Scope and scale in valuing coastal management in the remote Kimberley region of Australia

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This research was supported by the Kimberley Marine Research Program, administered by the Western Australia Marine Science Institution (WAMSI).

24 October 2016
Working Paper 1612
School of Agricultural and Resource Economics
http://www.are.uwa.edu.au

Citation: Spencer-Cotton, A., Burton, M. and Kragt, M.E. (2016) *Scope and scale in valuing coastal management in the remote Kimberley region of Australia.* Working Paper 1612, School of Agricultural and Resource Economics, University of Western Australia, Crawley.

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Abstract

The Kimberley region in northern Western Australia is well known for its impressive coastal landscapes, unique marine ecosystems, its Aboriginal heritage and culture, and its rich minerals and metals deposits. To inform future management of Kimberley coastal waters, a discrete choice experiment was undertaken to estimate the values that Western Australians attach to different management outcomes in the Kimberley. These management outcomes (marine reserves, aboriginal values, recreational facilities and development) were made spatially explicit to show respondent in what regions of the Kimberley outcomes would occur. A split sample design was used to estimate values for the Kimberley region as a whole, and for two separate smaller sub-regions. This choice experiment design allows us to test for scope sensitivity, which has not been explored much in the choice experiment literature. This study is one of the few discrete choice experiments that explores scope effects for environmental non-market valuation. Willingness to pay results show similar estimates between the two smaller sub-regions. Willingness to pay for the attributes increased when management occurs at the larger geographical scope. However, it was less sensitive to changes in attribute scale. We contribute to the literature on exploring scope effects for environmental non-market valuation using discrete choice experiments in the remote Kimberley region of Western Australia.

Key words: discrete choice experiments, willingness to pay, environmental management, non-market valuation, scope tests

Funding: This research was supported by the Kimberley Marine Research Program Administered by the Western Australian Marine Science Institution.

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1. Introduction

Understanding social values and preferences is essential for long term effective environmental management and planning (Voyer, Gladstone et al. 2012). Non-market valuation techniques can be used to estimate what values people hold for environmental goods or services. Such estimates have been used by decision makers to guide natural resource management.

Values for environmental goods or services may vary based on their location or the extent of the good in the landscape. Economic theory suggests that a person should be willing to pay more for greater provision of the good (greater *scale*). Economic theory also predicts diminishing marginal values as the geographical *scope* of the good increases. If the WTP for a good displays inconsistency with economic theory then it is said to display scope insensitity. Mitchell and Carson (1989) were among the first to identify possible reasons for scope insensitivity in non-market valuation. Part-whole bias is said to occur when a policy package as a whole is valued different from its parts and vice versa. Bias may also arise from valuing the geographical extent differently from that intended by the researcher (geographical bias), or valuing the policy package differently from that intended (policy package bias). Respondents may also use the opportunity to show their support for the cause (e.g. an environmental policy *per se*) without fully considering the amounts of the good on offer, sometimes referred to as a 'good cause dump'. This type of reaction can also cause marginal values to be similar regardless of the amount of good offered, which can be a result of 'warm glow effect'. This is a relevant bias to consider in the case of the Kimberley, which is an iconic remote region of Western Australia where tension arise between contentious development and environmental conservation objectives. In this paper, we will address issues of scope in the context of coastal management in the Kimberley region. We test whether people's choices in a discrete choice experiment display scope inconsistency and insensitivity and discuss what this tells us about preferences in the Kimberley.

There is a need to clarify the terminology used in the non-market valuation literature between scope and scale (Figure 1). Testing for scope insensitivity in environmental choice experiments is often divided into two effects: internal scale and external scope (Rolfe and Wang 2011). Scope refers to the context in which the good is described, including the attributes used and the policy context. Geographical scope changes occur when the context of the good changes due to changes in the geographical location. Scale, on the other hand, refers more specifically to changes in the amount of the good provided (irrespective of scope). In this study, we are specifically concerned with attribute scale, referring to the levels of the attributes offered in each choice question. Scale effects are inevitably confounded with changes in scope because, for example, increasing the geographical extent of a good may also increase the scale. We refer to this as ‘geographical scale’. In the present study, we will test for sensitivity to attribute scale, geographical scope and geographical scale.

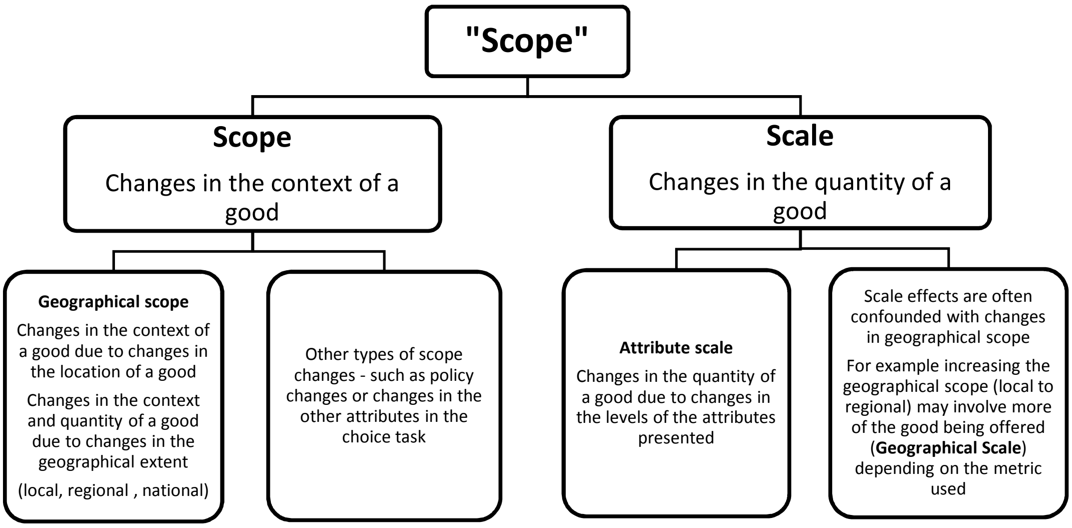


Figure 1. Internal and external scope effects for environmental choice experiments.

In the contingent valuation (CV) literature, tests for scope insensitivity most commonly consist of a ‘standard’ scope test, applied at the general or uppermost level in Figure 1 (Desvousges, Mathews et al. 2012). This scope test in CV consists of asking respondents for their WTP for different quantities or extent of a good and testing if WTPs are statistically different from each other. Desvousges et al (2012) concluded that this ‘standard’ scope testing is uninformative and more diverse types of testing for adequate responsiveness to scope is required. They suggest the ‘adding up’ test where the value of the whole is equal to sum of the incremental parts. However, there is also critique of the adding up test, as it assumes the structure of preferences (Haab, Interis et al. 2013) and does not include any measure of economic significance (Whitehead 2016). Both the standard scope test and the adding up tests have been questioned for their effectiveness (for example Bateman 2011, Haab, Interis et al. 2013)(Heberlein, Wilson et al. 2005). As an alternative, Whitehead (2016) suggests calculating scope elasticities. In a CV, scope elasticity is a measure of the response in WTP to a specific change in quantity. A suggested plausible scope elasticity would be between zero and one. This measure allows for comparisons between similar studies and a discussion around the economic relevance rather than a single ultimatum style scope test.

Discrete choice experiments (DCE) are a method for non-market valuation that can inherently include tests for attribute scale sensitivity as multiple attribute levels are used in the experiment. In the past decade, there have been a limited number of spatially explicit choice experiments (Horne, Boxall et al. 2005, Brouwer, Martin-Ortega et al. 2010, Schaafsma, Brouwer et al. 2012, Kubo and Shoji 2014). Previous research (Schaafsma and Brouwer 2013, Holland and Johnston 2014) has demonstrated the importance of carefully presenting spatial information to clarify study location and attribute characteristics. This helps reduce cognitive burden and to ensure that respondents are aware of the location of attributes and potential substitutes to assist respondents to correctly consider the scope of the good offered.

Previous studies into the effects of geographical scope and scale insensitivity in choice experiments report diverse results (for example Van Bueren and Bennett 2004, Rolfe and Windle 2008, Mazur and Bennett 2009, Rolfe and Windle 2010). Mazur and Bennett (2009) found attribute scale sensitivity as respondents were willing to pay more for more environmental goods in their study. They also found scope sensitivity as WTP estimates were different for the same good valued at different geographical extent. In contrast, tests for geographical scope sensitivity by Rolfe and Windle (2008) found no significant differences in environmental values for the Great Barrier Reef between state and regional contexts. However they also note that the use of percentages to measure attribute scale may have effected how respondents made decisions. For example, proportional values for different regions remained consistent when geographic scope and scale increased, while absolute values declined. These Australian examples demonstrate the mixed results found by Desvousges, Mathews et al. (2012).

In this paper we seek to understand how people's preferences for management on the Kimberley coast vary with changes in scope and scale. We implement a choice experiment that aims to estimate values for two smaller regions of the Kimberley and a third larger encompassing region. Three sources of scope/scale sensitivity are investigated: attribute scale sensitivity within each region; response to geographical scope sensitivity from a change in the location of the management; and tests for geographical scale sensitivity when increasing the geographical scale from a sub-region to a larger region that encompasses the sub-region(s).

2. Methods

2.1. The Kimberley

In this study values for environmental management were estimated for the Kimberley region, in the far north of Western Australia (Figure 2). The region is large (420,000 km^2), has low population levels (approximately 35,000 permanent residents (ABS 2011)), is relatively undeveloped, and presents abundant recreation opportunities such as remote 4WDriving, camping and fishing. Economic development opportunities include tourism, particularly eco-tourism, and significant mineral, oil and gas deposits, both on- and off-shore. The area is characterised by high biodiversity conservation values and is rich in Aboriginal cultural history and active Aboriginal communities. This remote region of Australia has potential for conflicting future uses which calls for adequate planning and management. Our focus here is on coastal management, partly because of ongoing marine-park planning in the region by the Western Australian government.

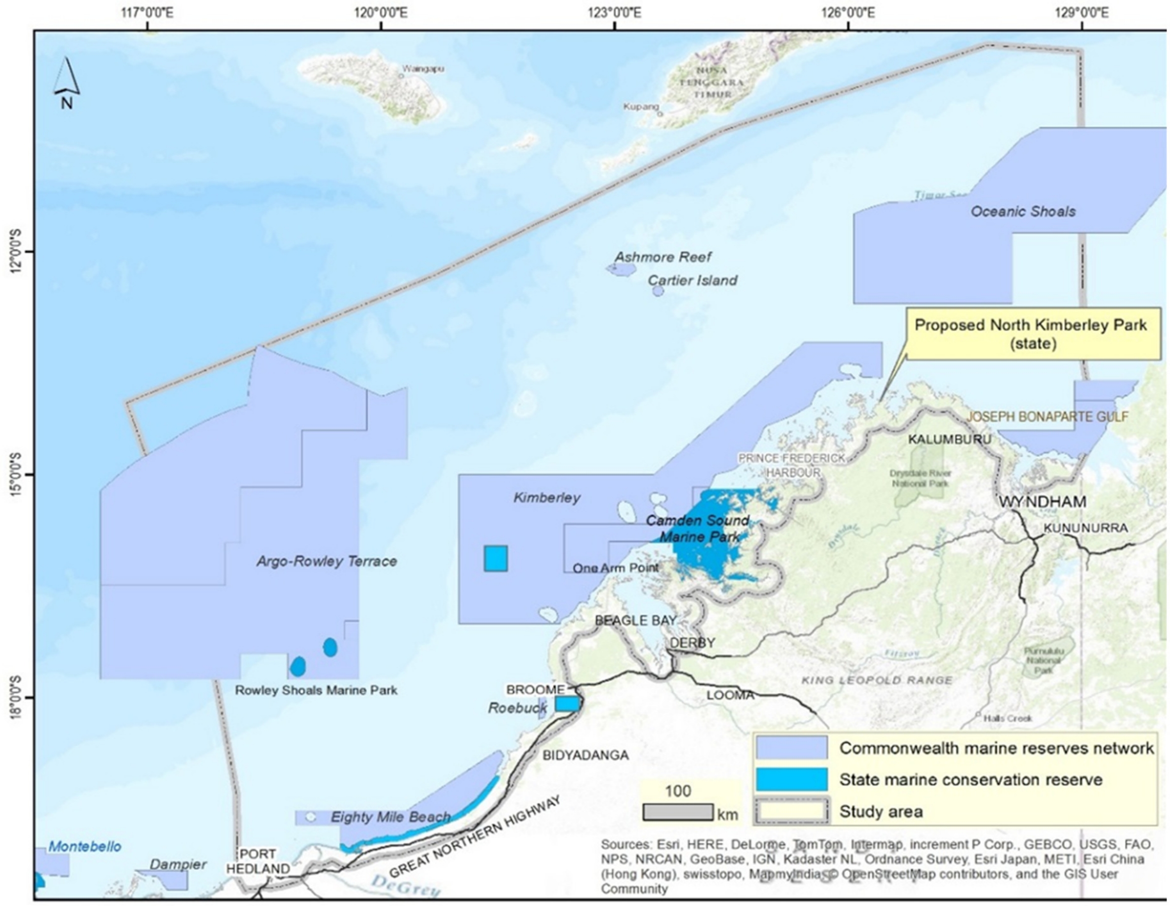


Figure 2. Map of Kimberley study region showing marine parks.

2.2. The choice experiment

We use a spatially explicit choice experiment design that can accommodate tests for attribute scale and geographic scope. The choice experiment encompassed three split samples: the whole Kimberley Coast and two smaller case study regions (Roebuck Bay and Camden Sound) (Figure 3). The Roebuck Bay region is relatively easy to access with a regional town centre and tourism hub Broome. This region covers an area of approximately …… and has good overall recreation facilities. The region has high conservation value including the Roebuck Bay Ramsar Site, protected for the conservation of wetlands and migratory bird species, and a marine park. The second region, Camden Sound, is more remote and difficult to access, mostly restricted to air or sea access. High environmental values, in particular for whale migration, has resulted in a marine park over much of this sub-region. The final study sample is the whole Kimberley coastal region, stretching from Eighty Mile Beach to the Joseph Bonaparte Gulf it is characterised by highly diverse ecosystems, restricted access, and is known as a wilderness destination.

The choice attributes used in the experiment were selected to capture the dominant values and preference for management values in the Kimberley region and are expected to reflect both use and non-use values. Management outcomes and key performance indicators from current State marine park management plans were consulted to increase the usability and relevance of the results. Payment for management was made via an overall increase to non-specific State and Commonwealth taxes. The payment vehicle and cost levels were tested in focus groups. The attributes and their levels used in the choice set were tested in a pilot survey and focus groups and are presented in Table 1. These were finalised in consultation with senior planners in the WA Department of Parks and Wildlife, whose responsibility is to manage marine and terrestrial environments for conservation outcomes in the study region.

The same survey and choice set design was used in all three split samples. Three management options were presented in the choice sets, with respondents choosing their single most preferred option. A D-optimal experimental design was created in Ngene (ChoiceMetrics 2012) for 18 choice situations, then applied to each split sample. The 18 choice sets were blocked into three groups so that each respondent only faced six choice questions. Choice sets included a map to visually remind respondents of the region the management would occur in: an example of a choice set used in the study is given in Figure 4. All choice sets contained the status quo alternative representing no additional management in the region.

The survey was presented in three parts. Firstly respondents were given information on the attributes and the region, then they were asked six choice questions, followed by profiling and attitude questions.

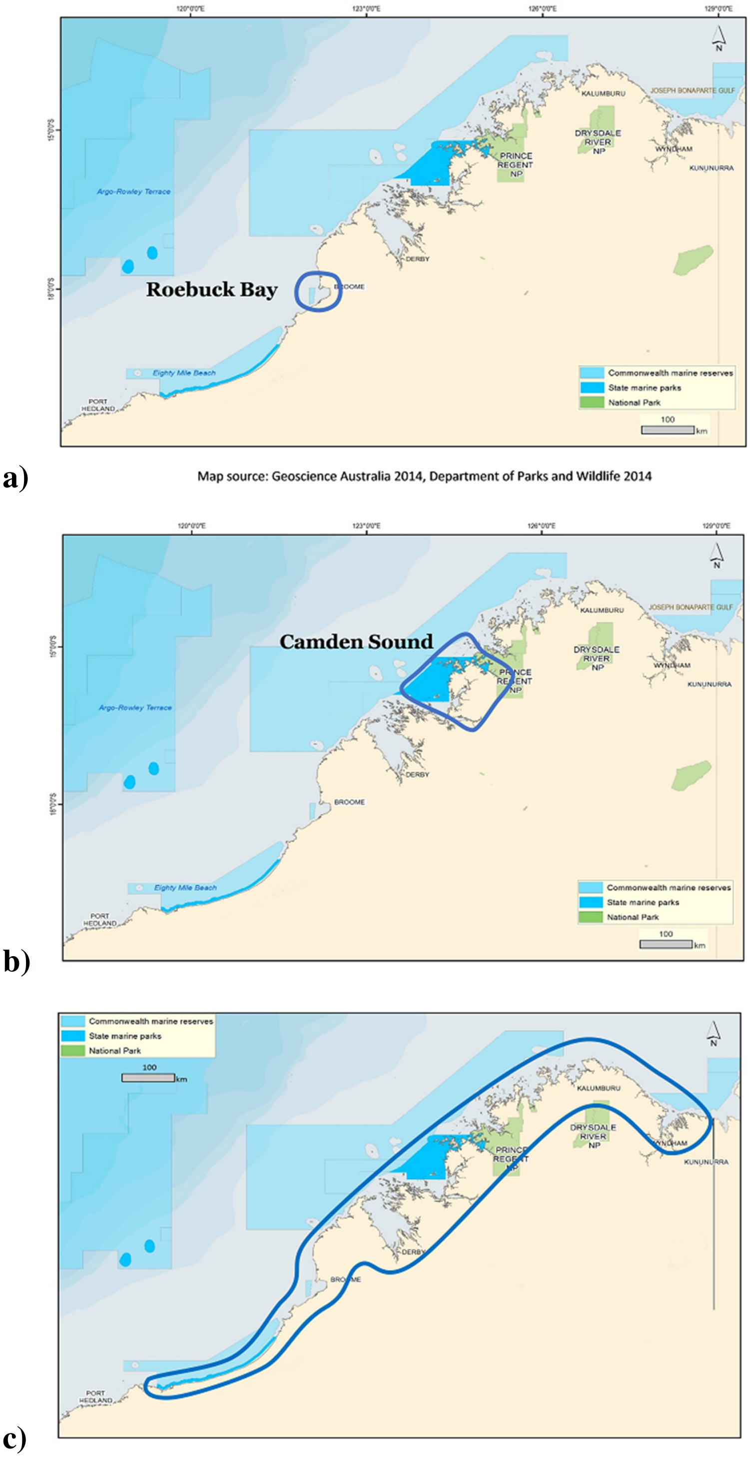
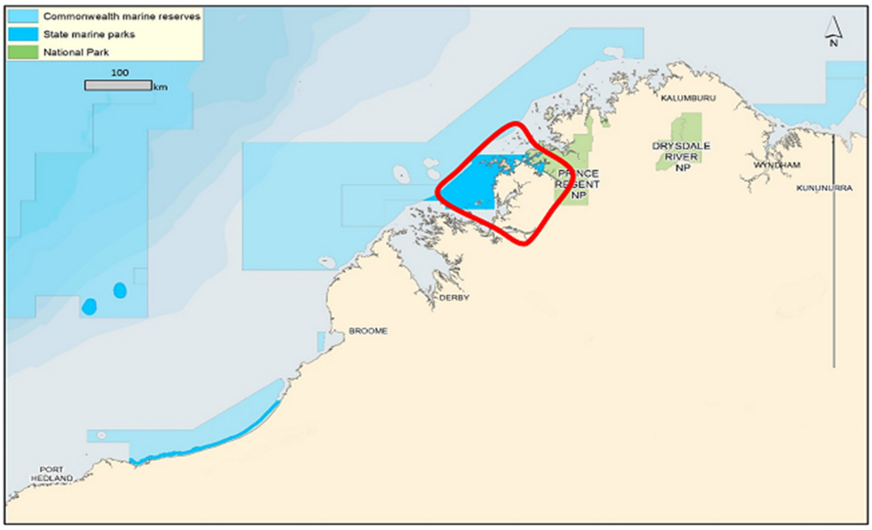


Figure 3. Maps of the Kimberley showing the zones presented in the split-samples, a) Roebuck Bay, b) Camden Sound, and c) Kimberley Coast.

Table 1. Environmental management attributes used in the choice experiment.

Attribute	Description	Status Quo	Levels of management
Sanctuary area	Percent of additional State waters in zone as Sanctuary area	0%	0%, 15%, 30%, 40%
Recreation	Average overall recreation facilities in the area	Roebuck Bay – Medium Camden Sound – Low Kimberley Coast - Low	Low, Medium, High
Rangers	Number of additional full-time Aboriginal rangers working in the area	Roebuck Bay – 4 Camden Sound – 12 Kimberley Coast – 44	0, 5, 10, 30
Development	Coastal development: Defined as a small amount of extra coastal development in the area, such as a small jetty and light commercial buildings.	No (0)	Yes (1), NO (0)
Cost	Annual household cost ($) collected through increased taxation	$ 0	$0, $10, $50, $75, $100, $150, $200



Zone	**Camden Sound**	**Camden Sound**	**None**
Annual cost to you	**$100**	**$75**	**$0**
Sanctuary area (% State waters already sanctuary)	10% (10%)	50% (10%)	***No new management on the Kimberley coast***
Recreational facilities (existing level)	MEDIUM (LOW)	HIGH (LOW)	
Aboriginal rangers (existing number)	42 (12)	17 (12)	
Increase coastal development	YES	NO	
	OPTION A	**OPTION B**	**OPTION C**

Figure 4. Example choice set for the Camden Sound study area.

Respondents were drawn from a Western Australian internet panel between May and June 2015. A total of 456 valid surveys were completed. The Roebuck Bay study region has 153 valid completed surveys, Camden Sound 151 and Kimberley Coast 152. More than a third (44 percent) of respondents had visited the Kimberley in their lifetime. The socio-demographics for the samples are presented in Table 2, also shown are WA average statistics. There is higher female representation in all samples as well as higher education levels.

In the choice experiment questions, between 16 and 19 percent in the three samples selected the status quo in all six choice questions and were then identified as protest voters from a follow up question on their motivation for serial 'opt-out' behaviour (Table A9 in Appendix A). The group were not significantly different from the rest of the sample in gender, age and education, except for slightly higher in males in the Roebuck Bay sample. Protesters were omitted from further analysis.

Table 2. Respondent descriptive characteristics.

	Roebuck Bay	Camden Sound	Kimberley Coast	Pooled sample	WA[a]
Number of respondents	153	151	152	456	
Age (median bracket for 18 +, years)	45-54	45-54	45-54	45-54	45-49
Female (%)	58	62	61	60	50
Income (median)	$65-77,999	$52-64,999	$52-64,999	$65-77,999	$65-77,999
University degree (%)	25	27	26	26	13
Postgraduate qualification (%)	12	11	15	13	5

[a] Australian Bureau of Statistics (2011)

2.3. Modelling/testing strategy

Choice experiments are a stated preference method elicited using survey methods. Based on Lancaster (1966) consumer theory that the value of goods is determined by the characteristics that comprise the good. McFadden (1980) random utility theory supposes that utility is comprised of a determinist component that can be modelled and a random component. The discrete choice model used in this research is the multinomial logit (MNL) model and its extensions, including error component logit models. Socio-demographics are not included in this current analysis and results are comparing the average values across the samples.

The utility gained by person i selecting option j is given by:

$$U_{ij} = \beta X_j + \varepsilon_{ij} \tag{1}$$

That is, the utility obtained by individual *i* from outcome *j* is determined by a linear function of a vector of attributes *X*, weighted by parameters *β*, and an unobservable 'random' element ε. This random utility specification accounts for the possibility that not all aspects that determine choice have been quantified by the researcher. If an individual is faced with *J* alternatives, and an assumption that the random element follows a Type I Extreme value distribution, then the probability that they select option *n* is given by:

$$P(Y = n) = \frac{\exp(\bar{\beta} X_n)}{\sum_j \exp(\bar{\beta} X_j)} \tag{2}$$

where $\bar{\beta}$ are normalised parameters, to account for the scale factor associated with the error variance.

If one assumes that the errors are identical and independently drawn across all alternatives, then the resulting model exhibits independence of irrelevant alternatives. However, when one option is a status quo, or opt-out alternative, it may be more appropriate to assume that the two policy options are closer substitutes than the status quo. This can be accommodated by assuming a correlation structure across the errors, and estimating an error components model (Scarpa, Ferrini et al. 2006).

Attribute scale

Internal tests for attribute scale were conducted on the two cardinal attributes, Sanctuary and Rangers, in each of the three study regions. For each region a general model was estimated that allowed for n-1 levels of the attributes to be individually estimated, dummy coded. Then the model was restricted, so that utility was a linear function of the attribute, and a version in which any change from the status quo was treated equally (the 'Plus' model). The parameter restrictions associated with these models can be represented by:

$$U = ... + \sum \beta_k D_{x_k} + ... \qquad \text{General model}$$

$$U = ... + \beta X_k + ... \qquad \text{Linear model}$$

$$U = ... + \sum \beta D_{x_k} + ... \qquad \text{Plus model}$$

Where X is the cardinal attribute with n levels, and D_{xk} the set of n-1 dummy variables associated with its non-status quo attribute levels.

Likelihood ratio tests are used to test if the parameter restrictions implied by the linear and Plus model are accepted.

Geographical scope

The tests for geographical scope differences between the three regions were conducted by pooling samples, and testing whether parameters can be restricted to be common across samples. Tests were initially made for differences in preferences between the smaller regions, Roebuck Bay and Camden Sound. Then between the two smaller zones and the whole Kimberly Coast region. The general model that allowed for separate parameters for each attribute in each region was tested against a restricted model that restricted parameters to be the same for each region (up to a scale factor). Again, Likelihood Ratio tests assess the estimation gains for the unrestricted models.

3. Results

Separate choice models were estimated for each study region and are presented in Table 3. For the cardinal variables, sanctuary area and rangers, the most general model, with dummy variables, is reported. As expected, cost is negative and significant in all three samples. Priors for recreation and development were uncertain, as one could make a case for either positive or negative. The estimation results suggest that Development is not welcomed in any region. On average respondents are indifferent to changing recreational facility levels in any region, however high levels of recreation facilities are not favoured in Roebuck Bay (in this region the status quo level was already at a Medium level). For the two attributes with cardinal measures, Sanctuary and Rangers, all three models suggest that there is a significant positive utility from provision. However, these general models are dummy coded for the attributes, we will now restrict the relationship for tests of attribute scale.

Table 3. General specification mixed logit models for three regions, estimated separately.

	Roebuck Bay	Camden Sound	Kimberley Coast
Cost	-0.014*** (0.001)	-0.014*** (0.001)	-0.010*** (0.001)
Sanctuary 15%	0.389* (0.199)	0.300 (0.198)	0.864*** (0.184)
Sanctuary 30%	0.488** (0.244)	0.670*** (0.239)	0.565** (0.226)
Sanctuary 40%	0.579*** (0.156)	0.584*** (0.155)	0.887*** (0.145)
Rangers 5	-0.103 (0.202)	0.110 (0.211)	-0.076 (0.199)
Rangers 10	0.418* (0.241)	0.323 (0.237)	0.092 (0.220)
Rangers 30	0.322** (0.146)	0.177 (0.145)	0.127 (0.135)
Recreation Medium		0.157 (0.261)	0.225 (0.250)
Recreation High	-0.218 (0.169)	0.098 (0.169)	-0.089 (0.161)
Development	-0.200* (0.117)	-0.452*** (0.114)	-0.234** (0.104)
Random parameters			
Mean			
SQ ASC	-1.691*** (0.290)	1.893*** (0.306)	-1.807*** (0.332)
Standard Deviation			
SQ ASC	2.483*** (0.282)	2.458*** (0.285)	2.729*** (0.325)
Model statistics			
N Obs (Respondents)	918 (153)	906 (151)	912 (152)
AIC	1469.3	1464.2	1534.2
Log Likelihood	-723.7	-720.1	-755.1
McFadden R-squared	0.28	0.28	0.25

Standard errors in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

3.1 Attribute scale

Tests for responsiveness to attribute scale for each region reveal insensitivity within Sanctuary and some sensitivity in Rangers. Table 4 reports the parameter estimates for the sanctuary area and number of rangers from two restrictions to the general model presented in Table 3. The tests are applied independently i.e. the restrictions are applied to Sanctuary area while leaving Rangers unconstrained (Panel a), and then Rangers are constrained, while leaving Sanctuary as dummy variables (Panel b). Here the attribute is restricted to a linear estimate and also to a single dummy variable (PLUS) that indicates any improvement in the attribute beyond the SQ level. For each model we report only the parameters that are restricted and the log likelihood: full model results are shown in Table A1, A2, and A3; in Appendix A. We then test if the general model can be restricted to a linear relationship or to one where any change from the SQ is treated as equivalent, using appropriate Log Likelihood tests.

For the sanctuary area attribute, in both Roebuck Bay and Camden Sound regions, it is not possible to reject the restriction from the general model to either the Linear or Plus models (p values >0.05 in all cases). Both specifications suggest that respondent's value increases in the attribute beyond the status quo level, but the Plus model implies that there is no further sensitivity to increases beyond a 15% increase. In the Kimberley Coast sample, the attribute can be restricted to the Plus model (p=0.44), but it rejects the linearity model (p<0.01). Respondents may have been expressing general support for sanctuary areas in the Kimberley Coast and as a result are less sensitive to changes in the levels of the attribute, suggesting evidence of a warm glow effect.

For Rangers, the results are generally similar, with Plus or Linear restrictions were not rejected, except for in the Roebuck Bay region where the Plus restrictions were rejected. This may suggest there may be more sensitivity to this attributes scale as demonstrated by the coefficients in Roebuck Bay. However what is notable in the case of Rangers is that parameter estimates are generally not significantly different from zero, making tests for scale redundant.

Table 4. Partial results from models estimated for internal tests for attribute scale, likelihood ratio tests using restriction to the general error components mixed logit model for each region (as shown in Table 3).

		Roebuck Bay	Camden Sound	Kimberley Coast
Panel a:				
Sanctuary Area				
Linear		0.014*** (0.004)	0.015*** (0.003)	0.018*** (0.003)
	Log Likelihood	-724.1	-720.6	-760.9
	LR chi2(2)	0.93 (p=0.63)	0.92 (p=0.63)	11.56 *** (p<0.01)
Plus		0.530*** (0.137)	0.572*** (0.133)	0.804*** (0.125)
	Log Likelihood	-724.2	-721.8	-756.0
	LR chi2(2)	1.08 (p=0.58)	3.44 (p=0.18)	1.66 (p=0.44)
Panel b:				
Aboriginal Rangers				
Linear		0.011*** (0.004)	0.004 (0.004)	0.005 (0.004)
	Log Likelihood	-725.3	-720.8	-755.3
	LR chi2(2)	3.28 (p=0.19)	1.43 (p=0.49)	0.41 (p=0.82)
Plus		0.267** (0.138)	0.184 (0.139)	0.100 (0.131)
	Log Likelihood	-727.0	-720.5	-755.8
	LR chi2(2)	6.60** (p=0.04)	0.70 (p=0.71)	1.40 (p=0.50)

Standard errors in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

3.2 Geographical scope

The second part of this study asks about the differences in preferences for the attributes in response to changes in geographic scope. Geographic scope tests compared the management values between the two smaller regions, Roebuck Bay and Camden Sound, and then between the smaller sub-regions and the whole Kimberley Coast, log-likelihood ratio tests are presented in Table 5 (full model results are presented in Appendix A: Table A4 and A5). We employ a general model, with dummy coding for Sanctuary and Rangers.

Log-likelihood ratio tests allow for the restriction of the parameters and indicate that preferences are essentially the same between the two sub-regions (test 1, Table 5). We therefore accept the restriction that respondents value management in Roebuck Bay and Camden Sound the same, and now ask if values are different between the two smaller regions and the whole Kimberley Coast. Log-likelihood ratio tests between the general model and the model with all attributes restricted to single effect identify significant differences between the models (test 2, Table 5). An inspection of coefficients reveals that the difference is due to different coefficients for cost (a test for differences in error variance confirmed that this was not the cause of the divergence). A model that restricts all parameters to be equal across the pooled sample, apart from cost, is accepted (test 2a, Table 5).

Table 5. Log-likelihood ratio tests for geographical scope.

Test	Region	General Model	Restricted model	Degrees of freedom	Likelihood Ratio chi2
1	Roebuck Bay vs. Camden Sound	Separate effects for all attributes for both zones	All attributes restricted	11	7.66 (p=0.74)
2	(Roebuck Bay & Camden Sound) vs. Kimberley Coast	Separate effects for Kimberley Coast	All attributes restricted	12	23.57 ** (p=0.02)
2a		Separate effects for Kimberley Coast	All attributes restricted except for cost	11	7.41 (p=0.765)

*** Significant at 1%, ** Significant at 5%, * Significant at 10%.

We then consider attribute scale tests for Sanctuary and Rangers within this pooled sample. The results from this mixed logit model, with two estimators for cost, are presented in Table 6. In this pooled sample, for Sanctuary we can accept a restriction that all increases in area beyond the status quo are valued equally. This confirms what was revealed in the individual samples and may reflect the hypothesis that there exists a warm glow effect for conservation activities in the region. For Rangers the hypothesis that Rangers at attribute level 10 and level 30 are different from each other was rejected using a Wald test. The model suggests that people are indifferent to small increases in provision (an additional 5 rangers) but do value a higher level of provision.

Table 6. Mixed logit model for Roebuck Bay, Camden Sound and Kimberley Coast (KC) pooled.

	Pooled general model	Pooled scale and scope model
Cost	-0.014*** (0.001)	-0.014*** (0.001)
KC*Cost	0.004*** (0.001)	0.004*** (0.001)
San 15%	0.544*** (0.111)	
San 30%	0.592*** (0.135)	
San 40%	0.696*** (0.087)	
San PLUS		0.658*** (0.074)
Rangers 5	-0.029 (0.116)	-0.056 (0.115)
Rangers 10	0.263** (0.133)	
Rangers 30	0.201** (0.081)	
Range 10 & 30 PLUS		0.192** (0.079)
Rec Medium	0.142 (0.124)	0.131 (0.123)
Rec High	-0.016 (0.106)	0.021 (0.084)
Development	-0.294*** (0.064)	-0.315*** (0.060)
Random parameters		
Mean		
SQ ASC	-1.734*** (0.183)	-1.737*** (0.183)
Standard Deviation		
SQ ASC	2.550*** (0.171)	2.552*** (0.170)
Model statistics		
N Obs (Respondents)	2736 (456)	2736 (456)
AIC	4439.0	4435.5
Log Likelihood	-2206.5	-2207.7
McFadden R-squared	0.27	0.27

Standard errors in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

The WTP is calculated from the pooled scale and scope model for all three regions (Table 7). Confidence intervals are estimated using the Delta method.

Respondents were willing to pay $46 per year for an increase in Sanctuary areas in the smaller regions and $63 in the Kimberley Coast. WTP values for Aboriginal Rangers in the sub-regions are $13 per year for between 10 and 30 additional Rangers. The WTP estimates were almost $5 higher per year to have Aboriginal Rangers working in the whole Kimberley coastline. The scope WTP arc elasticity (as defined in Whitehead (2016)) for attributes between Camden Sound and Kimberley Coast (Kimberley Coast is approximately six times the size) is

0.18 (absolute value) for Sanctuary, Recreation and Development. Scope arc elasticity is not defined for Aboriginal rangers because respondents were willing to pay more but the quantity didn't change, only the context of the provision changed.

As a side note it is worth considering that the Sanctuary attribute was measured as a percentage. A higher WTP for the Kimberley Coast of 1.4 times more is not proportional to the difference in region sizes. This spatial consideration translates into a willingness to pay for sanctuary area that is less per unit area in the larger region than the smaller region.

Table 7. WTP estimations for the two geographical regions (95 percent confidence intervals).

	Roebuck Bay & Camden Sound	Kimberley Coast	Difference
Additional Sanctuary Area (15, 30, or 40 percent)	46.01 *** (36.02 : 56.01)	62.91 *** (47.74 : 78.08)	16.90 *** (6.98 : 26.82)
Additional Aboriginal Rangers (10 or 30 rangers)	13.42 ** (2.62 : 24.22)	18.35 ** (3.46 : 33.23)	4.93 ** (0.14 : 9.71)
Recreation Medium	9.19 ns (-7.73 : 26.11)	12.56 ns (-10.63 : 35.76)	3.37 ns (-3.13 : 9.88)
Recreation High	1.50 ns (-10.01 : 13.01)	2.05 ns (-13.69 : 17.79)	0.55 ns (-3.69: 4.79)
Development	-22.04 *** (-30.22 : -13.86)	-30.14 *** (-41.69 : -18.58)	-8.09 *** (-13.39 : -2.79)

*** Significant at 1%, ** Significant at 5%, * Significant at 10%, ns: not significant.

4. Discussion/conclusions

Our results indicate some geographical scope insensitity. We found that preferences remained stable despite trade-offs being made over different geographical regions, hence the WTP estimates were the same between the smaller sub-regions. This suggests that people who live in Perth may have consistent preferences for management regardless of where management action occurs along the Kimberley coast. For policy makers and managers stable preferences for this sample group also presents opportunities for long term effective environmental management and planning.

Our sample population were willing to pay more for management action to occur across the whole Kimberley coast, and conversely willing to pay more to avoid negative actions. This effect may be due to policy-package bias and 'good-cause dump' bias caused by respondents valuing a wider or narrower range of benefits. The iconic, tourism and wilderness nature of the Kimberley likely shapes how Perth respondents view the Kimberley and hence policy and management for the region. Further research into preferences for environmental management in the Kimberley needs to include the policy context within which values are derived.

Internal attribute scale tests also reveal some insensitivity, especially for Sanctuary areas in the larger sample size. It can be proposed that this attribute fails a standard scope test, however it is not clear that is reason enough to question the validity of the CV. This may be a bias reflecting general preferences for conservation action in the Kimberley, revealed as a warm glow effect for additional sanctuary areas. It is also possible that there may be a point of satiation for the attributes, suggesting that we may not fully understand the preference structure we are trying to estimate, as has been noted by other CV researchers (Bateman 2011). An additional note on the sanctuary attribute is that in this study we found that respondents were valuing a specific percent of sanctuary area the same in all three study regions. Hence not responding as we may expect to changes in the region size. The effect of this insensitivity is that they valued per unit areas zoned as sanctuary less if the region being zoned was larger.

In this study we had to objective of exploring scope, if we had not we may incorrectly specify the model in another part of the research, often automatically using linear estimators for the cardinal attributes. It is evident that some exploration of the responsiveness to scope and scale should be conducted within any contingent valuation study. However, it is still not clear how observations of scope or scope tests in CV relate to the plausibility or adequateness of the study and hence to the validity of the results. Insensitivity to scope may not necessarily suggest that these valuation methods are invalid, but may be linked to issues of survey administration and methodology as suggested by Carson and Mitchell (1993), and Bateman (2011), or that we may not clearly understand the sources and patterns of preferences for public goods. Additionally, we may need to utilise alternative economic decision theories to utility maximisation, and behavioural economics may be able to offer assistance to future non-market valuation studies (Desvousges, Mathews et al. 2015). We align with Haab, Interis et al. (2013) in suggesting that as researchers we should not be focusing on whether a study passes a specific scope test but instead focus on improving CV methods, with a particular focus on how the survey design and administration can improve value estimations.

With much of the past discussion focused on all the contingent valuation methods, choice experiments may be able to offer additional insight into the patterns (scale and scope) of preferences, given they offer inherent ability of adjust the scale and repeat questioning offers opportunity for scope exploration. Future scope sensitivity analysis in choice experiments can contribute not only to the ongoing discussion on the validity of non-market valuation techniques but what they may really contribute toward is an understanding the patterns of environmental and landscape preferences.

Acknowledgements

This research is thanks to research team from Murdoch University Susan Moore, Halina Kobryn, and Jennifer Strickland-Munroe, and from University of Queensland Greg Brown.

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APPENDIX. Table A.1. Mixed logit models for Roebuck Bay. Attribute scale tests for sanctuary area and Aboriginal ranger attributes.

		Sanctuary		Rangers	
		LINEAR	PLUS	LINEAR	PLUS
MODEL	1	2	3	4	5
Cost	-0.014*** (0.001)	-0.014*** (0.001)	-0.014*** (0.001)	-0.0149*** (0.00106)	-0.0142*** (0.00101)
San 15%	0.389* (0.199)			0.404** (0.193)	0.374* (0.194)
San 30%	0.488** (0.244)			0.606*** (0.228)	0.550** (0.230)
San 40%	0.579*** (0.156)			0.597*** (0.152)	0.553*** (0.156)
San LINEAR		0.014*** (0.004)			
San PLUS			0.530*** (0.137)		
Rangers 5	-0.103 (0.202)	-0.0736 (0.200)	-0.117 (0.201)		
Rangers 10	0.418* (0.241)	0.462** (0.234)	0.399* (0.235)		
Rangers 30	0.322** (0.146)	0.350** (0.142)	0.303** (0.145)		
Range LINEAR				0.0115*** (0.00440)	
Range PLUS					0.267* (0.138)
Rec High	-0.218 (0.169)	-0.239* (0.123)	-0.187 (0.126)	-0.140 (0.160)	-0.157 (0.161)
Development	-0.200* (0.117)	-0.192* (0.109)	-0.218** (0.109)	-0.215* (0.116)	-0.210* (0.117)
Random parameters					
Mean					
SQ ASC	-1.691*** (0.290)	-1.724*** (0.286)	-1.682*** (0.289)	-1.643*** (0.283)	-1.594*** (0.284)
Standard Deviation					
SQ ASC	2.483*** (0.282)	2.472*** (0.280)	2.488*** (0.282)	2.477*** (0.281)	2.453*** (0.279)
Model statistics					
N Obs (Respondents)	918 (153)	918 (153)	918 (153)	918 (153)	918 (153)
AIC	1469.3	1466.3	1466.4	1468.6	1471.9
Log Likelihood	-723.7	-724.1	-724.2	-725.3	-727.0
McFadden R-squared	0.28	0.28	0.28	0.28	0.28
Likelihood Ratio tests chi2(df)		(2) 0.93 (p=0.628)	(2) 1.08 (p=0.583)	(2) 3.28 (p=0.194)	(2) 6.60** (p=0.037)

Standard errors in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table A.2. Mixed logit models for Camden Sound. Attribute scale tests for sanctuary area and Aboriginal Ranger attributes.

		Sanctuary		Rangers	
		LINEAR	PLUS	LINEAR	PLUS
MODEL	6	7	8	9	10
Cost	-0.014*** (0.001)	-0.014*** (0.001)	-0.014*** (0.001)	-0.014*** (0.001)	-0.014*** (0.001)
San 15%	0.300 (0.198)			0.351* (0.192)	0.304 (0.196)
San 30%	0.670*** (0.239)			0.770*** (0.225)	0.716*** (0.227)
San 40%	0.584*** (0.155)			0.614*** (0.153)	0.590*** (0.155)
San LINEAR		0.015*** (0.003)			
San PLUS			0.572*** (0.133)		
Rangers 5	0.110 (0.211)	0.138 (0.205)	0.046 (0.207)		
Rangers 10	0.323 (0.237)	0.388* (0.226)	0.304 (0.227)		
Rangers 30	0.177 (0.145)	0.186 (0.142)	0.136 (0.144)		
Range LINEAR				0.004 (0.004)	
Range PLUS					0.184 (0.139)
Rec Medium	0.157 (0.261)	0.145 (0.259)	0.094 (0.262)	0.180 (0.254)	0.201 (0.246)
Rec High	0.098 (0.169)	-0.003 (0.125)	0.0478 (0.128)	0.158 (0.160)	0.130 (0.163)
Development	-0.452*** (0.114)	-0.416*** (0.107)	-0.456*** (0.108)	-0.443*** (0.114)	-0.454*** (0.114)
Random parameters					
Mean					
SQ ASC	1.893*** (0.306)	-1.925*** (0.304)	-1.930*** (0.305)	-1.904*** (0.299)	-1.866*** (0.301)
Standard Deviation					
SQ ASC	2.458*** (0.285)	2.470*** (0.285)	2.475*** (0.286)	2.451*** (0.284)	2.451*** (0.284)
Model statistics					
N Obs (Respondents)	906 (151)	906 (151)	906 (151)	906 (151)	906 (151)
AIC	1464.2	1461.1	1463.6	1461.6	1460.9
Log Likelihood	-720.1	-720.6	-721.8	-720.8	-720.5
McFadden R-squared	0.28	0.28	0.27	0.28	0.28
Likelihood Ratio tests chi2(df)		(2) 0.92 (p=0.630)	(2) 3.44 (p=0.179)	(2) 1.43 (p=0.490)	(2) 0.70 (p=0.706)

Standard errors in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table A.3. Mixed logit models for Kimberley Coast. Attribute scale tests for sanctuary area and Aboriginal Ranger attributes.

		Sanctuary		Rangers	
		LINEAR	PLUS	LINEAR	PLUS
MODEL	11	12	13	14	15
Cost	-0.010*** (0.001)	-0.010*** (0.001)	-0.011*** (0.001)	-0.010*** (0.001)	-0.010*** (0.001)
San 15%	0.864*** (0.184)			0.847*** (0.174)	0.820*** (0.178)
San 30%	0.565** (0.226)			0.576*** (0.214)	0.547** (0.216)
San 40%	0.887*** (0.145)			0.880*** (0.143)	0.873*** (0.145)
San LINEAR		0.018*** (0.003)			
San PLUS			0.804*** (0.125)		
Rangers 5	-0.076 (0.199)	0.097 (0.191)	-0.069 (0.195)		
Rangers 10	0.092 (0.220)	0.205 (0.215)	0.044 (0.216)		
Rangers 30	0.127 (0.135)	0.202 (0.130)	0.130 (0.134)		
Range LINEAR				0.005 (0.004)	
Range PLUS					0.100 (0.131)
Rec Medium	0.225 (0.250)	0.361 (0.238)	0.279 (0.243)	0.264 (0.243)	0.325 (0.235)
Rec High	-0.089 (0.161)	-0.009 (0.113)	0.052 (0.116)	-0.075 (0.153)	-0.078 (0.156)
Development	-0.234** (0.104)	-0.227** (0.097)	-0.275*** (0.098)	-0.242** (0.103)	-0.232** (0.104)
Random parameters					
Mean					
SQ ASC	-1.807*** (0.332)	-1.814*** (0.326)	-1.765*** (0.328)	-1.778*** (0.328)	-1.758*** (0.329)
Standard Deviation					
SQ ASC	2.729*** (0.325)	2.685*** (0.320)	2.706*** (0.322)	2.730*** (0.325)	2.729*** (0.325)
Model statistics					
N Obs (Respondents)	912 (152)	912 (152)	912 (152)	912 (152)	912 (152)
AIC	1534.2	1541.8	1531.9	1530.6	1531.6
Log Likelihood	-755.1	-760.9	-756.0	-755.3	-755.8
McFadden R-squared	0.25	0.24	0.25	0.25	0.25
Likelihood Ratio tests chi2(df)		(2) 11.56 *** (p=0.003)	(2) 1.66 (p=0.436)	(2) 0.41 (p=0.816)	(2) 1.40 (p=0.497)

Standard errors in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table A.4. Geographical scope tests between Roebuck Bay and Camden Sound.

	Interactions with Camden Sound	
MODEL	16	17
Cost	-0.014*** (0.001)	-0.014*** (0.001)
San 15%	0.389* (0.199)	0.348** (0.140)
San 30%	0.488** (0.244)	0.599*** (0.168)
San 40%	0.579*** (0.156)	0.584*** (0.110)
Rangers 5	-0.103 (0.202)	0.001 (0.145)
Rangers 10	0.418* (0.241)	0.359** (0.168)
Rangers 30	0.322** (0.146)	0.242** (0.102)
Rec Medium		0.117 (0.158)
Rec High	-0.218 (0.169)	0.018 (0.146)
Development	-0.200* (0.117)	-0.336*** (0.081)
CS*Cost	0.001 (0.002)	
CS*San 15%	-0.087 (0.281)	
CS*San 30%	0.183 (0.342)	
CS*San 40%	0.006 (0.219)	
CS*Rangers 5	0.213 (0.292)	
CS*Rangers 10	-0.095 (0.338)	
CS*Rangers 30	-0.145 (0.205)	
CS*Rec Medium	0.158 (0.261)	
CS*Rec High	0.316 (0.239)	
CS*Development	-0.252 (0.164)	
Random parameters		
Mean		
SQ ASC	-1.687*** (0.282)	-1.725*** (0.227)
CS*SQ ASC	-0.212 (0.395)	
Standard Deviation		
SQ ASC	2.471*** (0.202)	2.474*** (0.200)
CS*SQ ASC	0.082 (1.165)	

Model statistics		
N Obs (Respondents)	1824 (304)	1824 (304)
AIC	2933.6	2919.3
Log Likelihood	-1443.8	-1447.6
McFadden R-squared	0.28	0.28
Likelihood Ratio tests chi2(df)		(11) 7.66 (p=0.743)

Standard errors in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table A.5. Geographical Scope tests between small study region and Kimberley Coast.

	Interactions with Kimberley Coast	Restricted	Restricted
MODEL	18	19	20
Cost	-0.014*** (0.001)	-0.013*** (0.001)	-0.014*** (0.001)
San 15%	0.349** (0.140)	0.541*** (0.111)	0.544*** (0.111)
San 30%	0.599*** (0.168)	0.572*** (0.134)	0.592*** (0.135)
San 40%	0.585*** (0.110)	0.696*** (0.0869)	0.696*** (0.087)
Rangers 5	0.001 (0.145)	-0.025 (0.116)	-0.029 (0.116)
Rangers 10	0.359** (0.168)	0.273** (0.133)	0.263** (0.133)
Rangers 30	0.243** (0.102)	0.200** (0.081)	0.201** (0.081)
Rec Medium	0.117 (0.158)	0.141 (0.123)	0.142 (0.124)
Rec High	0.018 (0.146)	-0.026 (0.106)	-0.016 (0.106)
Development	-0.336*** (0.081)	-0.292*** (0.064)	-0.294*** (0.064)
KC*Cost	0.004*** (0.001)		0.004*** (0.001)
KC *San 15%	0.513** (0.232)		
KC *San 30%	-0.033 (0.281)		
KC *San 40%	0.300* (0.182)		
KC *Rangers 5	-0.077 (0.246)		
KC *Rangers 10	-0.267 (0.277)		
KC *Rangers 30	-0.116 (0.169)		

KC *Rec Medium	0.107 (0.296)		
KC *Rec High	-0.106 (0.218)		
KC *Development	0.101 (0.132)		
Random parameters			
Mean			
SQ ASC	-1.732*** (0.228)	-1.729*** (0.183)	-1.734*** (0.183)
KC*SQ ASC	-0.063 (0.397)		
Standard Deviation			
SQ ASC	2.493*** (0.202)	2.550*** (0.171)	2.550*** (0.171)
KC*SQ ASC	0.976 (1.085)		
Model statistics			
N Obs (Respondents)	2736 (456)	2736 (456)	2736 (456)
AIC	4453.6	4453.2	4439.0
Log Likelihood	-2202.8	-2214.6	-2206.5
McFadden R-squared	0.28	0.26	0.27
Likelihood Ratio tests chi2(df)		(12) 23.57 ** (p=0.023)	(11) 7.41 (p=0.765)

Standard errors in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table A.6. Mixed logit model for Roebuck Bay, Camden Sound and Kimberley Coast pooled, with attribute scale tests for Sanctuary and Rangers.

		Sanctuary		Rangers	
		LINEAR	PLUS	LINEAR	PLUS
MODEL	21	22	23	24	25
Cost	-0.014*** (0.001)	-0.014*** (0.001)	-0.014*** (0.001)	-0.014*** (0.001)	-0.014*** (0.001)
KC*Cost	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)
San 15%	0.544*** (0.111)			0.559*** (0.106)	0.521*** (0.108)
San 30%	0.592*** (0.135)			0.656*** (0.127)	0.604*** (0.128)
San 40%	0.696*** (0.087)			0.707*** (0.086)	0.686*** (0.087)
San LINEAR		0.016*** (0.002)			
San PLUS			0.651*** (0.076)		
Rangers 5	-0.029 (0.116)	0.044 (0.114)	-0.0550 (0.115)		
Rangers 10	0.263** (0.133)	0.343*** (0.129)	0.232* (0.130)		
Rangers 30	0.201** (0.081)	0.246*** (0.078)	0.185** (0.080)		
Range LINEAR				0.007*** (0.002)	
Range PLUS					0.181** (0.078)
Rec Medium	0.142 (0.124)	0.168 (0.122)	0.132 (0.123)	0.163 (0.122)	0.194 (0.122)
Rec High	-0.016 (0.106)	-0.032 (0.083)	0.0181 (0.084)	0.029 (0.102)	0.014 (0.103)
Development	-0.294*** (0.064)	-0.277*** (0.060)	-0.315*** (0.060)	-0.298*** (0.063)	0.295*** (0.064)
Random parameters					
Mean					
SQ ASC	-1.734*** (0.183)	-1.762*** (0.181)	-1.736*** (0.183)	-1.710*** (0.180)	-1.670*** (0.181)
Standard Deviation					
SQ ASC	2.550*** (0.171)	2.533*** (0.169)	2.551*** (0.170)	2.546*** (0.170)	2.538*** (0.170)
Model statistics					
N Obs (Respondents)	2736 (456)	2736 (456)	2736 (456)	2736 (456)	2736 (456)
AIC	4439.0	4443.3	4437.3	4438.5	4441.3
Log Likelihood	-2206.5	-2210.6	-2207.7	-2208.2	-2209.6
McFadden R-squared	0.27	0.26	0.27	0.27	0.26

Note on the Wald test:
Results for Range 10= Range 30 from MODEL 23
chi2(1) = 0.16
Prob > chi2 = 0.6937

Table A.7. Pooled scale and scope model.

	26
Non-random parameters	
Cost	-0.014*** (0.001)
KC*Cost	0.004*** (0.001)
San PLUS	0.658*** (0.074)
Range 5	-0.056 (0.115)
Range 10 & 30 PLUS	0.192** (0.079)
Rec Medium	0.131 (0.123)
Rec High	0.021 (0.084)
Development	-0.315*** (0.060)
Random parameters	
Mean	
SQ ASC	-1.737*** (0.183)
Standard Deviation	
SQ	2.552*** (0.170)
Model statistics	
N Obs (Respondents)	2736 (456)
AIC	4435.5
Log Likelihood	-2207.7
McFadden R-squared	0.27

Standard errors in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Table A.8. Approximate size of the study regions.

Region	Total approx. area of zone (hectares)	Total approx. area of zone as State waters (hectares)
Roebuck Bay	578,000	143,000
Camden Sound	2,844,000	1,305,000
Kimberley Coast	18,054,000	6,467,000

Table A.9. Follow-up questions to identify 'protester' behaviour.

You often selected to take no management action. Was this because	
1) I do not care about the Roebuck Bay zone	**Non protest**
2) I would like to see some improvement in the management of the zone but I do not have the money to make a payment	**Non protest**
3) I already pay enough in taxes and charges	**Protest**
4) I should not have to pay for any additional management action	**Protest**
5) I should not be making decisions for the Roebuck Bay zone	**Protest**
6) I do not want to choose between the available options	**Protest**
7) Other, please specify	**Assesed individually**
An indivdiual was identified as a 'protester' if they selected any one of answers 3-6, or equivalent statements in the open ended option.	

Table A.10. Scale Heterogeneity Test between three study samples.

	GMNL with scale for each sample	GMNL
Mean		
Cost (scaled)	1 (.)	1 (.)
KC*Cost	-0.313*** (0.0814)	-0.269*** (0.0598)
Sanctuary	0.117*** (0.0136)	0.119*** (0.0133)
Rec Medium	1.306 (0.832)	1.297 (0.851)
Rangers	0.0514*** (0.0163)	0.0532*** (0.0164)
Rec High	-0.0235 (0.550)	-0.0306 (0.570)
Development	-1.771*** (0.405)	-1.833*** (0.406)
SQ ASC	-12.18*** (1.297)	-12.41*** (1.291)
Standard Deviation		
SQ ASC	-17.44*** (1.431)	-17.78*** (1.387)
Het		
Const	-1.875*** (0.112)	-1.949*** (0.0452)
RB	-0.0696 (0.119)	
CS	-0.0925 (0.120)	
tau		
_cons	0 (.)	0 (.)
N Obs (Respondents)	2736 (456)	2736 (456)
AIC	4447.7	4444.3
Log Likelihood	-2212.8	-2213.1
LR Test		LR chi2(2) = 0.59 (p=0.744)

Standard errors in parentheses. *** Significant at 1%, ** Significant at 5%, * Significant at 10%.