Integrated Value Mapping for Sustainable River Basin Management: Economics, Ethics and Social Psychology

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List of Abbreviations and Acronyms

	Attitude towards behaviour
CBA	Cost benefit analysis
CVM	Contingent valuation method
DK	Don't know
ECOMOD	Economic model
ETHIMOD	Ethical model
GAC	General awareness of consequences
GIS	Geographic information systems
IVM	Integrated value mapping
LR	Likelihood ratio
MLP	Modified lexicographic preferences
PBC	Perceived behaviour control
PSYCHOMOD	Social psychology model
SN	Subjective norms
RA	Refused to answer
TPB	Theory of planned behaviour
TRA	Theory of reasoned action
WFD	Water framework directive
WTP	Willingness to pay
WTPP	Willingness to pay principle
ZB	Zero bids

AT_b

Abstract

Recent studies in social psychology and in environmental ethics suggest alternative models of environmental behaviour that challenge the rational expectation assumptions of CBA and, in turn the use of CBA in environmental policy making. This paper integrates some of the alternative models and tests their relative strengths and complementarities in explaining human dispositions to pay for biodiversity restoration using logistic models. Primary data were collected from face-to-face interviews of a stratified random sample of 1012 individuals across Scotland. The results of the analysis provide empirical evidence of the long-standing concerns for using single domain models to aid environmental decision making and illustrate the case for considering integrated value mapping alternatives.

1. Introduction

Critics of the neo-classical welfare economic theory find the use of economic costs and benefits as a main criteria for setting environmental priorities morally objectionable (see for example: Niemeyer and Spash, 2001; Spash, 2002). One central theme of the criticism of the neo-classical model is based on the concept of value pluralism, i.e. values associated with environmental entities are complex, incommensurable and ultimately cannot be reduced to a single metric, such as pecuniary values. Critics argue therefore that environmental values cannot adequately be assessed under the standard neo-classical framework. Empirical evidence suggesting that non-economic values exist and often inform the environmental priorities of significant proportions of the public has continued to challenge the use of cost benefit analysis (CBA) in setting environmental priorities in the past decade (see for example, Stevens et al., 1991; Spash and Hanley, 1995; Spash, 2002 and Urama 2003). Yet, CBA practitioners still proceed as if values are commensurable and ultimately reducible to a single metric (for details see Rosenberger, et al., 2003). Dealing with non-economic value categories in the analysis of CBA data is therefore problematic. Indeed, the standard practice in the estimation of environmental demand models such as WTP is to ignore them (see for example, Mitchell and Carson, 1989, Arrow et al., 1993, and Bateman et al., 2002). Thus, all respondents who refuse to "play the economic game" and instead are guided by ethical, moral or other principles are excluded from the analysis.

Despite these problems CBA continues to be promoted as a tool for informing environmental policy, such as the EU Water Framework Directive (WFD)[1]. For CBA to be useful for decision-making under the WFD their underlying assumptions must, in principle, be seen as valid by individuals who must also be prepared to play the economic game – i.e. trade environmental entities for money. Empirical evidence from previous studies show that this is often far from true (Burgess, Clark and Harrison 1995; Burgess, Clark and Harrison 1998). Alternative decision-making models exist in the fields of social psychology and environmental ethics that are not based on these assumptions and challenge the use of economic valuation methods, especially the CBA, to aid environmental policy choices. The epistemological debate regarding the limitations of applying single disciplinary models to inform complex environmental policy decisions (and hence the call for integrated modelling alternatives) has peppered the environmental valuation literature in the past decade (Urama, 2003, Urama and Hodge, in press), but has gone largely unheeded.

[1] WFD is an EC water legislation requiring all inland and coastal waters to reach "good status" by 2015 (EEC, 2000)

This paper integrates three contending models: neo-classical welfare economics; environmental ethics; and social psychology; tests their relative contributions to understanding public dispositions to pay for biodiversity restoration, and examines the potential synergies and/or complementarities between them.

The paper is presented in the following format. First, the theories behind the contending models and the rationale for integrating them are discussed briefly. Second, the integrated model is specified followed by a brief discussion of the case study and survey design. Finally, the model results are presented and discussed, critically examining the relative contributions to the explanatory power of each model, the precision of parameter estimates, and their overall statistical robustness.

2. Theoretical Frameworks of Contending Models and Rationale for Integration

Learning from Environmental Ethics: The Role of Fundamental Ethical Beliefs

The dominant economic theory of decision-making requires a fundamental philosophical assumption; that individuals believe the net utility from the consequences of an action determines whether that action should be undertaken. Thus, CBA and its tools, such as contingent valuation (CVM), assume that individuals are able and willing to consider trade-offs in relation to the quantity and/or quality of public goods. Debates in environmental ethics have raised the issue of individuals refusing to make these trade-offs and so questioned the applicability of economic efficiency arguments (Sagoff 1998; Stevens et al., 1991). One aspect of refusal can be a basis of belief in inviolable rights so that actions are intrinsically of value or deontological (Spash 2002). Other motivations for non-compensatory preference expressions may include dual, non-reducible utility functions (Sen, 1977; Etzioni, 1998, Sagoff, 1988, 1998); ambivalence between hard-to-compare values (Opaluch, and Segerson, 1989); inability to commodify environmental goods (Vatn, 2000); the essentiality of a good (Lockwood, 1996; Schmidtz, 2000), or lack of environmental knowledge (Urama, 2003).

Micro-economic welfare theory recognises the fundamental differences in utility functions for these different types of goods and their associated preference structures, (see for example, Koutsoyiannis, 1991). Yet some CBA critiques still reject the neoclassical paradigm on the basis of deontological arguments (see for example, Spash, 1998, Niemeyer and Spash, 2001, Spash 2002). “Such preferences mean that utility functions including environmental aspects which are to be protected at all costs are undefined for an individual (since the axiom of continuity is violated), and the indifference curves collapse to single points (denying the principle of gross substitution). These preferences are termed lexicographic by neo-classical economics because they give absolute priority to one commodity over all others and therefore imply a strict ordering, as in a lexicon…Economists have tended to regard the denial of continuity and violation of gross substitution as of little relevance because lexicographic preferences as unrealistic and unlikely to occur” (Spash, 1998: 60)[2].

[2] In other words, such preferences mean that utility functions including environmental aspects which are to be protected at all cost are undefined for an individual since the axiom of continuity is violated, and that indifference curves collapse to single points, denying the principle of substitution (Spash, 1998).

Existing empirical evidence on the role of lexicographic preferences in environmental valuation is mixed. While some studies suggest that a significant proportion of respondents hold lexicographic preferences towards environmental attributes such as biodiversity (Stevens, et al., 1991, Spash and Hanley 1995; Spash 2002), others suggest that such rights-based preferences are not strictly lexicographic (Urama 2003) and/or are sometimes internally inconsistent (Rosenberger et al., 2003). If respondents perceive an environmental entity as an "essential good", their WTP for that good increases since the axiom of rationality suggests that economic agents' disposition to pay for a good increases with the essentiality of the good. This fundamental principle of the neo-classical welfare theory seems to be ignored or addressed fleetingly in the lexicographic preference literature. Spash, (1998) had argued that the extreme lexicographic position does indeed, seem likely to be uncommon because of the overriding ranking of a good above even the individuals own life (Spash, 1998: 60)[3]. However, he went on to argue that "a range of broadly right-based or deontological positions do, however, appear to be relevant to the general public when considering the environment (Spash, 1997) and have important implications for the application of monetary valuation to environmental policy" (cited in Spash, 2000: 196). Tracing the theoretical history of lexicographic preferences back to Georgescu-Roegen (1954) and Lockwood (1996), a set of modified lexicographic preference (MLP) positions based on thresholds has therefore been developed (for details see Spash, 2000; Rosenberger, et al., 2003: 64)[4]. Spash, (2000) defines two MLP positions: the strong MLP and weak MLP signifying beliefs in rights to life for species regardless of considerations for one's minimum living standards, and rights to life for species qualified by considerations for one's minimum living standards, respectively (Spash, 2000). While these modifications are conceptually more compatible with the neoclassical model than the extreme positions, i.e. allowing for different types of utility preferences, it has been recognised that empirical estimation of these modifications can be problematic (Urama, 2003). The conceptual problems associated with defining "the minimum standards of living" dates back to Sen's work on the concept of "functionings" (Sen, 1987)[5].

We therefore hypothesise that respondents holding strong ethical positions regarding rights to life for species would in principle be prepared to pay more for biodiversity restoration than those believing in human rights to life vis a vis species. As noted by Rosenberger, et al., (2003: 65) "we must also accept that some people seemingly expressing lexicographic preferences are actually being inconsistent in their expressions". Overall, the propositions regarding the role of these ethical preference expressions on WTP models still require further validation. These preference categories were therefore replicated in this study to test the hypothesis of their relative contribution to people's dispositions to pay for biodiversity restoration in Scotland.

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[3] A martyr would fit this category, but it might be rare to find individuals choosing to die to protect environmental entities.

[4] There exist certain thresholds, or minimum levels of a good that are necessary and prior to other choices of goods (for details see Rosenberger, et al., 2003: 64).

[5] The various living conditions one can achieve and one's capabilities (i.e. abilities to achieve them) are essential parts of one 's living standard rather than commodities. Hence different respondents may have different standards in different circumstances, making it difficult to establish a common metric for relating responses to MLP questions to standard economic variables like income.

Learning from Social Psychology: the Role of Attitudes, Social Norms, and Perceived Behaviour Control

Proponents of CBA now increasingly recognise the benefits of cross fertilisation between the neo-classical model and those developed by cognitive psychologists and sociologists (see for example: Mitchell and Carson, 1989; Ajzen and Driver, 1991; Bateman et al., 2002, and Pouta and Rekola, 2001 and 2003). "Of particular interest are the attitude-behaviour models that look at the links between people's attitudes and intended behaviour as revealed by surveys, and subsequent actual behaviour" (Bateman et al., 2002: 113). Examples of such models, which have obvious implications for CBA include Fishbein and Ajzen's (1975) theory of reasoned action (TRA) and Ajzen's (1991) theory of planned behaviour (TPB)[6].

Micro-economic welfare theory assumes that individuals hold complete, invariant and transitive preferences, which they seek to maximize (see Kahneman, 1986) often in static equilibrium conditions. Conversely, Ajzen's TPB model postulates three conceptually dependent determinants of human actions: specific beliefs about the likely consequences of the behaviour (behavioural beliefs); beliefs about normative expectations of others (normative beliefs); and beliefs about the presence or absence of factors that may further or hinder performance of the behaviour (control beliefs). In their respective aggregates, behavioural beliefs produce a favourable or unfavourable attitude toward the behaviour (AT_b)[7]; normative beliefs result in perceived social pressure or subjective norm (SN); and control beliefs give rise to perceived behavioural control (PBC), the perceived ease or difficulty of performing the behaviour." (Hrubes, et al., 2001: 166). In combination, $AT_b, SN, \ \& \ PBC$, lead to the formation of a behavioural intention, such as WTP. A schematic representation of Ajzen's (1991) TPB is shown in Figure 1.

As a general rule, "the more favourable the $AT_b \ \& \ SN$, and the greater the PBC, the stronger should be the individual's intention to perform the behaviour in question" (Ajzen 1991:188). Relying on the expectancy-value theory, the TPB also specifies the nature of relationships between beliefs and attitudes: people's overall attitude toward a behaviour is determined by the subjective values of the outcomes associated with the behaviour and by the strength of these associations (Fishbein, 1963; 1967; Fishbein & Ajzen, 1975)[8]. A stated intention, such as WTP Principle is therefore assumed to be the immediate antecedent of behaviour, such as making actual payments to support the policy option specified in the WTP question.

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[6] The TPB is a product of further development of TRA and has been widely tested and accepted in the Social Psychology field and in CVM literature as a useful model for understanding the relationship between specific attitudes and behavioural intentions (see Mitchell and Carson, 1989, Ajzen, 1991, Ajzen and Driver, 1991, Pouta, 2001, Bateman et al., 2002, and Pouta, 2003) to mention just a few studies.

[7] In this case (AT_b) is used to signify specific attitude towards a referent behaviour "B".

[8] Further details on the meaning of ATb, SN and PBC and how to estimate them in empirical surveys can be found in Ajzen, (1991, and 2002), respectively.

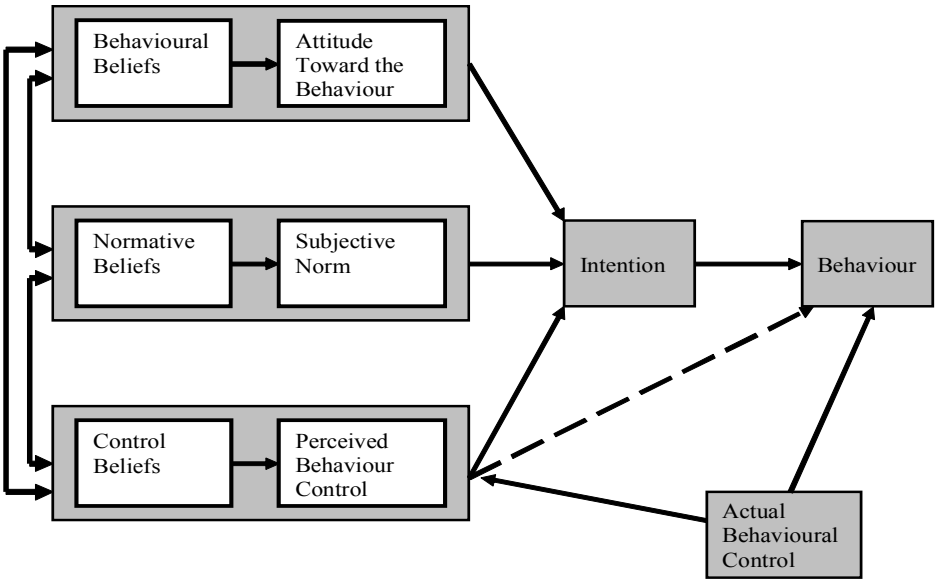

Figure 1: The theory of planned behaviour (Ajzen, 2002)

There is now a growing body of evidence suggesting that learning from Ajzen's TPB model could improve economic valuation experiments (see for example Mitchell and Carson, 1989; Ajzen and Driver, 1991; Blamey, 1996, Bateman et al., 2002, and Pouta and Rekola 2001, and Pouta 2003). However, the application of the TPB in CV experiments poses a specific design challenge. The referent behaviour (B) of interest in the model must "be defined in terms of Target, Action, Context, and Time (TACT)" elements, for the model assumptions to hold (Ajzen 2002: 2; also cited in Eagly and Chaiken 1993: 164). Mitchell and Carson, (1989) therefore identify three important connections between the earlier version of Ajzen's model (i.e. Fisbein and Ajzen's, 1975) theory of reasoned action and the design of CV surveys: (i) Correspondence: asking questions about attitudes to public goods is not as powerful a predictor of underlying values as eliciting attitudes towards paying for public goods: (ii) Proximity: attitudes are poorer indicators of likely payment behaviour than are statements regarding valuation intentions, that is, willingness to pay, and (iii) Familiarity: "the more familiar the behaviour, the more likely the respondent's attitude and/or behavioural intentions will predict that behaviour" (Mitchell and Carson, 1989: 186, also cited in Batemen et al., 2002: 114 -5). This means that specific attitudes toward payment to support a specific policy measure, to achieve a specific goal, within a specific context, in a specified period are required for TPB model application as opposed to general environmental attitudes/awareness of consequences (GAC) scales[9]. This is necessary to maintain the level of specificity required by the TPB component of the integrated model[10].

[9] The contending propositions regarding the role of GAC Scales in understanding WTP by (Stern, Dietz and Kalof, 1993; Guagnano, Dietz and Stern, 1994; Stern et al., 1995; and Spash, 1998) were therefore not considered in this paper.

[10] The Spash, (1998) study also recognised that specific attitudes and social/subjective norms may operate differently as explanatory factors and could perform better (than GAC scales) in explaining WTP.

In what follows the three models are tested drawing on the relevant theories and assumptions in their respective disciplines: neo-classical economics, ethics, and social psychology. The aim was to retain the assumptions of the individual model applications as much as possible, and assess the contributions of each domain model and the various combinations of the models to public willingness to invest in biodiversity restoration in Scotland (Figure 2).

As shown in Figure 2, seven different modelling alternatives are considered: (i) maintaining the strict assumptions of each domain[11]; (ii) bilateral integration between economics and social psychology (IVM^1), economics and ethics (IVM^2), and ethics and social psychology (IVM^3), and (iii) full integration of the three models (IVM^4).

Despite their differences in disciplinary perspectives, standard models for WTP Principle models, Ajzen's TPB model, and the ethical models share a common focus on individuals' specific behavioural intentions. However, the standard neo-classical economic WTP models make cognitive processes of choice endogenous, and exclude social norms, individual beliefs and attitudes, their perception of peer pressure and other control factors. Conversely, social psychology models treat individual behaviour as the result of interaction between social norms, attitudes and perceived behaviour control factors. On the other hand ethical models regard human behaviour toward environmental entities as a product of rights-based beliefs, some of which are inviolable, leading to a collapse of a key assumption of the neo-classical model. The modified lexicographic preferences categories (discussed above) relaxed the strict incommensurability assumption, paving the way for testing the ethical model within the neo-classical WTP framework.

[11] ECOMOD = the single domain model maintaining the underlying assumptions of neo-classical welfare theory; ETHIMOD = the single domain model maintaining the underlying assumptions of environmental ethics; and PSYCHOMOD = the single domain model maintaining the underlying assumptions of social psychology, in this case Ajzen's TPB.

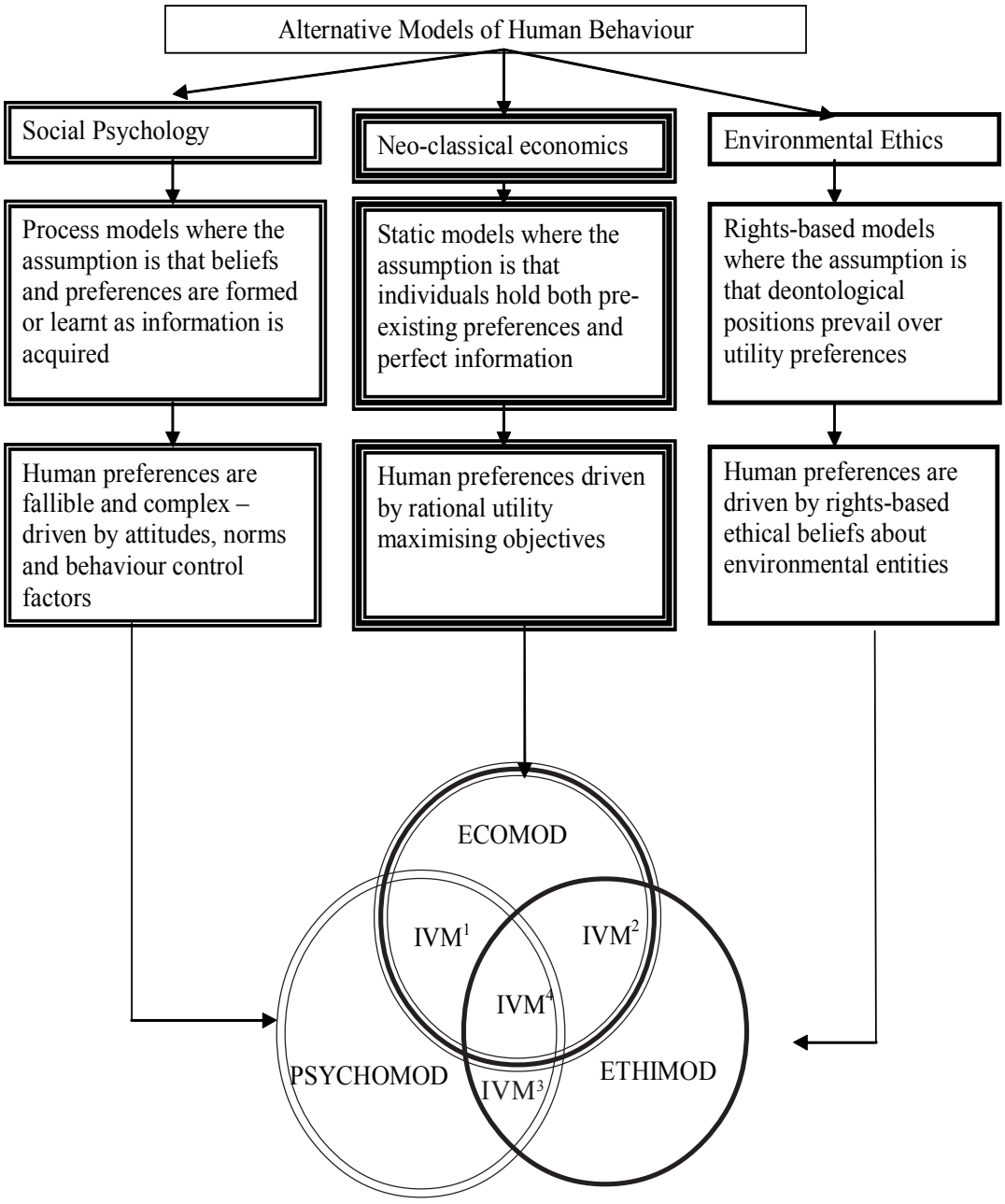

Figure 2: The underlying assumptions of the selected models

3. Model Specification and Estimation Procedure

Model estimation focused on mapping out the significant drivers of an individual's disposition to pay for biodiversity restoration in principle (WTPP) from a vector of consistently significant variables suggested by the relevant theories underpinning the separate models[12]. The dependent variable is assumed to be binomial, taking the value "1" if the respondent is willing to pay in principle and "0" if otherwise. We therefore use the logistic regression model proposed by Wrigley (1985):

[1][13]

where $P_{1_i} = P(WTPP_i = 1)$ ranges from 0 to 1 as $\boldsymbol{\beta}'\mathbf{x}_i$ ranges from .

$\mathbf{x}_i$ to + The generalized linear models for each of the contending theories are therefore specified as in $P_{1_i} = P(WTPP_i = 1) = \frac{\exp(\boldsymbol{\beta}'\mathbf{x}_i)}{1+\exp(\boldsymbol{\beta}'\mathbf{x}_i)}$ equation 1 where $\mathbf{x}_i$ is the individual specific vector of regressors in the logistic function for each modelling alternative, and $\boldsymbol{\beta}$ is a vector of estimated parameters in the function for each modelling alternative. $\boldsymbol{\beta}'\mathbf{x}_i$ is the log of the odds that the i[th] respondent is in principle willing to pay for biodiversity restoration. The dependent variable remains the same for all the modelling alternatives while the vectors of regressors and the parameters change as specified below[14]:

For the neo-classical model (ECOMOD):

[2]

[12] These variables were selected from relevant state of the art manuals and empirical tests of each model component (Mitchell and Caron, 1989, Arrow et al. 1993, and Bateman et al., 2002 for the standard economic model; Spash, 1998, 2000, 2002 and Rosenberger et al., 2003, for the ethical model; and Aizen, 1991, Ajzen and Driver, 1991, Pouta and Rekola 2001, Ajzen 2002, and Pouta 2002, 2003, for the social psychology model).

[13] Equation 1 is linear logit model where for each individual "*i*", the probability of "being willing to pay in principle" or "not willing to pay in principle" depends on a vector of explanatory variables, "$\mathbf{x}_i$" and a vector of associated parameters $\boldsymbol{\beta}$. The parameters $\boldsymbol{\beta}$ are estimated using the maximum likelihood method (MLM), which maximizes the probability of obtaining the sample actually observed.

[14] See Table 1 for definition of the variables in the models.

For the ethical model (ETHIMOD):

$$\boldsymbol{\beta}'\mathbf{x}_i = \phi_0 + \phi_1 KNBIOD_i + \phi_2 UNDBIOD_i + \phi_3 SMLP_i + \phi_4 WMLP_i + \phi_5 CONSEQ^1{}_i + \phi_6 CONSEQ^2{}_i + \phi_7 HUMRGT_i \quad [3]$$

For the social psychology model (PSYCHOMOD):

$$\boldsymbol{\beta}'\mathbf{x}_i = \lambda_0 + \lambda_1 KNBIOD_i + \lambda_2 UNDBIOD_i + \lambda_3 AT_{B\,i} + \lambda_4 SN_i + \lambda_5 PBC_i \quad [4]$$

Using the neo-classical WTP model as the baseline, the functional forms of the integrated models (IVM^1 – IVM^4) are specified in equations 5 -8, respectively:

$$\boldsymbol{\beta}'\mathbf{x}_i = \gamma_0 + \gamma_1 KNBIOD_i + \gamma_2 UNDBIOD_i + \gamma_3 INCREF_i + \gamma_4 AGECL + \gamma_5 EDUCL_i + \gamma_6 GEND_i + \gamma_7 LOCSCOT_i + \gamma_8 ATB_i + \gamma_9 SN_i + \gamma_{10} PBC_i \quad [5]$$

$$\boldsymbol{\beta}'\mathbf{x}_i = \vartheta_0 + \vartheta_1 KNBIOD_i + \vartheta_2 UNDBIOD_i + \vartheta_3 INCREF_i + \vartheta_4 AGECL_i + \vartheta_5 EDUCL_i + \vartheta_6 GEND_i + \vartheta_7 LOCSCOT_i + \vartheta_8 SMLP_i + \vartheta_9 WMLP_i + \vartheta_{10} CONSEQ^1{}_i + \vartheta_{11} CONSEQ^2{}_i + \vartheta_{12} HUMRGT_i \quad [6]$$

$$(P_{1_i})$$

$$\boldsymbol{\beta}'\mathbf{x}_i = \varpi_0 + \varpi_1 KNBIOD_i + \varpi_2 UNDBIOD_i + \varpi_3 SMLP_i + \varpi_4 WMLP_i + \varpi_5 CONSEQ^1{}_i + \varpi_6 CONSEQ^2{}_i + \varpi_7 HUMRGT_i + \varpi_8 ATB_i + \varpi_9 SN_i + \varpi_{10} PBC_i \quad [7]$$

$$\boldsymbol{\beta}'\mathbf{x}_i = \Omega_0 + \Omega_1 KNBIOD_i + \Omega_2 UNDBIOD_i + \Omega_3 INCREF_i + \Omega_4 AGECL_i + \Omega_5 EDUCL_i + \Omega_6 GEND_i + \Omega_7 LOCSCOT_i + \Omega_8 SMLP_i + \Omega_9 WMLP_i + \Omega_{10} CONSEQ^1{}_i + \Omega_{11} CONSEQ^2{}_i + \Omega_{12} HUMRGT_i + \Omega_{13} ATB_i + \Omega_{14} SN_i + \Omega_{15} PBC_i \quad [8]$$

where $\boldsymbol{\alpha}, \boldsymbol{\varphi}, \boldsymbol{\lambda}, \boldsymbol{\gamma}, \vartheta, \varpi, \text{and } \boldsymbol{\Omega}$ are the parameters to be estimated.

For specific values of the independent variables, the corresponding estimated value of is the probability of the event that the i^{th} individual answered "Yes" to the WTP principle question. Therefore, alternative values of the regressors can be used in the estimated model to predict the probability of respondents being willing to pay for biodiversity restoration (in principle) under the conditions specified in the survey.

Each estimated coefficient reflects the effect of a unit change in the corresponding regressor on the logarithm of the odds[15] of the event to occur, *certris paribus*. These coefficients are therefore difficult to interpret because the magnitude of the increase in probability depends on the original probability, which is determined by the individual values of all independent variables and their coefficients[16]. The effect of individual explanatory variables was therefore assessed by estimating their marginal effects model:

$$\partial P_1 / \partial x_k = f(\boldsymbol{\beta}' \bar{\mathbf{x}}) \beta_k \qquad [9]$$

where *f* is the derivative of $F(\boldsymbol{\beta}'\mathbf{x}) = \dfrac{\exp(\boldsymbol{\beta}'\mathbf{x})}{1+\exp(\boldsymbol{\beta}'\mathbf{x})}$ with respect to $\boldsymbol{\beta}'\mathbf{x}$.

These marginal effects correspond to changes in the probability of a respondent being willing to pay in principle, given an infinitely small change in the characteristic explanatory variable in the vector of regressors.

The definitions of variables in the models are presented in Table 1. Respondents' knowledge of biodiversity and understanding of the impact scenario were included in all the models to test the rationality assumption common to all the contending models. Initial exploration of the income data found the responses unreliable. There were many non-responses and some of the responses were substantially below expected income levels vis a vis stated occupational classes and education. Following Spash, (1998) a dummy variable INCREF was applied to cover respondent refusal to give income level[17]. In addition, respondent's level of education was used as a proxy to income. The occupation of the respondent was tried as an alternative proxy for income, but this was significantly correlated with education. The rest of the variables and how they were generated are discussed in the following sections.

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[15] The odds of an event to occur is the ratio of the probability that the even will occur over the probability that it will not occur. This can be stated mathematically as follows: log of the odds of an event = log {Prob(event)/Prob(no event)} = $\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n$

[16] One important point about the logistic transformation is that while the probabilities are bounded between 0 and 1, the logits are unbounded with respect to the values of the explanatory variables X. The predicted logit values are likewise unbounded, but the predicted probabilities can be found by substituting the estimated parameters into equation 1.

[17] The aim was to test the significance of people refusing to respond to income questions on WTP.

Table 1: Variables in the models

Variables	Symbol	Description of variable	WTP Corr*
Log WTP	LnWTP	Natural logarithm of actual WTP with zero values assigned a value of £ 0.0001.	
Variables on respondent's cognitive processing of information			
Knowledge of biodivesity	KNBIOD	Knowledge of biodiversity, 1 if level of knowledge of biodiversity is greater than 3, zero otherwise.	+ve
Understanding of valuation scenario		Understanding of information on impacts presented in the valuation scenario. 1 if level of understanding is greater than 3, zero otherwise.	+ve
Variables from neo-classical economics			
Income Refused	INCREF	Refused to give income level, 1 if refused to give income level	-ve
Age Class	AGECL	Age class, 1 if age class is greater than 34 years, zero otherwise.	+ (-) ve
Education Class	EDUCL	Education class, 1 if educated for more than 16 years	+ve
Gender	GEND	Gender, 1 if male, zero if female	+ (-) ve
Location	LOCSCOT	Location in Scottish council area, I if urban, zero if rural	+ (-) ve
Variables from environmental ethics			
Strong MLP	SMLP	Strong modified lexicographic preference, (i.e. strong species rights), 1 if prepared to protect rights to life for species at the expense of living standards	(-) ve
Weak MLP		Weak modified lexicographic preference (i.e. weak species rights), 1 if rights to life for species is qualified by considerations for living standards	(-) +ve
Consequentialist 1		Consequentialists favouring animals, 1 if relative utility favouring species first. Zero otherwise	+ve
Consequentialist 2		1 if relative utility favouring humans first. Zero otherwise	+(-ve)
Strong Human rights		Strong human rights, 1 if prefers to commit resources to help humans rather than wildlife.	-ve
Variables from social psychology – the theory of planned behaviour			
ATB Scale		ATB Scale computed as shown in section 4	+ (-) ve
SN Scale		SN Scale computed as shown in section 4	+ (-) ve
PBC Scale		PBC scale computed as shown in section 4	+ (-) ve

**expected correlation with WTP.*

4. Case Study and Survey Design

Case Study

The CVM experiment was carried out in the Tummel catchment located in the Grampian Highlands of Scotland. The river Tummel is part of a freshwater system made up of an intricate network of rivers, streams and lakes with 1,253 km of river channel and 77 km^2 of standing waters covering an area of 1,713km^2. The area includes eight reservoirs and pre-existing lakes which are used for hydro-power generation, along with the rivers and streams draining into and connecting them. The Tummel area has a very low population density (less than 0.10 persons per hectare) and the area is classified as a less remote rural zone (Black et al., 2002). Figure 3 shows the location of the Tummel catchment and the hydro-power structures in the catchment.

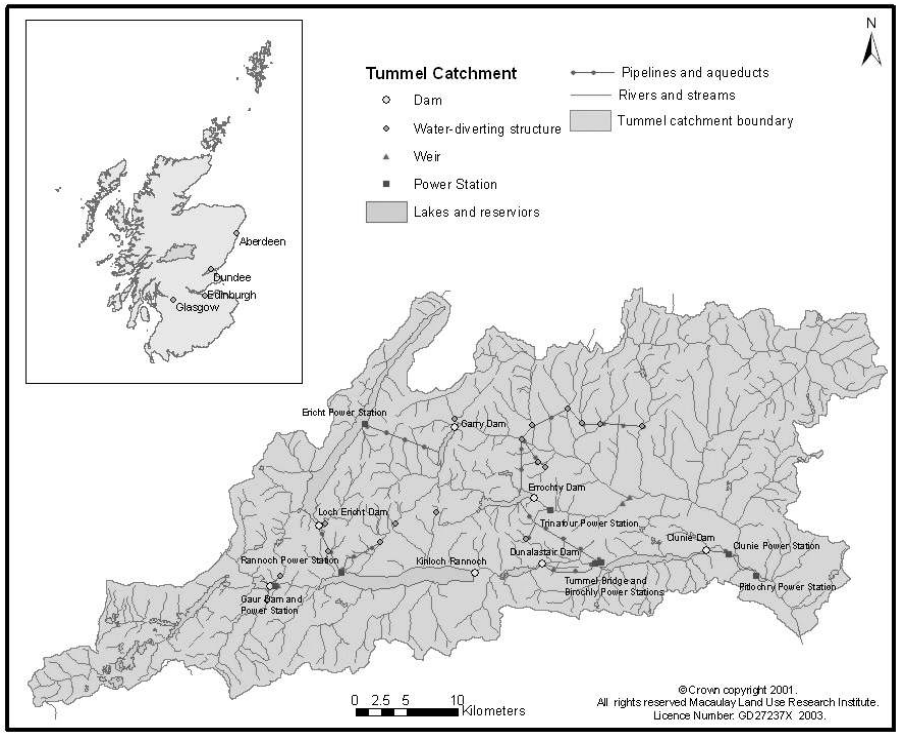

Figure 3: Location of the Tummel catchment and the hydropower structures

In order to comply with the EU Water Framework Directive (WFD) a previous study by Black et al., (2002) had identified measures which might be taken in the catchment. One of these was the introduction of a compensation flow regime from the dammed lochs to mimic the natural flow in some of the rivers within the catchment. The aim was to restore the diversity and abundance of species and habitats in the river catchment. Grounded in real policy concerns, the Tummel provided a scenario of reduced biodiversity in the rivers downstream of the hydro-dam due to low flow. This was a suitable basis for the development of a practical, feasible and believable scenario for a WTP question. Increasing river flows from the hydro-system would potentially reduce electricity generation and increase costs for the hydropower companies. Such costs would then be (wholly or partially) transferred to electricity consumers. Eliciting willingness to accept increments in household electricity bills in principle was therefore seen as a realistic bid vehicle suiting the scenario (see Spash et al., 2004 for details).

Survey Design

The development of the CV questionnaire followed five stages: (i) gathering scientific information on the current level of biodiversity in the Tummel catchment and the potential impacts of the compensation flow regime if introduced; (ii) scenario setting/framing of the hypothetical market, (iii) initial design of the questionnaire, focus groups and consultation with relevant experts, (iv) pre-testing of the survey questionnaires, and (v) final re-design of the survey questionnaires in line with lessons learned.

The survey questionnaire- The survey questionnaire had five sections (A to E): introductory framing and information; monetary valuation and follow-up; questions eliciting information on ethical positions, $AT_b, SN, \& PBC$; socio-economic data; and interviewee and interviewer evaluation.

Section A: Framing concern for public policy issues and the environment: The first section of the questionnaire asked the respondents to rank their concern for the quality of selected public services such as education, road transport and the National Health Service, and then to rank their concern for selected environmental policy issues, including biodiversity restoration, on the same scale. Such framing has been suggested to avoid embedding problems by making explicit the context of the WTP question as only one area of potential expenditure.

The final questions in Section A related to respondents' familiarity with the case study area, their understanding of biodiversity and the impacts described in the survey. Respondents were asked whether they were familiar with the area and then provided with information about the water courses, the hydropower schemes and informed about the associated changes in biodiversity. Information provided was based on previous scientific reports concerning physical characteristics of the water bodies in the Tummel catchment, land and water use in the area, the hydro-schemes and their likely impacts on biodiversity, current ecological status, and the proposed mitigation actions (see for example, Black et al., 2002).

Three types of information were used in the final survey. First, information about biodiversity in general, aquatic biodiversity and the web of life provided background on the decline in biodiversity due to hydropower, and the potential increases in biodiversity as a consequence of compensations flows. Second, information about the Tummel catchment, the hydro-power schemes in the area along with details of the decline in biodiversity specific to those schemes. Third, information that familiarised respondents with the two scenarios was provided. The "business as usual" scenario described biodiversity at 14% of natural levels due to reduced water flow in the catchment. The alternative scenario involved an increase in water flows and an associated increase in biodiversity in the catchment to 70% of natural levels at the expense of reduced energy generation and increased electricity bills. The neo-classical model assumes that respondents understand this perceived change in the pre-and post-payment quality of the environmental good and make a rational choice of the preferred scenario that maximize their individual utility. A follow-up question asked respondents how well they had understood the scenario described.

Section B: The hypothetical market scenario: After describing the pre-and post payment scenarios, the respondents were told that "in order to achieve the described increase in river flow, electricity generation will be reduced and hydropower companies will incur extra costs". Three types of valuation questions were then asked. First, the payment in principle (WTP Principle) question: "Would you be willing to accept an increase in your energy bill in order to increase biodiversity?" This WTP principle question addressed whether respondents found acceptable the idea of paying an increase in their energy bill to improve biodiversity (without reference to the Tummel). Only those who answered "YES" to the WTP Principle question were asked the specific WTP question where the 14% to 70% change in biodiversity in the Tummel area is specified as the object of value. The specific WTP question was open-ended with provisions for zero bids (ZB), refuse to answer (RA) and don't know (DK). The WTP Principle and WTP Specific questions had follow-ups eliciting the reason(s) behind each response category. The third valuation question elicited information on how valuable the restoration of biodiversity in the River Tummel was to the respondent, ranked from "1 = not at all valuable" to "7 = extremely valuable". The question was included to explore the consistency between qualitative and quantitative preference expression.

The open-ended WTP question format was selected as the most easily understood by respondents and as avoiding leading respondents to a desired answer (as occurs with some other methods due to starting point bias and anchoring effects). The scenario also presented a suitable payment vehicle in the form of respondent's willingness to accept an increase in energy bills in a given time frame. In the context of neo-classical economics, increasing river flows from the lochs in the hydro system would reduce electricity generation and increase costs for the hydropower companies. Such costs would then be (wholly or partially) transferred to electricity consumers. Eliciting WTP for increments in household electricity bills was therefore seen as an appropriate bid vehicle. This is a credible scenario familiar to energy consumers in Scotland, providing an effective payment vehicle. From the social psychology perspectives, the framing also ensured that the referent behaviour of interest was defined in terms of a specific target, action, context, and time (TACT) elements and achieved the level of specificity required by the TPB model (Ajzen 2002: 2; also cited in Eagly and Chaiken 1993:164).

Section C: Environmental ethics and social psychology: This section comprised questions on ethical beliefs, attitudes towards behaviour (AT_b), subjective norms (SN) and perceived behavioural control (PCB). Section C_1 aimed to obtain measures of the underlying ethical motives for respondents WTP using questions adapted from Spash, (1998). Specifically, respondents were told that: "A major aim of maintaining natural flows of water is to provide habitat for endangered wildlife species such as otters and kingfishers". They were then asked which one of four statements (presented on a show card) most closely matched their opinion about the scheme to get hydropower companies to release more water to the rivers to mimic a natural flow (in the Tummel). The respondents also had a fifth choice "can't answer – this is too complicated". The set of statements on the show card measured the extent to which the respondents saw rights as relevant to the Tummel case study. Those making a specific attribution of rights were then probed further to elicit the strength of these ethical positions. The questions and method of analysis replicated the original study by Spash (1998) to ensure consistency with the original model. The aim was to identify the different categories of non-economic ethical positions including the modified lexicographic preference categories to test the hypothesis on their relative contribution to WTP Principle. The different ethical categories and the position statements used in the survey are presented in Table 2. Section C_2 aimed at creating suitable scales to test the hypothesis on Ajzen's TPB model. The questions and scales followed Ajzen's guidelines for constructing a TPB questionnaire (Ajzen 1991: 91; and 2002: 10).

Specifically, AT_b was determined by the total set of accessible behavioural beliefs linking the behaviour to various outcomes and other attributes. The AT_b scales therefore involved pairs of questions eliciting the strength of each belief (b) and the evaluation (e) of the outcome or attribute. An example of the AT_b pair of questions was:

Table 2: Ethical Positions / Positions Statements Specified in Survey

Variables	Symbols	Position Statements
Strong species rights	SMLP	"I would protect the right to life for species at the expense of my standard of living."
Weak species rights	WMLP	"I would be prepared to see some species become extinct if protecting endangered wildlife would mean I had to incur a personal cost which reduced my standard of living to what I regard as a minimum."
Consequentialist favouring species	CONSEQ[1]	"Protection of such endangered species must be weighed against economic considerations, but in this case, the endangered species should come first."
Consequentialist favouring people	CONSEQ[2]	"Protection of such endangered species must be weighed against economic considerations, and in this case, people's livelihoods come first."
Humans first	HUMRGT	"Too much concern is shown for wildlife and not enough for humans, so I would rather see the resources used to help humans."

(i) Eliciting behavioural beliefs strength (b_i) :

"Paying more for electricity to restore biodiversity will increase the diversity and abundance of plant and animal species in the Tummel area." This was scored from "1 = extremely likely" to "7 = extremely unlikely".

(ii) Eliciting evaluation of outcome (e_i) :

"Increasing the diversity and abundance of plant and animal species in the Tummel area is…". This was also scored from "1 = extremely bad" to " 7 = extremely good".

A total of 13 pairs of questions were asked. Following Ajzen, (2002: 10), the AT_b scale was created using equation 10:

$$AT_{B_r} \propto \sum_{i=1}^{13} b_{i_r} e_{i_r} \qquad [10]$$

where r is the respondent, b_{i_r} the strength of each salient belief (the subjective probability) that the behaviour will produce outcome i, e_{i_r} the respondent's evaluation of the outcome i and the sum is taken over all accessible outcomes.

Similarly, the subjective norm (SN scale) comprised six pairs of questions eliciting the respondent's accessible normative beliefs (n) concerning making payments to restore biodiversity in the Tummel catchment and their motivation to comply (m) with that referent norm in question. An example pair of SN scale questions was:

(i) Eliciting normative belief (n):

"My spouse / partner would think that I … pay more for electricity to preserve biodiversity in the Tummel area." This was scored from "1= should" to "7 = should not", and

(ii) Eliciting motivation to comply (m):

"Generally speaking, how much do you want to do what your spouse/partner thinks you should do?" This was scored from " 1= not at all" to "7 = very much".

The normative belief (n) is multiplied by the relevant motivation to comply (m), and the resulting products are summed over all accessible behavioural outcomes to create the SN scale[18]:

$$SN_r \propto \sum_{i=1}^{13} n_{i_r} m_{i_r} \qquad [11]$$

[18] Respondents who had no spouse/partner did not respond to the question.

where r is the respondent, is a belief in a referent norm i, is the respondent's motivation to comply to the referent norm i, and sum is taken over all accessible norms.

Finally, perceived behavioural control (PBC) was determined by the total set of accessible control beliefs, i.e. beliefs about the presence of factors that may facilitate or impede performance of the behaviour. A total of five PBC questions were asked. An example is: "I can easily afford to pay more for my electricity." This was scored from "1 = strongly agree to 7 = strongly disagree". Control belief strength is generally multiplied by control belief power "the extent to which the control factors presence has the power to impede performance of the behaviour" (Ajzen, 2002:5). The results of the focus groups, however, showed that the hypothetical referent behaviour in this case involved three linked behavioural control items: the individual's ability to (i) pay higher energy bills, (ii) trust in the ability and willingness of the hydro-power companies to ensure that the money went to biodiversity restoration, (iii) believe in the efficacy of the proposed compensation flow scheme (when implemented) to deliver the proposed improvements in biodiversity. Belief power was therefore too obscure for respondents to assess within the context of the survey. The perceived behaviour control questions therefore measured control belief strength only.

Section D covered relevant socio-economic data including gender, age groupings, education levels, income groupings, actual disposable incomes, standard educational classifications, household location, etc. The categories used corresponded with the 2001 Scottish census (General Register Office for Scotland, 2001). Finally, Section E asked for interviewer evaluation of the context of the interviews, difficulties encountered by the respondents in responding to particular sections of the questionnaire, and how seriously they seemed to take the survey. This information was necessary for validating survey results. m_{i_r}

The final version of the survey as discussed above was informed by a series of reviews which involved expert consultation with aquatic ecologists, social psychologists, economists, geographic information systems (GIS) specialists, relevant end users, and presentations at stakeholder conferences / project meetings; two public focus groups and 81 pre-test interviews. Details of these exercises can be found in (Spash et al, 2004).

The same multi-stage probability proportional to size quota sampling technique was employed for the focus groups, the pre-tests and the main survey[19]. The main survey sample consisted of 1,012 face-to-face interviews that took place between August and December 2003 in urban and rural council areas in Scotland (Figure 4). The sample provided a good representation of the Scottish population based on the socio-economic statistics gathered (Appendix 1).

[19] As noted above aim was to get a good representation of each strata of the Scottish population and ensure ease of comparison of data between the different social groups, at each stage of the survey.

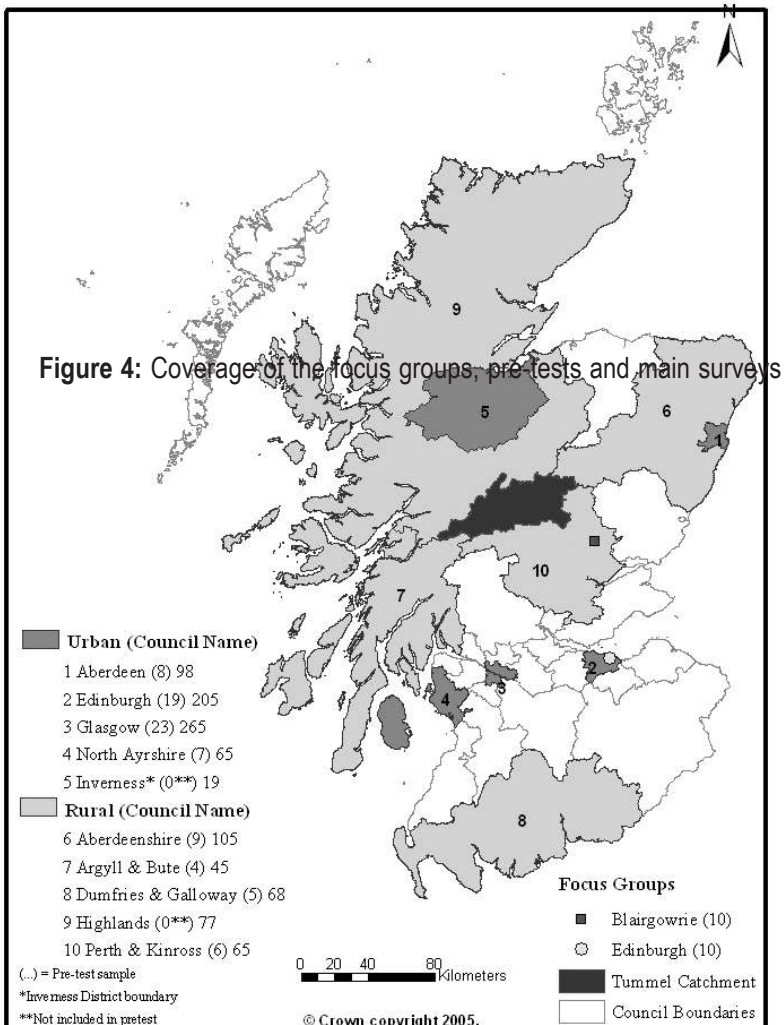

Figure 4: Coverage of the focus groups, pre-tests and main surveys

5. Model Results and Discussion

Sample and Descriptive Statistics

Table 3 presents the distribution of responses to the payment in principle (i.e. WTP Principle). About 38% of the sample (387 respondents) were explicitly willing to pay in principle, 43% (437 respondents) were explicitly not willing to pay, 18% (180 respondents) were undecided and 0.8% (8 respondents) explicitly refused to respond to the WTP Principle question.

Table 3: WTP Principle Category of Response

Response category	Number	% of Sample
Yes in Principle	387	38.24
No in Principle	437	43.18
Don't know in Principle	180	17.79
Refuse in Principle	8	0.79
TOTAL	1012	100.00

Analysis of the follow-up questions found that the reasons for don't know responses and the refusals to offer a positive bid were diverse as were the reasons for positive bids (see Spash et al., 2004). About 31 percent of the refusals, don't knows and zeros were related to the payment vehicle used in the survey while 18% were related to income constraint. About 88% of the respondents who were willing to pay something stated that it was because they wanted to help nature or restore biodiversity. Only about 4% of the payments were not directly related to biodiversity restoration. Thus the behavioural intention (WTP Principle) and actual referent behaviour (i.e. WTP Specific) meets the Ajzen's (TACT) requirements (see Ajzen, 2002: 2), providing suitable dependent variables for testing the TPB model.

Scale reliability tests found that the $AT_b, SN, \& PBC$ scales were reliable (Cronbach's alpha ≥ 0.93)[20]. There were also significant partial correlations between the predictor variables (i.e. $AT_b, SN, \&$ scales) and WTP Principle, fitting *a priori* expectations and the assumptions of the TPB model.

Descriptive comparison of respondent's ethical beliefs and WTP Principle categories also found that ethical categories do have a significant influence on WTP Specific (Table 4). The chi-squared

[20] Ten out of the 13 AT_b scale items with the highest Cronbach's apha were included in the model.

results are highly significant. However, the analysis also suggests a deviation from the proposition by Spash, (1998: 60) that ethical beliefs necessarily suggest a violation of the axiom of continuity and that indifference curves collapse to single points, denying the principle of substitution. The strong rights (SMLP) and consequentialist favouring species (CONSEQ[1]) are over-represented in the category of respondents who are willing to pay in principle (i.e. the Yes category) and underrepresented in the "No, Don't Know, and Refused" categories. If the SMLP category signifies that preferences are strictly lexicographic, it is expected that respondents holding such beliefs are more likely to reject the trade-off, falling in the "No", "Don't know" and "Refused" categories. In this case, Consequentialist favouring people (CONSEQ[2]) and the human right group (HUMRGT) were more likely to reject payment in principle while those with strong rights for species and those who held ethical rights favouring species were more disposed to accept the idea of payment in principle. As shown in Appendix 2 those in the strong rights position also had the highest mean WTP and, with the consequentialist favouring humans, the highest median WTP.

Table 4: Ethical Position on Species Protection Compared with WTP Principle Category

Ethical Positions		WTP Principle				
		Yes	No	Don't Know	Refused to answer	Total
SMLP	Actual	138	66	25	1	230
	Expected	88.2	99.4	40.7	1.8	230
	% within ethical positions	60.0	28.7	10.9	0.4	100
	Adjusted Residual	7.7	-5.1	-3.1	-0.7	
WMLP	Actual	18	28	9	0	55
	Expected	21.1	23.8	9.7	0.4	55
	% within ethical positions	32.7	50.9	16.4	0	100
	Adjusted Residual	-0.9	1.2	-0.3	-0.7	
CONSEQ 1	Actual	161	79	38	0	278
	Expected	106.6	120.1	49.1	2.2	278
	% within ethical positions	57.9	28.4	13.7	0	100
	Adjusted Residual	7.9	-5.8	-2.1	-1.8	
CONSEQ 2	Actual	49	131	29	1	210
	Expected	80.5	90.7	37.1	1.7	210
	% within ethical positions	23.3	62.4	13.8	0.5	100
	Adjusted Residual	-5.0	6.3	-1.7	-0.6	
Human	Actual	4	57	20	0	81
Rights	Expected	31.0	35.0	14.3	0.6	81
	% within ethical positions	4.9	70.4	24.7	0	100
	Adjusted Residual	-6.4	5.1	1.7	-0.8	
can't answer	Actual	16	74	57	6	153
	Expected	58.6	66.1	27.0	1.2	153
	% within ethical positions	10.5	48.4	37.3	3.9	100
	Adjusted Residual	-7.7	1.4	6.9	4.7	
	Total Number	386	435	178	8	1007
Chi-Square tests		Value	df	Asymp. Sig.		
Pearson Chi-square		250.61	15			<0.001
Likelihood Ratio		257.66	15			<0.001
Linear-by-Linear Association		139.08	1			<0.001

Excludes refusals to answer questions on ethical categories: missing N= 5.

The analysis shows that 74.33% of those holding strong beliefs in rights to life for species were willing to play the economic game (i.e. WTP e" 0). The mean WTP for the SMLP sub-group is £10.58 (min £0.00, max £120.00). The median was £5.00 which means that more than half of the respondents who held strong beliefs in rights for species (i.e. the SMLP category) were willing to pay $\geq £5.00$ for biodiversity restoration in the Tummel. In contrast, the mean WTP for the extreme human rights group (i.e. HUMRGT category) was £0.54 (min £0.00, Max, £3.91). The median WTP for this group was £0.00 which means that more than half of the respondents who believe that "too much concern is shown for wildlife and not enough for humans" were not willing to pay for biodiversity restoration in the Tummel catchment. Although this analysis questions the concept of "lexicographic preferences" signifying a collapse of the neo-classical welfare theory, it does suggest that ethical considerations do significantly affect WTP principle for biodiversity restoration in this case study. Instead of rejecting the trade-off, respondents holding strong ethical rights positions were more willing to pay for biodiversity restoration in the Tummel than any of the other sub-categories in this case. Belief in strong rights to life for species can, in this case, be seen as signifying increasing values placed upon biodiversity rather than a total collapse of the neo-classical welfare theory as currently argued by some critics of the neoclassical model. Hence ethical factors do not necessarily explain negative responses to WTP principle questions in CV surveys. An unknown proportion of the public may hold strong ethical beliefs as well as legitimate dispositions to pay for improvements in aspects of the environment which they hold dear.

This finding corroborates an earlier suggestion by Rosenberger et al., (2003: 65) that "… some people seemingly expressing lexicographic preferences are actually being inconsistent in their expressions". In an earlier study, Urama (2003) finds that lexicographic preference expressions are in fact inconsistent and weakly held preferences which change with further information on the welfare impacts of proposed changes in the valuation scenario. There may therefore be other factors that inform human valuation of environmental entities that are excluded in single domain models, be it neo-classical economics or environmental ethics, furthering the case for the use of integrated models in environmental valuation. This result does not however suggest any paradigm shift within the single domain models. Instead the results strongly question some fundamental assumptions underpinning the contemporary critique of CBA. It shows that occurrence of strong ethical beliefs neither signify "a collapse of indifference curve to single points, denying the principle of gross substitution" (Spash, 1998: 60) nor "a departure from the usual economic paradigm" (Spash, 2000: 195). This however, is an area that requires further research.

Comparing Single Domain Models

In this section, the contributions of factors taken from three different single domain models to public disposition to pay for biodiversity restoration, in this case study are compared. The aims of the analyses are threefold: (i) to test the hypothesis that human dispositions to invest in biodiversity restoration schemes are significantly driven by multiple factors including ethical values, social psychology factors and socio-economic ones; (ii) to test the hypothesis that each of the single domain models provide complementary insights to our understanding of human valuation of biodiversity consistent with their respective theoretical assumptions and; (iii) to test the hypothesis

that integrated models would, *ceteris paribus,* explain public willingness to invest in biodiversity restoration *in principle* better than the single domains models.

Table 5: Logistic Regression of the Probability that Respondents are Disposed to Pay in Principle Using the Single Domain Models

Coefficients	**Single domain models**					
	Economic model		Ethics model		Social Psychology model	
Variables						
Constant	-1.69 (7.82)***	-	-2.39 (8.85)***	-	4.67 (9.26)***	-
Knowledge of diversity	0.18 (1.16)	0.42 (1.15)	0.18 (1.19)	0.04 (1.18)	0.27 (1.56)	0.06 (1.53)*
Understanding of impacts	1.25 (6.95)***	0.26 (8.16)***	0.73 (3.80)***	0.16 (4.12)***	0.51 (2.42)**	0.11 (2.57)**
Income refused	-0.28 (1.94)**	-0.06 (1.96)**				
Age class	0.23 (1.65)*	0.05 (1.66)*				
Education class	0.56 (3.20)**	0.13 (3.13)***				
Gender	0.12 (0.87)	0.02 (0.87)				
Location in Scottish council area	0.01 (0.04)	0.00 (0.04)				
Strong MLP			2.10 (7.13)***	0.48 (8.31)***		
AT_B						
Weak MLP			1.12 (2.88)***	0.27 (2.91)***		
Consequentia lists favouring animals			2.01 (6.96)***	0.46 (7.86)***		
Consequentialists favouring humans			0.57 (1.84)*	0.13 (1.79)*		
Human rights			-0.95 (1.66)*	-0.17 (2.10)**		
Scale					-0.23 (10.96)***	-0.05 (11.42)***
SN Scale					-0.08X (10.96)***	-0.02 (6.35)***
PBC Scale					-0.46 (5.27)***	-0.10 (5.24)***
LR Chi^2 (Significance)	98.57 (<0.01)***		233.79 (<0.01)***		405.01 (<0.01)***	
Pseudo	0.08		0.18		0.31	
N	982.00		998.00		973.00	

The absolute z values associated with the underlying coefficients reported in brackets.
** coefficient significant at 10% level; ** coefficient significant at 5% level, *** coefficient significant at 1% level. Dependent variable = WTP principle. The correlations between the predictor variables were all £0.36, suggesting that multicollinearity was not a serious problem. The pseudo R^2 is the difference between the log-likelihoood for the full model and the log-likelihood for the intercept only model divided by the log-likelihood for the intercept only model.*

The estimated WTP principle models, i.e. the standard economic model, the ethical model, and the social psychology model are presented in Table 5. Their relative contributions to the probability of positive dispositions to pay for biodiversity within their respective theoretical assumptions are discussed below.

The model results show that the standard economic model explains 8% (Pseudo R^2 = 0.08) of people's dispositions to pay for biodiversity improvement, in this particular context[21]. This is relatively low compared to the ethical and social psychology models, which explain 18% and 31% of WTP principle respectively.

The levels of significance of the individual models followed similar patterns with the psychological model attaining the highest level of stability and Chi^2 value $(LR\ \chi^2 = 405.01, P < 0.01)$ followed by the ethical model $(LR\ \chi^2 = 233.79, P < 0.01)$ and lastly the neo-classical economic model $(LR\ \chi^2 = 98.75, P < 0.01)$. Understanding of the impacts of the proposed scheme on biodiversity was consistently significant in explaining WTP Principle in all three models corroborating earlier findings by Urama, (2003). This also suggests that the responses to the WTP principle question involved a cognitive activity instead of a "yea saying" exercise.

The implications of these findings are two-fold. First, the social psychology factors (i.e. $AT_b, SN, \& PBC$) outperform the ethical and socio-economic variables in explaining public disposition to pay for biodiversity restoration in the case study. Second each of the three single domain models meets *a priori* expectations and is consistent with the assumptions of their underlying theories. The neo-classical model suggests that understanding of the impact scenarios and level of education are the most significant determinants of WTP principle for biodiversity restoration in the case study. Holding all other factors constant, the log of odds ratio in favour of getting a positive response to the WTP principle question goes up by 1.25 and 0.56 units per unit changes in understanding of impacts and education levels, respectively. A unit change in the respondents' understanding of the impact scenario and in his/ her level of education results in an increase in the probability of a positive disposition to pay for biodiversity restoration of 0.26 and 0.13, respectively. Refusal to give income data was also significant but negative corroborating earlier findings by Spash et al., (2004). As noted by Spash et al., (2004:27), "This may be interpreted as those refusing to pay wishing to avoid being seen as miserly and so refusing to admit their income level". Overall, the estimated model based on socio-economic factors is consistent with the neoclassical welfare theory. The results of the analyses do not therefore suggest any fundamental contradictions to the

[21] Following Mitchell and Carson, 1989, and Gujerati, 1995, adjusted R^2 values were used as a test of explanatory power of the model. Only the variables predicted by the underlying theories were included in the individual models. $KNBIOD*$ and $UNDBIOD*$ were included in all the individual models because each model requires that the respondent knows what he/ she is valuing and understands the questions clearly.

ontological assumptions of the standard neo-classical welfare model as some critiques of CBA have argued (see for example, Niemeyer and Spash, 2001).

The results of the WTP principle model based on ethical positions suggest that belief in species rights, i.e. both strong and weak species rights positions (SMLP & WMLP), and belief in consequentialism favouring animals (CONSEQ[1]) were the most significant drivers of public dispositions in principle to pay for biodiversity restoration, in the case study. All had positive signs, indicating that the stronger the belief in rights to life for species, the higher the probability of positive dispositions to pay for biodiversity restoration. SMLP and CONSEQ[1] had the highest marginal contributions to the probability of positive disposition to payment while human rights beliefs had a significant negative marginal effect at the 5% level. While this finding contradicts the suggestion that holding strong ethical beliefs signifies the collapse of neoclassical welfare theory (Spash, 1998, Spash, 2000)[22], we argue that it is consistent with neo-classical welfare theory (see Koutsoyiannis, 1991). Holding ethical beliefs in rights to life does not necessarily lead to a rejection of making payments towards protection of species. Instead, this analysis suggests that people's disposition to pay for biodiversity restoration increased with the strength of their belief in rights to life for species. The analyses of the ethical model do not therefore suggest a rejection of the ontological assumptions of the standard neo-classical welfare theory. Instead, strong species rights can be seen as signifying the essentiality of restoring biodiversity (see Lockwood, 1996; Schmidtz, 2000) as reflected in the high WTP bid amounts discussed above.

Finally, all three factors taken from the TPB were the most significant determinants of WTP in the case study. Consistent with the underlying assumptions of the TPB model, specific attitude toward payment to restore biodiversity in the specific context of the Tummel catchment was the most significant driver of WTP Principle within the social psychology model (significant at the 1% level). Subjective norms and perceived behaviour control factors were also significant at the 1% level. Together with the respondent's knowledge of biodiversity and understanding of the impacts described in the survey, $AT_b, SN, \& PBC$ explained more of WTP principle than the ethical and socio-economic variables combined. $AT_b, SN, \& PBC$ had negative marginal contributions to the probability that the respondents are disposed to pay for biodiversity restoration in principle. A unit increase in the strength of specific attitudes towards payments for biodiversity restoration reduced public disposition to pay by 0.05. In the same way, each unit change in perception of factors that are likely to inhibit payment (i.e. PBC) reduced the willingness to pay in principle by 0.1. These findings are consistent with *a priori expectations.* The attitude scales used in the study measured specific attitudes towards payments for restoring biodiversity to meet the "TACT" requirements of the TPB model.

[22] Respondents holding lexicographic preferences are expected to reject the trade-off, hence bidding zero, refused, or don 't know (see for example Spash, 1998).

Overall, the results of the single domain models suggest that the social psychology model outperforms the ethical and socio-economic factors in terms of explaining the probability of positive responses to WTP Principle question, while the ethical variables had the largest marginal contributions to the probability of positive responses. Judging by the explanatory power of each model and the level of significance of their individual predictor variables, it can be argued that social psychology and ethical factors should have even more weight amongst the criteria for justifying environmental policy in the Tummel catchment, than the socio-economic ones. Applying the neo-classical economics approaches (e.g. CEA and CBA) as the only criteria for justifying environment policy would, in this case, leave out a significant proportion of the factors driving public dispositions to pay for biodiversity restoration in the Tummel catchment that could be explained with insights from social psychology and environmental ethics. In the same way, using any of the single domain alternatives (SPYCHOMOD or ETHIMOD) as the sole criterion for environmental decision making would also lose the perspectives from the contending models. This led to the second part of the analysis examining the relevance of integration. Will integration enable us to explain public dispositions to pay for biodiversity restoration better than single domain models? Will integration of models reduce the precision of model parameter estimates? These questions are examined in the subsequent sections.

The Value of Integrated Modelling in Environmental Valuation

The integrated value-mapping models (IVM) are presented in Table 6. Four models are estimated considering the different possible combinations of the individual domain models (see IVM^1 – IVM^4 in Figure 2). The analysis finds that combining all three models (IVM^4) explains about 36% of WTP Principle in the case study, outperforming alternative combinations of models (IVM^1, IVM^2 and IVM^3) respectively. IVM^4 fits significantly better than the next best model IVM^3 ($P = 0.005$).

Respondent's age and education class were the only socio-economic variables significant in the fully integrated model (IVM^4). On the contrary, all the social psychology variables, and all the ethical variables remained significant except for the human rights category. A unit increase in the belief in consequentialism but favouring species (CONSEQ1) increased disposed to pay for biodiversity restoration in the Tummel catchment by 0.42. This was followed by the strong modified lexicographic preference (SMLP) group with a 0.41 marginal increase in the probability of giving a "Yes response". Overall, all the ethical factors had a positive contribution to the probability that respondents will give a positive response to the WTP Principle question, contradicting the current perception that ethical positions lead to negative bidding in CVM experiments. The results further suggest that the strength of ethical positions reflect measures of essentiality of biodiversity, not a rejection of the neo-classical welfare theory. Those who hold strong beliefs favouring species (SMLP) and those who consider human welfare but favouring species were most disposed to pay than any of the other ethical categories.

Consistent with *a priori* expectations, all the social psychology factors had a negative contribution to the probability of a positive response. In other words, the stronger the specific attitudes toward monetary payments for the restoration of biodiversity, the existing subjective norms and the perception

Table 6: Logistic Regression of the Probability that Respondents are Disposed to Pay in Principle Using the Integrated Model Alternatives

Variables	Economics & Social Psychology Combined (IVM[1])		Economics & ethics combined (IVM[2])		Ethics & Social Psychology Combined(IVM[3])		All Three Models combined(IVM[4])		% change in precision due to integration
Constant	4.38	-	2.66	-	3.66	-	3.37		-
	(7.98)***		(8.21)***		(6.29)***		(5.39)***	-	-
Knowledge of	0.09	0.02	0.04	0.01	0.19	0.39	0.01	0.00	-
biodiversity	(0.45)	(0.45)	(0.23)	(0.23)	(1.01)	(1.00)	(0.05)	(0.05)	
Understanding	0.46	0.09	0.71	0.15	0.03	0.01	-0.10	-0.02	-
of impacts	(2.09)**	(2.20)**	(3.51)***	(3.82)***	(0.12)	(0.12)	(0.39)	(0.39)	
Income	-0.11	-0.02	-0.23	-0.05			-0.07	-0.01	27.67
Refused	(0.59)	(0.60)	(1.49)	(1.51)	(0.36)	(0.36)			
Age Class	0.40	0.09	0.26	0.06			0.40	0.08	30.10
	(2.26)**	(2.30)**	(1.68)*	(1.70)*			(2.15)**	(2.19)**	
Education	0.57	0.13	0.46	0.11			0.49	0.10	26.85
Class	(2.73)***	(2.63)***	(2.43)**	(2.36)**			(2.17)**	(2.04)**	
Gender	0.21	0.04	0.16	0.03			0.20	0.04	31.02
	(1.20)	(1.20)	(1.03)	(1.03)			(1.14)	(1.13)	
Location in	0.17	0.04	0.06	0.01			0.17	0.03	29.00
Scottish	(0.95)	(0.96)	(0.36)	(0.36)			(0.89)	(0.90)	
Council Areas									
Strong Species			2.16	0.49	1.70	0.38	1.82	0.41	24.30
Rights			(7.15)***	(8.43)***	(4.89)***	(4.98)***	(5.00)***	(5.16)***	
Weak Species			1.18	0.28	0.91	0.21	1.02	0.23	20.88
Rights			(2.95)***	(3.01)***	(1.99)**	(1.88)*	(2.16)**	(2.04)**	
Consequentialists			2.06	0.47	1.76	0.39	1.93	0.42	23.37
favouring animals			(6.92)***	(7.88)***	(5.17)***	(5.32)***	(5.42)***	(5.67)***	
Consequentialists			0.59	0.14	0.87	0.19	0.97	0.21	23.07
favouring humans			(1.85)*	(1.80)*	(2.39)**	(2.28)**	(2.56)**	(2.44)**	
Human rights			-0.85	-0.16	-1.10	-0.18	-0.87	-0.14	13.78
			(1.46)	(1.80)*	(1.72)*	(2.38)**	(1.34)	(1.71)**	
AT_B Scale	-0.25	-0.05			-0.21	-0.04	-0.23	-0.05	12.51
	(11.14)***	(11.64)***			(9.42)***	(9.81)***	(9.74)***	(10.20)***	
SN Scale	-0.08	-0.02			-0.09	-0.02	-0.08	-0.02	5.15
	(5.99)***	(6.06)***			(6.31)***	(6.37)***	(6.05)***	(6.09)***	
PBC Scale	-0.46	-0.10			-0.44	-0.09	-0.45	-0.09	8.84
	(5.18)***	(5.14)***			(4.83)***	(4.77)***	(4.79)***	(4.73)***	
LR Chi[2]	422.18		247.80		471.71		488.48		
(Significance)	(<0.01)***		(<0.01)***		(<0.01)***		(<0.01)***		
Pseudo	0.33		0.19		0.36		0.38		
N	957		982.00		973		957.00		

*The absolute z values associated with the underlying coefficients are reported in brackets. * coefficient significant at 10% level; ** coefficient significant at 5% level, *** coefficient significant at 1% level. Percentage change in precision due to integration was computed as the percentage reduction in the standard errors of IVM[4] parameter estimates relative to those of the individual single domain models.*

of the presence of factors that may impede payment, the less likely that the respondent will be willing to pay in principle.

To examine the source of improvement in the model, the different permutations of possible integration were examined: economics and social psychology (IVM^1), economics and ethics (IVM^2), and ethics and social psychology (IVM^3). Again, integration of ethics and social psychology significantly explained the probability of getting a positive response to the WTP principle question better than other alternatives. The pattern of marginal contributions of variables is also consistent with the fully integrated model (IVM^4).

Using the single domain models as base line models, we also find a consistent improvement in the precision of individual parameter estimates due to integration (see column 9 of Table 6). Again the least gain in precision is observed in the social psychology variables suggesting that the TPB model was the most robust of all the single domain models. The marginal contributions of each variable to the fit of the model are presented in Table 7.

Table 7: Marginal Contributions to the Explanatory Power of the Socio-economic Model

Variables	Marginal contribution to LR Chi^2 if added to economic model
Ethics variables	
	40.24
	0.41
	37.16
	32.19
	32.93
Social psychology variables	
	238.51
	116.17
	85.72
ETHIMOD	149.23
PSYCHOMOD	343.61
ETHIMOD + PSYCHOMOD	389.91

Baseline model = Standard neo-classical model for WTP Principle.

Overall, the analyses strongly suggest integration increased both the precision of the parameter estimates and the fit of the WTP Principle models. However, the social psychology model had the best fit of all the single domain models and all possible combination of the ethical and neo-classical economic predictor variables. Of all the components of the three single domain models, the social psychology factors were also the most precise.

To examine if disaggregating the negative outcomes to their individual categories would lead to different conclusions, each of the models discussed above was re-estimated using multinomial logit regression techniques. The analyses yield consistent conclusions. Table 8 presents the fully integrated multinomial logistic regression model (IVM^4) only. This models the probability of a positive outcome

against all other possible negative outcomes including No, Don't Know (DK) and Refused to Answer (RA)[23].

The analysis found that those holding strong modified lexicographic preferences (SMLP) and those who believe in consequentialism but favouring species were more likely to give a positive response to the WTP principle question than any other group. The probability of getting a "NO" response also significantly decreased with age of respondents and their level of education. The probability of getting a DK response significantly decreased by age of respondents and strength of belief in species' rights to life. On the other hand, all the social psychology variables significantly increased the probability of getting a NO or DK response.

Further Tests for Sensitivity, Specificity and Predictive Power of the Integrated Logistic Regression Models

For a particular classification threshold, the sensitivity of the logistic regression models was estimated as the fraction of observed positive-outcomes cases that are correctly classified while the model specificity was estimated as the fraction of observed negative-outcome cases that are correctly classified (StataCorp. 2003: 310). The predictive power of the model was estimated using the ROC curve (Peterson, 1954, Green and Swets, 1974)[24].

As shown in ROC curve (Figure 5 panel A), the model is of high predictive power (area under the curve = 0.89). As a general rule, ROC curve for a model with no predictive power would be a 450 line (StataCorp. 2003: 310).

The greater the predictive power of the model, the more bowed the ROC curve, and hence the area beneath the curve is often used as a measure of predictive power[25]. Figure 5 panel B measures the decrease in the Pearson χ^2 goodness-of-fit statistic that would be caused by deleting an observation. The points going from the top left to the bottom right correspond to positive outcomes, i.e. the probability of a Yes response; the points on the other curve correspond to zero outcomes, i.e. the probability of a No response (see Hosmer and Lemeshow, 2000: 198 -179; also cited in StataCorp. 2003: 318). These figures in conjunction with further tests including the test of deviance residuals against the probability of a positive outcome and sensitivity curves (see StataCorp, 2003: 311-318) show the IVM[4] model has a good fit.

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[23] Further details on the implications of these findings for the longstanding debate on the use of ethical positions in setting public environmental choices can be found in a companion paper (Urama et al., in preparation).

[24] ROC curve was first discussed in signal detection theory developed by Paterson, et al. (1954) and then was quickly introduced into psychology and medicine (Tanner and Swets, 1954; Metz, 1978; and Green and Swets, 1974).

[25] A perfect model would have a predictive power of 1 and hence the area under the ROC curve would be 1.

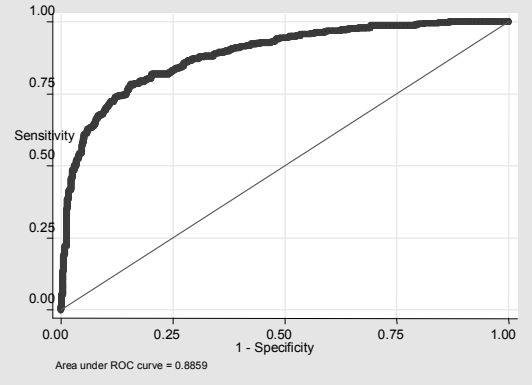
Table 8: Multinomial logistic regression of the probability of positive response compared to No, Refused and Don't Know using IVM[4].

Variables	No	DK	RA	Marginal contribution to the probability of outcomes		
	coefficients	coefficients	coefficients	Yes	No	DK
Constant	-4.85	-2.8	-10.22	-	-	-
	(7.08)***	1(3.83)***	(2.96)**			
Knowledge of biodiversity	0.01	-0.04	0.05	0.00	0.01	-0.00
	(0.05)	(0.17)	(0.05)	(0.03)	(0.15)	(0.22)
Understanding of impacts	0.15	0.00	0.04	-0.02	0.04	-0.02
	(0.56)	(0.01)	(0.36)	(0.40)	(0.71)	(0.38)
Income Refused	0.24	-0.28	-0.62	-0.02	0.09	-0.07
	(1.23)	(1.17)	(0.57)	(0.47)	(2.14)**	(2.14)**
Age Class	-0.35	-0.53	0.67	0.08	-0.02	-0.05
	(1.73)*	(2.33)**	(0.63)	(2.20)**	(0.71)	(1.63)
Education Class	-0.84	0.07	1.06	0.11	-0.21	0.10
	(3.39)***	(0.25)	(0.89)	(2.12)**	(4.33)***	(2.06)**
Gender	-0.20	-0.28	1.08	0.04	-0.02	-0.02
	(0.97)	(1.24)	(0.93)	(1.18)	(0.44)	(0.87)
Location in Scottish Council Areas	0.19	-0.14	1.35	0.04	-0.04	-0.00
	(0.99)	(0.59)	(1.08)	(0.97)	(0.83)	(0.06)
Strong Species Rights	-1.42	-2.28	-4.13	0.38	-0.18	0.20
	(3.65)***	(5.44)***	(2.82)**	(4.55)***	(2.14)**	(5.36)***
Weak Species Rights	-0.52	-1.62	-34.76	-0.18	-0.02	-0.16
	(1.04)	(2.84)***	(0.00)	(1.50)	(0.18)	(3.94)***
Consequentialists favouring animals	-1.61	-2.20	-35.01	0.40	-0.21	-0.19
	(4.22)***	(5.54)***	(0.00)	(5.09)***	(2.73)***	(5.14)***
Consequentialists favouring humans	-0.46	-1.73	-2.87	0.17	0.02	-0.19
	(1.17)	(4.00)***	(2.16)**	(1.93)*	(0.23)	(5.25)***
Human rights	1.32	0.42	-32.04	-0.18	0.26	-0.08
	(1.97)**	(0.61)	(0.00)	(2.30)**	(3.22)***	(1.83)*
AT_B Scale	0.24	0.21	0.23	-0.05	0.04	0.01
	(9.74)***	(7.80)***	(2.37)	(9.19)***	(6.93)***	(3.26)***
SN Scale	0.10	0.06	-0.25	-0.02	0.17	0.00
	(6.67)***	(3.64)***	(1.94)*	(5.79)***	(6.14)***	(0.03)
PBC Scale	0.51	0.31	1.53	-0.09	0.10	-0.00
	(5.60)***	(2.76)***	(2.82)***	(4.60)***	(4.43)***	(0.03)
LR Chi^2 (Significance)	579.41	(<0.01)	Pseudo	0.29	N	957.00

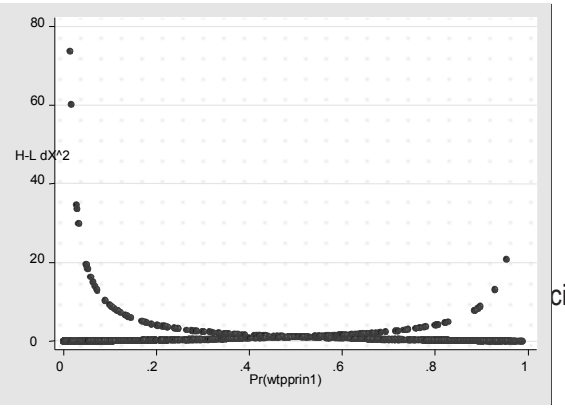
The absolute z-values associated with the underlying coefficients reported in brackets.

** coefficient significant at 10% level; ** coefficient significant at 5% level, *** coefficient significant at 1% level.*

Panel A: ROC Curve



Panel B: contributions of individual observations to Pearson χ^2 goodness-of-fit statistic



city and Predictive capacity of IVM[4] model

4. Conclusions and Policy Recommendations

Alternative models of human behaviour from social psychology and environmental ethics challenge the axiomatic claims made for the assumptions underlying CBA, suggesting that mainstream static economic models of behaviour are limited in their capacity to explain human dispositions to pay for environmental improvement. In social psychology behaviour is seen as a process where the emphasis is on how beliefs and preferences are formed or learnt, and how information is acquired (Green and Tunstall, 1999) while in the field of environmental ethics, certain positions (e.g. lexicographic preferences) suggest a rejection of the principle of trade-offs (Spash, 1998). Urama (2003) and Urama and Hodge (in press) argued that no single disciplinary approach is likely to provide a comprehensive valuation of environmental entities or a logical conclusion to the longstanding debate on the use of neo-classical economic tools to aid environmental policy. Critiques of CBA that draw on single disciplinary assumptions (such as environmental ethics or social psychology) might therefore be purely speculative (see Urama and Hodge, in press). Following recommendations by Urama (2003) and Urama and Hodge (in press) this paper examines the case for considering integration of models and different perspectives as a virtuous path for future environmental decision making.

The results of this study lead to three main conclusions. First, each of the single domain models significantly explained WTP Principle at the 5% level. Each of them also fits its own *a priori expectations* and *ceteris paribus* assumptions, suggesting they are all theoretically valid. Each provides valuable (and complementary) insights to the diverse factors that inform public dispositions to pay for biodiversity restoration in the Tummel catchment.

Second, integrating all three models (IVM^4) explained WTP principle better than any of the single domain models or any other bilateral integration possibilities (IVM^1- IVM^3). This also improved the precision of individual parameter estimates. Integrating factors from social psychology, environmental ethics and neo-classical economics therefore reduces the stochastic error in our current understanding of people's environmental preferences, without compromising the underlying assumptions of the component models. This finding validates the recommendation by Urama (2003) and Urama and Hodge, (in press): "integration of models from different perspectives is the virtuous path for future". Despite the statistical robustness and theoretical validity of the single domain models within their own disciplinary silos, integration of models would improve our understanding of public environmental priorities without losing the required precision in parameter estimates or robustness of models.

Third, the results of these analyses questions the growing critique of CBA based on the assumption that respondents holding strong ethical positions (e.g. those in the SMLP category) are more likely to reject the trade-offs, leading to a collapse of indifference curves to single points (see for example Spash, 1998, 2000). The analyses find that the probability of positive dispositions to pay for biodiversity increases with the strength of belief in rights to life for species. This is consistent with neo-classical welfare theory (see Koutsoyiannis, 1991). This is though, an issue that requires further research.

Overall, the results of the analyses provide empirical evidence to: corroborate the long-standing concerns that using single domain models to aid environmental decision making might be unnecessarily limiting; question the growing proposition that deontological positions constitute a rejection of the neoclassical paradigm; and illustrate the case for considering integrated value mapping alternatives in environmental policy planning.

Appendices

Appendix 1: Comparing the Sample Data with the Scottish Census Population

Socio-economics	**Sample** (n=1012)	**Scottish Popn** (N= 5,062,011)
	% of Total	% of Total
Gender		
Male	48	48
Female	52	52
Age class		
Under 25	20	30
25-34	21	14
35-44	19	15
45-54	18	14
55+	22	27
Occupational classifications		
Managers and senior officials	5.2	8.0
Professional occupations	6.5	7.1
Associate professional and technical occupations	3.7	9.2
Administrative and secretarial occupations	5.1	8.4
Skilled trades occupations	8.8	8.0
Personal services	9.3	4.7
Sales and customer service occupations	6.9	5.7
Process, plant and machine operatives	3.0	6.3
Elementary occupations	5.4	8.3
Housewife/husband	9.6	4.4
Retired	13.3	8.2
Student	9.9	15.5
Unemployed	9.9	6.2
No response	3.4	N/a
Rural – Urban Location by council areas	.	
Rural		
Aberdeenshire	10.4	10.0
Argyll & Bute	4.4	4.0
Highland	7.6	8.0
Perth & Kinross	6.4	6.0
Dumfries & Galloway	6.7	7.0
Urban		
Aberdeen	9.7	10.0
Edinburgh	20.3	21.0
Glasgow	26.2	26.0
Inverness	1.9	2.0
North Ayrshire	6.4	6.0

Appendix 2: Ethic beliefs and WTP Specific bids

Ethical Positions	Position Statements	WTP Statistics						
		Min	Mean	Median	Max	Std. Dev.	No of responses	% response rate
Strong Species rights	Strong MLP	0	10.58	5	120	19.51	170	74.23
Weak Species rights	Weak MLP	0	4.44	0	50	10.71	41	74.45
Consequentialists favouring animals	Relative utility, species first	0	7.29	5	60	10.31	201	72.30
Consequentialists favouring humans	Relative utility, Humans first	0	2.53	0	50	7.36	167	79.90
Human rights	Humans first	0	0.54	0	30	3.91	59	72.84

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