
- Have seen whale sharks before and are a member of an environmental group	75***	59**	0.470
T2: Government donation management:			
- Have not seen whale sharks before and are not a member of an environmental group	56***	55***	0.887
- Have seen whale sharks before, but are not a member of an environmental group	21*	24**	0.834
- Member of an environmental group, but have not seen whale sharks before	141***	82***	0.045
- Have seen whale sharks before and are a member of an environmental group	107***	51*	0.084

Note: ***, **, * denotes significance at the 99%, 95% and 90% level of confidence respectively.

WTP is positive for fish and coral conservation (Table 6). For coral conservation, the value increases if the individual has seen live coral before. However, in the case of individuals who have seen whale sharks before, the opposite is true for whale shark conservation where WTP is lower than for other individuals. As was the case for individuals who have visited the marine park before being more inclined to select the status quo over a conservation program, this could reflect a diminished option value. Individuals who belong to an environmental group are willing to pay more for whale shark conservation, which can be expected.

A scale sensitivity test was performed on the partworth values on the basis that, observationally, the WTP values do not appear very different as conservation level increases. Nonlinear combination tests, based on the delta method, were applied to determine whether WTP significantly increases as the conservation outcome level increases from 5% to 10% (2% to 5% for whale sharks). The probabilities that the WTP values are significantly different are reported in Table 6, confirming that in most cases they are not statistically different. Scale insensitivity could have been present for a number of reasons, including: individuals hold diminishing marginal utilities for attribute conservation; or, the range of attribute levels was not sufficient or not well defined enough to detect scale effects.

Discussion and policy implications

This study investigated the impact of including management processes on preference formation for marine conservation. It aimed to explore whether the explicit inclusion of management processes in a DCE can improve the quality and relevance of information for decision making in conservation policy. The study builds upon previous research related to management inclusion in choice models by applying the investigation in a marine policy context, with a valuation of the Ningaloo Marine Park in Western Australia. In comparison to the marine application by Rolfe and Windle (2011), the study focuses on the impact on preferences for conservation outcomes depending on whether management process is specified or unspecified, rather than differences between separate and combined management programs. While Rolfe and Windle (2011) examine preferences for marine reserve management and conservation at a whole-of-system scale, here we focus on ecological components within the broader system. The results provide evidence that management processes do affect preferences for conservation outcomes, and that policy relevant information is generated using this approach. These results are in line with similar DCE applications in other policy realms (Johnston and Duke 2007; Czajkowski and Hanley 2009)).

Important conclusions are drawn from the results of the hypothesis testing. First, we establish that, within the management sample, preferences for conservation outcomes are not homogeneous across the management types specified for each attribute. It is worth noting that this test is performed on a general model that estimates mean preferences across a range of demographics, including users and non-users of the Ningaloo Marine Park. That is, this result arises with the inclusion of individuals that are not necessarily motivated by direct use of the resource.

Second, we discover that individuals from the outcome-only sample, where management process is not specified, form preferences in a manner that is statistically similar to the preferences held by individuals in the management sample for management type T1. Although the management specification of T1 varied across attributes, a commonality was that it was the most restrictive management process (in comparison to management type T2) in terms of human use of the marine park. Therefore, in instances where management is not specified, one might incorrectly assume that the values retrieved for conservation outcomes are applicable for any form of management process, when in fact individuals have values that are consistent with a particular type of management process, or a specific range of processes, even though the process is not explicitly observed. The evidence suggests that, in this particular application, the assumed management forms reflect management processes that are restrictive on human use, such as the processes defined in management T1 for each attribute.

We also find that there are significant welfare implications for particular societal demographics that result from the selection of different management processes. In the combined model, this issue is illustrated with respect to the four wheel driver demographic. Four wheel drivers have a significant negative reaction to management type T1 in the case of turtle conservation. In one instance, WTP for turtle conservation under this management approach is negative.

Indeed, this result is not unexpected given that the management process involves a restriction of beach access which would exclude this demographic from partaking in their activity of choice. However, the result highlights the importance of considering management process in conservation policy. In this case, if policy makers were unaware of management preferences and implemented a beach closure to protect turtles at Ningaloo, at least a portion of the four wheel driving demographic would experience a reduction in welfare. On the other hand, if policy makers were aware of such preferences and the alternative management process (fox baiting) was initiated, four wheel drivers would still not be willing to pay to protect turtles, but they would at least not be made worse off. From a political viewpoint, this sort of information about welfare impact could mean the difference between smooth policy implementation and uproar from lobbying groups.

One could extrapolate this result to mean that environmental managers should always choose to use the least restrictive management process that is sufficient to achieve conservation efforts. However, in contrast to the four wheel drivers, we see from another user-demographic – individuals who have walked on the beach at Ningaloo – that they are willing to pay more for turtle conservation than other individuals (*ceteris paribus*) even when the management process could interrupt their chosen activity. Thus, understanding how management process can affect preferences of different users will allow decision makers to opt for processes that achieve a net benefit in welfare.

Finally, we cannot reject the hypothesis that proposes a restriction of the ASC parameter across the management and outcome-only models. That is, respondents do not change their propensity to select conservation programs or the status quo depending on whether management processes are included in the choice model. From a design perspective, this is reassuring, in that it suggests that individuals do not suffer from increases in cognitive burden when the choice scenario includes the complexity of management processes. For example, Boxall *et al*. (2009) relate an increase in frequency of selecting the status quo alternative to cognitive burden. This suggests that any concern over the complexity added by including management processes could be outweighed by the benefit of additional information that can be provided for policy guidance.

In summary, this study finds that the inclusion of management processes in a DCE does have a significant impact on individuals' preferences for conservation outcomes. In particular, we discover that individuals hold significantly different preferences for the same conservation outcome depending on what management process is specified. We also find that, where management process is not specified, individuals appear to form assumptions about management that align with more restrictive management forms. There is also evidence that specific demographics can be adversely affected by the proposed management for a particular policy or program.

In general, individuals were willing to pay to protect the ecological components of the Ningaloo Marine Park. This suggests that future policy should be aimed at protecting Ningaloo's ecology to maintain positive social welfare. However, in doing so, the results of this study indicate the importance of considering policy process, and the impact it may have on welfare, in marine conservation decisions. A better understanding of community preferences for management process can maximise the social welfare derived from conservation activities and assist the acceptance of marine policy by the community.

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