Community attitudes towards water management in the Moore Catchment, WA.[1]

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The Moore Catchment, which lies to the north of Perth, WA, suffers from a number of problems related to water management. Farmers want to manage salinity and waterlogging problems through the use of drains, but this has negative off-farm impacts on both the environment and flood risk. Views on responsibilities for managing water within the catchment differ between farmers, local communities and government agencies. This paper reports the results from surveys of attitudes towards catchment management, for two community groups: residents of Perth and residents of rural towns in the catchment. A parallel study of farmers has been undertaken but is not reported here. These surveys elicited general attitudes towards the environment and agriculture, and views on responsibilities for managing the catchment. It also included a choice modelling section, where the attributes under consideration included the area of land under salt and trees, ecological risks to off-farm wetlands and risk of flooding, farm incomes and personal financial contributions to a management fund. Preliminary results indicate that residents of both rural towns and Perth are willing to pay to avoid damage to the natural environment, both on and off-farm, as well as the risk of flooding. Perhaps more surprisingly, whether farmers' incomes were being negatively affected in a choice set has a very strong impact on the choice made.

1. Introduction.

There has been an ongoing attempt to integrate the management of the Moore catchment, bringing together resources from the various agencies involved and the local community. Previous community consultation has identified salinity, waterlogging and flooding, soil erosion and loss of native vegetation and wildlife as priority issues to be addressed (Black, 1999). Part of an NHT project in the catchment required an assessment of community attitudes to alternative methods of catchment management, and the impact of floods in 1999 and the search for management solutions in the aftermath has given that need a little more urgency.

This paper reports the results of a survey to identify those attitudes, for people in both the catchment and Perth during 1999. Attitudes are elicited in two ways: through a sequence

[1] The research reported here was in part funded by the Waters and Rivers Commission, WA. Particular thanks go to Jonelle Black for comments on earlier drafts and assistance.

of questions where they had to give a rated response, and through a choice modelling framework. The latter uses a non-market valuation technique which allows us to quantify values placed on different aspects of the catchment, both environmental and social.

The Moore Catchment is situated in the Northern Agricultural Region in Western Australia. It covers an area of 14 000 km^2 in eight shires: Victoria Plains, Dandaragan, Moora, Dalwallinu, Coorow, Carnamah, Gingin and Perenjori. It extends from Guilderton to just south of the Yarra Yarra Lakes (near Three Springs).

There is a diverse array of farming systems in the Moore Catchment, ranging from intensive horticulture, floriculture and aquaculture in Gingin to broadacre wheat and sheep enterprises in the upper reaches of the catchment. The Moore Catchment is experiencing many problems that are common to most wheatbelt areas. Salinity, flooding and environmental damage are all major problems for the catchment, and which are in part the consequences of past and present agricultural practices (State Salinity Council, 1998).

Wetlands are an important part of the Moore Catchment. The Karakin Lakes, listed in the Australian Directory of Important Wetlands, covers an area of 530ha in the shire of Gingin. The site is described as a seasonal fresh water marsh. Major threats to this wetland are grazing, eutrophication (as a result of the application of fertilisers on agricultural land), and groundwater extraction. Another important wetland area is the Wannamal Lake System, also found in the shire of Gingin. These wetlands contain a permanent saline/brackish lake, shrub swamps and a seasonal freshwater lake. This area is threatened by salinisation, excessive inundation (causing death of wetland vegetation), eutrophication, vegetation clearing and water diversion (Carpenter, 1999).

Changes in water management are also having significant impacts on rural communities. The town of Moora is situated on a floodplain, and Moora and surrounding areas were flooded three times in the winter of 1999, resulting in the WA government establishing a $10 million trust to help the victims (Evans, 1999).

2. Survey design and implementation.

A survey was designed that combined both explicit attitudinal questions and a choice modelling exercise. There have been a number of studies that have applied non-market valuation techniques to various aspects of land management in Australia (e.g. see Abelson, 1979; Bennett, 1987; Carson *et al*, 1994; Sinden, 1987,1994; Wilks, 1990, Yapp *et al*, 1992), and a recent area of research has been in the application of choice modelling techniques (e.g. see Bennett (1999), Morrison *et al.* (1996,1998) and the papers produced as part of the research project, *'Using Choice Modelling to Estimate Non-Market Values'*, at the University of New South Wales). Given the diversity of issues that are involved in the catchment, a choice modelling framework was thought to be a more flexible than other, single issue valuation techniques. The results from the attitudinal section will be used both as a direct feedback to the catchment group involved, and also provide input into the choice modelling work.

Three populations were surveyed: residents of three rural towns in the catchment, farmers within or farming close to the catchment, and residents of Perth. The focus of the current paper is on the rural towns and Perth city responses: the farm survey results are not reported.

The survey consisted of 4 sections. In the first a set of eighteen statements were presented, where survey respondents had to indicate their degree of agreement with the statement (see Appendix I). Of the eighteen, six looked at environmental attitudes, six investigated the participants' awareness of agricultural and related environmental problems and six examined their attitudes towards responsibility for environmental problems. They were grouped in these categories, but these descriptions were not given to the respondents. The statements are quite general, and do not refer to the Moore Catchment at all.

Section 2 of the survey contained the background information to the study and this was given to the participants so that everyone had, at least, a basic understanding of the issues involved with the problem of water management in the Moore Catchment. The design had to balance the need to give clear, factual information on a number of complex issues, while at the same time not overloading respondents with information in the context of a short survey.

Section 3 introduced the concept of the choice questions, and introduced the notion of hypothetical scenarios, across which they would have to make a choice. Definitions of the attributes used to describe the scenarios are then given so that participants could understand the very brief description of the attributes and the attribute levels that is later given in the choice question. These definitions contained a description of each attribute and details about the different attribute levels used in the choice questions.

2.1. Identification of relevant attributes in the choice model

In identifying appropriate attributes to include in the study, we attempted to specify only the **outcomes** of certain management practices to be presented to the participants – they were not given specific information as to how the outcomes were attained, although some background information was given. After consultation with members of the Waters and Rivers Commission, five attributes were identified:

- i) Area of farm land affected by salt in the catchment
- ii) Area of farm land planted to trees in the catchment
- iii) Ecological impact on off-farm wetlands in the catchment
- iv) Risk of a major flood event
- v) Change in farmers' incomes
- vi) Annual contribution to a management fund.

The attribute levels are reported in Table 1 below.

Table 1. Attribute levels for the Perth city, and Rural towns surveys

Attributes	Level
Area of farm land affected by salinity	5%, 15%, 30%
Area of farm land planted to trees	5%, 20%, 50%
Ecological impact on off-farm wetlands	None, low, high
Risk of major flood event in Moore Catchment	1/50 year, 1/100 year, 1/150 year
Change in farmers' income per year	-$20,000, -$5,000, 0, $5,000, $10,000
Your annual ($) contribution to a management fund	0, 10, 20, 30, 40, 50, 60, 70, 80, 90

For the personal contribution question, the rural towns were informed that every tax payer in the catchment would contribute, while in the city survey it was suggested that all WA taxpayers would contribute. This was designed to avoid strategic overbidding by the Moore Catchment communities, who might see this as a mechanism for leveraging large sums of money into the catchment from which they may expect some personal gain.

After the preliminary analysis of the rural towns survey it was realised that the pictures depicting ecological impacts may be inappropriate, so a change was introduced into the wording associated with that aspect, giving more detailed information on the ecological impacts implicit in the pictures. This was included in half of the city surveys, allowing us to test to see if this made any difference to responses.

The inclusion of tree cover in the catchment raises the issue of whether this should be viewed as a *casually prior attribute* (Blamey *et al.*, 1998) i.e. respondents may believe that high tree cover is required to protect wetlands, and hence may favour options that include high tree cover, even though at the experimental design level, there is no link between levels of tree cover and wetland impact. Because tree cover was viewed as a potential output in itself, we did not want to exclude it from the attributes but instead emphasised that there were (unspecified) management strategies which could produce these outcomes, and they should treat all scenarios as possible.

In section 4 of the survey, 10 choice sets were presented. Each contained 3 scenarios, or options to select from, with the same baseline (status quo) scenario presented in each. This was described as 15% of farm land affected by salinity, 5% of farm land planted to trees, high ecological impact on off-farm wetlands, 1/50 year risk of a major flood event in the Moore Catchment, no change in farmers' incomes and no contribution to a management fund by the general public. A main effects survey design was employed, so that each attribute level appears in a scenario with every other attribute level, in some version of the questionnaire (Bennett, 1999).

The final section of the survey recorded some basic socio-economic variables, such as age, gender, income etc.

The survey of the rural towns in the Moore Catchment was carried out during July, 1999. The towns that were surveyed were Moora, Dalwallinu and Guilderton. These towns were chosen because they represent three different parts (upper, middle and lower) of the catchment. A total of 101 people completed the survey during the five days. The Perth survey was conducted in the center of Perth: a total of 99 people were surveyed from the city. It should be noted that both of these samples are relatively small. This was conditioned by the resources available for the study. The attitudinal results can only be taken as indicative of their respective populations. In the choice modelling exercise, with 10 replications per individual, there are a reasonably large number of observations for the statistical analysis, although again, although the statistical results may be robust for the sample, they may only be indicative of the population as a whole

3. The results of the attitudinal questions.

All responses in the attitudinal section of the survey were scored to consistently reflect the response with regard to environmental concerns, awareness and responsibility for degradation. Scores for each individual in each section of the questionnaire were summed to give a scale score. This scale score is taken as an indication of a person's 'position' on the abstract dimension which the individual questions are intended to tap (De Vaus, 1995). In this case, the three scale scores indicate the extent to which the respondent favours conservation of the environment, is aware of environmental problems caused by agricultural activities, and favours individual (as opposed to public) responsibility for degradation problems.   These summated scores were statistically tested for unidimensionality and reliability. A unidimensional scale is one in which items in the scale measure the same underlying concept, and tests for reliability assess the likelihood that individuals would obtain the same scale score on different occasions. The tests indicated that the scale scores for level of environmental concern and perception of responsibility did not measure well on either unidimensionality or reliability. The scale score for awareness of environmental issues, however, scored well on both counts, and can be considered a valid scale score indicating an overall level of awareness. The scale scores used as independent variables in the regression analyses were adjusted to maximise their unidimensionality and reliability, by dropping various items from the scale. The resulting scale was then normalised to lie between 0-1.   Table 2 below indicates the interpretation that may be given to values across the range of the scales.

Table 2 The scoring system of the attitudinal responses from the surveys.

Attitudes	Low	High
Environment utilization (e)	Pro-Agriculture	Pro-Conservation
Awareness (a)	Unaware	Aware
Responsibility (r)	Public	Individual

Figures 1-3 gives the distribution of each of these indices, for both the rural town and Perth samples.

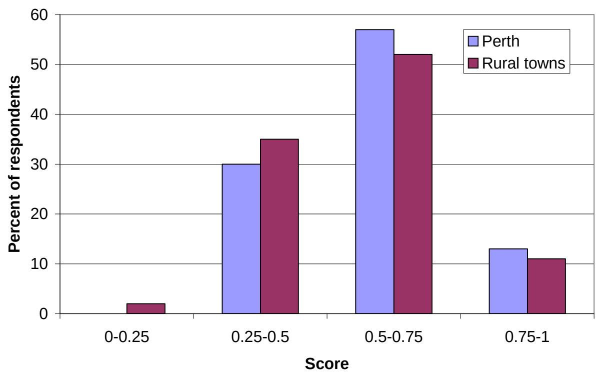

Figure 1. Distribution of attitudinal scores for Environmental Utilization (e)

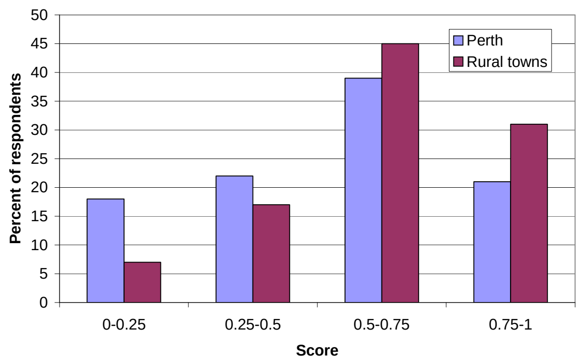

Figure 2. Distribution of attitudinal scores for Awareness (a)

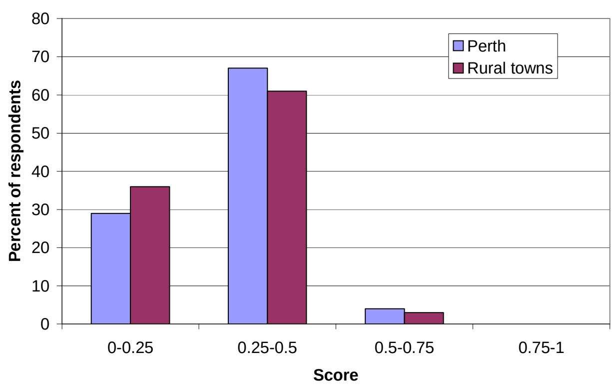

Figure 3. Distribution of attitudinal scores for Responsibility (r)

4. The conditional logit model.

The conditional logit model is a method commonly used to analyse choice models. It has a theoretical basis derived from Random Utility Theory (Carson *et al.*, 1994; Greene, 1997). This assumes that observed choices made by an individual are based on comparisons of utility, and that the researcher can identify the determinants of utility (and hence choice), but there is always some, unobservable, random element that cannot be identified by the researcher. Thus, in analysing these choices one has to accept that there an irreducible element of error involved.

Formally, let the utility obtained from outcome j, identified by the set of k attributes X_{kj} be given by:

$$U_j = \Sigma_k \beta_k X_{kj} + \varepsilon_j$$

where β is a vector of parameters, and ε a random variable.

Outcome j will be chosen if the utility of j is greater than that generated by all other options, but because the random component is unobserved one can only infer that:
$Prob(U_j > U_l)$ for all other $l \neq j$

The model is implemented by choosing a particular distribution of disturbances. The logit model rather than the probit model, is generally used for choice modelling because it has more flexibility. It is assumed that the disturbances are independent and identically distributed, with a Gumbel distribution (Greene, 1997):

$$F(\varepsilon) = \exp(-\exp(u))$$

where u is normally distributed.

It can then be shown that the probability of choosing j from a set of n alternatives can be expressed as

$$\text{Prob}(Y = j) = \frac{\exp\left[\lambda \sum_k \beta_k X_{kj}\right]}{\sum_n \exp\left[\lambda \sum_k \beta_k X_{kn}\right]}$$

where λ is a scale parameter which is inversely related to the variance of the error term. The scale parameter is usually normalised to equal one, but if some assumption is made as to how it varies (across sub-populations of the sample, for example) one can identify changes in λ relative to some baseline category.

Individual specific covariates are included as interaction terms with the attributes, as otherwise they cannot explain choice *per se* (as they do not vary across options).
If one defines Z_{im} is the m'th characteristic for individual i which may affect values (i.e. age, education etc) a more general specification can be given as:

$$U_{ji}=\Sigma_k\beta_k X_{kj} + \Sigma_k\Sigma_m\alpha_{km} X_{kj}Z_{mi} + \varepsilon_{j.}$$

Not all of the interaction terms need to be included, and one may have some prior beliefs as to which attributes will be affected by which characteristics, but this can, to some extent, be determined empirically.

One specific form of covariate that can be included are alternative specific constants. The inclusion of such attributes essentially implies that there is some determinant of choice that is not associated with the attribute levels, but the alternative itself. Thus, if one option within the choice sets is the status quo, and there is an inherent preference for change irrespective of the attribute levels present in the alternatives, the inclusion of an alternative specific constant will capture that effect. Such variables are only meaningful if one can assign an interpretation to the option: where the interpretation of options within a choice set vary across choice sets, interpretation of alternative specific constants is difficult.

Although the estimated parameters associated with the attributes reveal significance and direction of the relationship between preferences and attributes, on their own they give little information: they identify the marginal utility associated with the attribute, but conflated by the scaling parameter λ. Alternatively one can identify the partworth of the attribute (Bennett, 1999). This can be interpreted as the change in income that is required to compensate for a change in an attribute level and leave the individual on the same level of utility. It is derived as the (negative) ratio of the attribute coefficient and the coefficient on the payment variable. As it is a ratio of parameter estimates the scaling parameter cancels.

5. The empirical application

The combination of attributes and levels within the choice model, indices of attitudes outlined in section 3 above and socio-economic variables for each individual, two sample populations and a number of potential technical issues relating to estimation gives considerable scope for reporting alternative specifications. The discussion that follows will broadly reflect the order in which the analysis proceeded, although not all alternative models will be presented in detail.

5.1. Attribute levels: categorical or cardinal?

The attributes contain a number where the levels could be strictly interpreted as cardinal, and included in the model as such: tree cover, area of salt affected land, change in farmers' income, risk of flooding and payment level. Only the impact on wetlands has strictly to be coded as a categorical variable (i.e. high, low or no impacts). However, there is no *apriori* reason to assume that there should be a linear relationship between the level of an attribute and valuation. It may be non-linear: increasing tree cover in a catchment may be viewed as a benefit up to some limit, but then reduce welfare at higher levels.

The initial modelling focussed on attributes only. All attributes other than payment were initially included as categorical variables, and then on inspection of the estimated coefficients, we were able to identify where a linear relationship could reasonably be imposed. In fact this was only the case for salt, where there was a clear progression in the coefficient values as the salt area increased, and restricting the coefficients to a linear relationship was accepted for both rural town and Perth data sets (a χ^2 value of less than 1.28 for both samples, compared to a critical value of 3.84). For tree area, 20% tree cover was preferred to 5% in both samples, but a 50% area was either valued less (rural towns) or equally (Perth). For risk, there is a strong aversion to the highest risk option (1/50 years) but indifference between 1/100 and 1/150 year flood risks. The response to wetland damage showed a similar effect: only the highest impact was valued (negatively) while the no and low impacts where valued equivalently. The pattern of coefficients for changes in farmers' incomes was most striking: they were approximately equal for any negative change in income, and equal for any positive change or constant income. Both samples rejected the restriction that the change in income should be included as a cardinal variable, (χ^2 values of 28.3 and 20.7; critical value of 7.8) but accepted a restriction that the change in income could be replaced by a dummy variable, taking a value of 1 if income falls, or zero if it is constant or rises: (χ^2 of 7.2 and 7.3 compared to a critical value of 7.8).

Tables 3 and 4 report the results for these preliminary models, and Table 5 reports the definition of the variable names used.

Table 3. Results for choice model, attributes only: Rural towns sample

Conditional (fixed-effects) logistic regression
Number of obs=938
LR chi2(9)=205.11
Prob > chi2=0.0000
Log likelihood = -927.94255
Pseudo R2=0.0995

	Coef.	Std. Err.	z
Tree_20	0.530	0.111	4.775
Tree_50	-0.050	0.115	-0.436
Salt	-0.025	0.005	-5.469
Risk_2	-0.184	0.130	-1.415
Risk_3	-0.397	0.127	-3.125
Wet_2	-0.051	0.137	-0.372
Wet_3	-0.989	0.132	-7.492
Inc	-1.006	0.142	-7.082
Pay	-0.004	0.002	-2.170

Table 4. Results for choice model, attributes only: Perth sample

Conditional (fixed-effects) logistic regression
Number of obs=979
LR chi2(9)=405.71
Prob > chi2=0.0000
Log likelihood = -872.68465
Pseudo R2=0.1886

	Coef.	Std. Err.	z
Tree_20	0.460	0.113	4.073
Tree_50	0.460	0.111	4.136
Salt	-0.036	0.005	-7.678
Risk_2	0.094	0.128	0.733
Risk_3	-0.430	0.118	-3.634
Wet_2	-0.176	0.138	-1.272
Wet_3	-1.417	0.137	-10.342
Inc	-1.043	0.134	-7.785
Pay	-0.003	0.002	-1.594

Table 5. Variable definitions

Name	Type	Definition
Tree_20, Tree_50	Dummy	Tree cover of 20 and 50% respectively
Salt	Cardinal	% of land affected by salt
Risk_2, Risk 3	Dummy	1/100 year flood risk, 1/150 year flood risk respectively
Wet_2, Wet_3	Dummy	Low and high impact on wetlands respectively
Inc	Dummy	Farm income falls, zero otherwise respectively
Pay	Cardinal	Level of personal contribution
M,G	Dummy	Location indicators, Moora and Guilderton respectively
Income	Cardinal	Respondents income
age	Cardinal	Respondents age
a,e,r	Cardinal	Summated scores for attitudes: Awareness, Environmental Utilization, Responsibility.
ASC_1	Dummy	Alternative specific constant, =1 for status quo, 0 otherwise

Although there are clear differences in parameter values, the possibility of pooling the data sets to generate a single model was formally tested. A null hypothesis of equality of both parameters and variances across the two samples was rejected (χ^2 (9)=46.75, compared to a critical value of 16.92). If the data in the Perth sample is optimally scaled to allow for a difference in variance, equality of the remaining parameters is still rejected (χ^2 (8)=25.03, critical value of 15.51)

Both models (just) satisfy the Independence of Irrelevant Alternative assumptions, when the models are tested by dropping the 'no-change' option (which is present in every choice set). Values for χ^2 (9) of 16.91 and 15.95 are generated, compared to a critical value of 16.92. However marginal these values are, it should be noted that these results are generated without considering any personal covariates, or alternative specific constants. They do give some support to the proposition that the reported choices are consistent, and give values which are largely consistent with *a priori* expectations[2]. A

[2] The Perth model was also investigated to check on the stability of the variance term, λ, across the choice sets. If there are learning or fatigue effects, then these may reveal themselves through a systematic change in this variable (see Rolfe *et al.*, 1999). A quadratic function form was employed, such that $\lambda=1+aT+bT^2$, where T is defined as the number of the choice set (defined as 0-9), and a and b are parameters. An extensive grid search of a and b found no evidence of a change in λ over the ten choice sets.

more detailed discussion of the results is reserved for after the full models are estimated, to which we now turn.

5.2 The inclusion of attitudes.

The inclusion of variables in the choice model that reflect either the socio-economic status of the individuals, or their elicited attitudes, can be justified on a number of criteria. They can be used as confirmation that the responses obtained are considered responses, and not randomly generated. One would expect that if an individual indicates that they place a higher weight on environmental preservation in the 'attitudes' section, then they will place a higher weight on environmental impacts in the choice model. Although this may appear tautological, given the complexity of the cognitive burden placed on the respondents in the choice modelling section, it is reassuring if this result does occur. Secondly, the inclusion of such additional variables should increase the precision with which the coefficients on the attributes are measured: they are no longer the average values for the sample as a whole. Thirdly, they may be required to generate models that satisfy formal requirements such as Independence of Irrelevant Alternatives (IIA) (see Morrison *et al.*, (1998) for example). Given the number of attitudinal and socio-economic variables a wide range of possible models could be estimated. However, after some preliminary investigations, a number of interactions have been identified as being particularly robust. In particular, the weights placed on wetland damage are modulated by the environmental and awareness variables (e and a). Recall that the higher the value of "e", the more the individuals have indicated pro-conservation attitudes, while the higher the value of "a" the more aware the individuals appear to be of environmental issues.

In both samples the marginal utility of money was found to vary according to the level of the responsibility index (r). Here, a higher value of r is interpreted as implying a belief that there is a community responsibility to deal with environmental problems caused by agricultural activities, while a low level implies a greater importance being placed on individual responsibility. The other general result that was found to hold is that an alternative specific constant was significant in both samples, with the result that there was a tendency to not select the status quo option, over and above the impact of the attribute levels within the choices. The full results for the rural town and Perth samples are reported in Tables 6 and 7 below.

Table 6. Results for choice model, full model: Rural towns sample

Conditional (fixed-effects) logistic regression
Number of obs=938
LR chi2(20)=298.25
Prob > chi2=0.0000
Log likelihood = -850.61042
Pseudo R2=0.1492

	Coef.	Std. Err.	z
Tree_20	0.404	0.148	2.731
Tree_50	-0.233	0.151	-1.545
Salt	-0.029	0.005	-6.047
Risk_2	0.002	0.172	0.012
Risk_2 *M	-0.530	0.249	-2.128
Risk_3	0.286	0.175	1.636
Risk_3 *M	-1.304	0.217	-6.009
Wet_2	0.153	0.581	0.264
Wet_2*a	0.951	0.597	1.593
Wet_2*e	-1.247	0.738	-1.690
Wet_3	0.138	0.503	0.276
Wet_3*a	1.192	0.489	2.437
Wet_3*e	-2.782	0.627	-4.439
Inc	-1.660	0.248	-6.696
Inc*Income	0.013	0.005	2.706
Pay	0.004	0.004	1.101
Pay*r	-0.030	0.011	-2.865
ASC_1	-0.907	0.327	-2.772
ASC_1*age	0.015	0.005	3.033
ASC_1*G	-1.137	0.244	-4.660

For the rural towns sample, many of the results from the simple model are still present. A 20% tree cover is seen as beneficial while a 50% tree cover is not. The level of salt affected land reduces utility, and is highly significant. The risk of flooding is not generally significant as a determinate of choice, at either the medium or high rates, for respondents living in Guilderton or Dalwallinu. Neither of these communities was particularly badly affected by the flooding in 1999 (but note the discussion that follows on the alternative specific constant). However, the Moora respondents, who were significantly affected by the flooding, place a higher weight on the higher risk of flooding. For wetlands, again, the low impact does not appear to be having any affect on choice, even when interaction terms are introduced for "e" and "a". This may well have been due to the pictures used to indicate the different impacts: that used to indicate a low impact revealed a degraded wetland, underwater with invasive plants around the border. However, visually, it may have appeared to be attractive, despite the description of the ecological impacts used.

The high impact is in general seen as having a negative impact, and the greater the environmental concern (e) the greater the weight attached to it, while the greater the awareness of environmental issues, the lower the weight. The latter is difficult to interpret: possibly those with lower understanding of the problems are placing a higher weight because they believe that it must be important if it is included in the survey. The aggregate effect of these across the population is complex, and will be discussed further when the partworths are reported (section 6 below).

A negative change in farmers' income is still seen as an adverse effect, but this varies by the individual's own income level. The higher the respondent's income the less weight they attach to changes in farmers' incomes. There are two possible reasons for this: those on lower incomes may be more sympathetic to the plight of others, or alternatively those on lower incomes may be more concerned about the affects of reduced farmer prosperity on their own welfare, as part of the local economy. An income of in excess of $120k is needed before the net coefficient falls to zero: a value outside those reported in the survey. As noted above, the alternative specific constant implies an underlying tendency not to choose the status quo, although the older the respondent the smaller this effect, with the transition from a negative to positive coefficient occurring at age 60.

There was also found to be a geographical affect: those in Guilderton were also more likely not to select the status quo. However, there were some complex interactions between the alternative specific constant, the risk variables and location. If location is not included as an interaction term with the risk attribute, then the respondents in Moora also show a significant tendency to prefer change rather than the status quo. If location is not included with the alternative specific constant, then respondents in Guilderton also place a significant, negative weight on the risk of flooding, although not to the same degree as those from Moora.

The interaction term between "r" and pay indicates that the (absolute) weight attached to the personal contribution being asked for declines as "r" becomes smaller: i.e. the more 'community' minded an individual is, the less concerned they are about the payment amount. The positive coefficient on pay itself is insignificant.

Table 7. Results for choice model, full model: Perth sample

Conditional (fixed-effects) logistic regression
Number of choice sets: 979
LR chi2(14)=426.16
Prob > chi2=0.0000
Log likelihood = -862.45966
Pseudo R2=0.1981

	Coef.	Std. Err.	z
Tree_20	0.340	0.140	2.438
Tree_50	0.325	0.145	2.235
Salt	-0.037	0.005	-7.768
Risk_2	0.061	0.129	0.475
Risk_3	-0.316	0.144	-2.190
Wet_2	-0.174	0.538	-0.324
Wet_2*a	0.028	0.465	0.060
Wet_2*e	-0.031	0.884	-0.035
Wet_3	-1.123	0.490	-2.294
Wet_3*a	0.760	0.402	1.889
Wet_2*e	-1.033	0.792	-1.304
Inc	-1.118	0.138	-8.127
Pay*r^2	-0.045	0.011	-4.158
ASC_1	-0.470	0.245	-1.918

The results for Perth are broadly similar. Both levels of tree cover are valued positively, although 50% cover is seen as equivalent to 20%. Again, the area of salt is highly significant. The medium risk of flooding is not significantly different from the low risk, but the high risk reduces utility. Again, the low level of risk to wetlands does not appear to be significant in determining choices. As noted earlier, half of the Perth survey had a modification that included greater emphasis on the description of the ecological impacts of the medium impact option, but this sub-population showed no significant difference in their response to this attribute level. Again, environmental awareness and concern alter the weight attached to the high wetland impact attribute.

In contrast to the rural towns sample, the level of income of the Perth respondent does not appear to affect the weight attached to negative changes in farm incomes. This may indicate that the result in the rural towns survey was driven by a concern about the effect of changes in farm incomes on the respondent's income.

There is a strong interaction between the responsibility index and the marginal utility of money. However, introducing a linear interaction led to a substantial portion of the sample having an inferred negative marginal utility of income. This makes the later interpretation of the results problematic, so for purely pragmatic reasons, the model was constrained to generate a positive marginal utility, but allowed to be non-linear in r. The resulting model includes only the r^2 term. It is important to note that there is no theoretical guidance on how to incorporate such effects and that r is itself a constructed index: the results would change if we altered the values of that index. However, both samples indicate that there is some persistent relationship between the responsibility index and the coefficient on the payment level in the choice sets. Again, the alternative specific constant indicates an underlying preference for change.

Both of the full models were tested for IIA. The Perth data set indicated no violation of the condition, again when the status quo option was dropped. The rural towns model failed the test. However, when a sequential nested logit model was estimated, the results suggested that the model was equivalent to a non-nested logit (the estimate of the inclusive value coefficient was not significantly different from one: see Hausman and McFadden, 1984; Kling and Thomson, 1996). Given the acceptance of the IIA assumption in the simple model (Table 1) an investigation of where in the process of extending the model the failure is induced was conducted, and it would appear that it is the inclusion of the location effects which cause problems. Given the problems noted above in distinguishing the relationship between the location effects, the alternative specific dummy and the risk variables, it is perhaps not surprising that the estimates alter as the status quo option is removed from the model. Given the result from the sequential nested logit model the results in Table 3 are used in the remainder of the paper.

6. Partworths

The calculation of partworths allows monetary values to be ascribed to the attribute levels, and because they are independent of the variance scaling effect, they can be compared across samples. In the current case, however, estimation of the partworths is complicated by the individual specific interaction terms, both on the attribute levels and the coefficient on the payment level.

Tables 8 and 9 report the median partworth for each attribute level that is significant. This is derived by estimating the partworth for each attribute for each individual in the sample. The distribution of partworths is indicated by reporting the 25th, 50th and 75 centiles of the distribution. The mean is also reported but this measure is distorted by a few individuals who have a very low infered marginal utilitiy of money, and hence very high (absolute) values for the partworths. In the case of the Perth sample, those respondents with an inferred marginal utility of money of zero were excluded from the calculations (some 6% of the sample).

Table 8. **Distribution of Partworths within the sample** ($ per year): Rural Towns

Baseline		Centile 25	Centile 50	Centile 75	Mean
5%	Trees, 20%	$35	$42	$77	$81
	Salt (per %)	-$5	-$3	-$2	-$6
1/150	Risk (1/100)	-$81	-$51	-$36	-$76
1/150	Risk (1/50)	-$155	-$98	-$70	-$146
low	Wet land damage (high)	-$170	-$120	-$83	-$185
0	Farm Income Change (-ve)	-$217	-$168	-$117	-$276

Notes:
Baseline column indicates the level of attribute from which the change is measured. Partworths for risk calculated for the Moora subsample only.
The value for salt is the value for each percentage point change in area affected by salt.

Table 9. Distribution of Partworths within the sample ($ per year): Perth

Baseline		Centile 25	Centile 50	Centile 75	Mean
5%	Trees, 20%	$47	$62	$121	$158
5%	Trees, 50%	$45	$59	$116	$151
	Salt (per %)	-$13	-$7	-$5	-$17
1/150	Risk (1/50)	-$112	-$57	-$44	-$146
low	Wet land damage (high)	-$406	-$278	-$178	-$583
0	Farm Income Change (-ve)	-$399	-$204	-$156	-$520

Notes: .
Baseline column indicates the level of attribute from which the change is measured..
The value for salt is the value for each percentage point change in area affected by salt.

There are a number of noteworthy features of these results. Firstly, there is a diversity of values within the samples that has been captured by the attitudinal variables of respondents. In particular, this is determined by the variation in the marginal utility of income that has been identified. Secondly, the city respondents are willing to pay to achieve environmental enhancements at levels equal to or in excess of the payments of those who live in the catchment. The only real point of departure is their attitudes towards the higher level of trees in the catchment.

The high weight attached to flood risk avoidance by people living in Moora is perhaps not surprising: the apparent lack of concern by others in the catchment is. What is also noteworthy is the significant values both samples place on avoiding income loss for farmers. The fact that this is seen as a catagorical variable is surprising, but the effect is very significant in both samples. It may be that the range of income losses offered was not great enough for the respondents to differentiate between. What is clear is that no weight was placed on increases in farm incomes, or alternatively: respondents were not prepared to trade-off other attributes in-order to increase farm incomes.

7. Conclusions

The results from the statistical analysis reported here present a number of tantalising conclusions.

There apears to be a systematic relationship between how people weight the required monetary payment in a scenario and their perceptions of community v. individual responsibilities. Those with a view that there should be greater community responsibility are less concerned about being asked to contribute to the management of the catchment.

Respondents appear to be concerned if farmers' incomes are reduced as a result of a particular scenario for catchment management, but place no weight on increased farm incomes: they are not prepared to trade off environmental attributes or their financial contribution in return for enhanced farmer prosperity. This raises questions about the circumstances in which the broader community thinks it is appropriate to make transfer payments to farmers.

There is a quite significant range of values for different aspects of the environment held by different individuals, even within a fairly homogenous population such as the Moore catchment, and despite their having shared substantial hardships as a result, in part, of previous land and water management practices. This may have important implications for the development of community acceptance for management in the catchment.

The results are tantalising because they are based on data samples that must have substantive questions asked of them: they are small, and collected at a time when there had been major flood events that had significantly affected the catchment. Perth residents were aware of the area and its problems, and residents in the catchment were very sensitised to water management issues. There are survey design issues such as the communication of risk, and the representation of a complex issue such as ecological damage to wetlands. Perhaps this work is best viewed as an extended statistical pilot, and hueristic device for the development of further research questions.

Appendix I. Attitude questions

Respondents were asked to indicate their response to each question on the following scale:

Strongly agree, Agree, Undecided, Disagree, Strongly disagree

Environment utilization (e)
1. Western Australia needs to maximise agricultural production even though this may cause some environmental damage.
2. Government should give higher priority to polices to conserve and protect the environment.
3. As salinity and waterlogging are major agricultural problems, landholders should be allowed to drain water off their properties.
4. Agricultural land should be used primarily for annual crops rather than tree plantations and native vegetation.
5. Society has a right to expect farmers to farm in such a way that maintains land and water in good environmental health.
6. Government legislation designed to protect the environment is seriously hampering primary industries, such as mining and agriculture.
Awareness (a)
1. Western Australian agricultural land faces serious degradation problems that have been caused by clearing native vegetation for farming activities.
2. Salinity will affect at least 30% of farming land in the south-west of Western Australia by 2050.
3. Agricultural activities are damaging river systems and wetlands
4. Salinity is reducing biological diversity in the Western Australian environment.
5. Buildings and roads in many rural towns in the south-west of WA are being seriously affected by salinity.
6. Extensive revegetation of land is required in the south-west of WA to reduce the area of land threatened by salinity.
Responsibility (r)
1. More government funding is needed to address the problem of salinity in Western Australia.
2. Rural landholders should be solely responsible for funding Landcare activities in their district.
3. The wider community should contribute more money to address degradation issues on farming land.
4. Individual landholders should pay a levy for the water, salt and nutrients that leave their property.
5. Damage to infrastructure in rural towns caused by encroaching salinity is the responsibility of the local Shire Council.
6. The general public should accept more responsibility for the environmental problems being caused by farming activities.

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