Environmental Resource Information and the Validity of Non-Use Values: The Case of Remote Mountain Lakes.

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ABSTRACT: The NOAA guidelines for the implementation of stated preference techniques for economic valuation of environmental resources (Arrow et al 1993) suggest that the outcomes of stated preference techniques should be compared to the opinions and rankings of experts as a test of their validity. Theoretical and empirical studies have indicated that the reliability of stated preference responses may be called into question when the level of information or knowledgeability that respondents bring to the survey is low, where there is a low level of familiarity with the good being valued, or the 'relevance' of the good to the individual is in question (Ajzen 1996, Mas-Colell et al 1995, Bergstrom et al 1986). In such cases the value of expert opinion as a validation of stated preference techniques may be amplified. Despite this only a few studies have addressed the reasoning behind the use of expert opinion in this way or have compared the preferences of experts and members of the public over the same goods (Boyle 1996, Kenyon and Edwards-Jones, 1998). To our knowledge no comparison has been made between the preference orderings of experts and members of the public for goods with a large non-use value component, the very class of resource values where the aforementioned problems are most likely to arise. This study endeavours to address the NOAA recommendation through the comparison of the outcomes of a Delphi experiment (consultation/consensus of experts) and a CVM survey, both of which address decisions concerning the same environmental resource. The comparison is broadened by the use of different levels of information for subsets of respondents to assess the informational effects, and hence different levels of knowledgeability on willingness to pay bids. This is undertaken for an environmental good for which non-use values are the predominant class of economic values, and for which public familiarity is low, i.e. Remote Mountain Lakes.

Keywords: Contingent Valuation Methodology, Delphi Method, Information Effects, Validation.

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1. Introduction.

The suitability and validity of using non-use values (NUVs) in environmental decision making has been the subject of continuing debate ever since Krutilla's 1967 seminal paper which spawned the concept (though not the term) of NUVs into the mainstream of environmental economic theory and policy. Though the validity of NUVs has been debated on conceptual and philosophical grounds (see Kontoleon, Macrory and Swanson 2001 for a survey) the bulk of the discussion has been pre-occupied with issues of measurement. Since the commonly accepted method for measuring NUV is the contingent valuation method[2], the debate over measurement of NUVs understandably falls back to one over the validity of the estimates derived from such a method (Mitchell and Carson 1989, Bateman and Willis 2000).[3] One of the main issues concerning the validity of NUV estimates from contingent valuation (CV) studies concerns the effect and role of environmental resource information that is provided to respondents participating in the contingent market.

Both the NOAA Panel (Arrow *et al* 1993) and CV practitioners have acknowledged the potential biases, framing effects as well as the possible confusion, manipulation and inducement of CV survey responses that can result from providing inappropriate types and quantities of information. Moreover it has been accepted that the problems of information provision are more likely to be augmented for environmental goods for which individuals have mainly non-use values, have low levels of information and familiarity or have low levels of relevance (Arrow et al 1993, Blomquist and Whitehead 1998, Ajzen 1996, Cameron and Englin 1997). Supplying the optimal type and quantity of information is thus crucial for the validity of contingent valuation estimates and for the use of NUVs for environmental policy and damage assessment purposes.

In this paper we follow NOAA Panel guidelines and undertake two tests of the validity of CV responses that are related to the effects and role of the provision of environmental resource information. The tests are explored in a case study that estimates the non-use values for a highly unfamiliar environmental resource, namely remote mountain lakes (RMLs). These ecosystems constitute a perfect example of a complex environmental good with which respondents are unfamiliar and for which non-use values are most likely the predominant element of total economic value. In the first validity test, the effects of varying levels of information on stated WTP are examined. This is a theoretical validity test in that it examines whether information provided to CV participants affects their WTP in a manner consistent with economic theory (Mitchell and Carson 1989). Such theoretical validity tests have been undertaken with varying results by numerous researchers.[4] These studies provide different levels of information within or across groups of CV respondents and examine whether and in what way their WTP is affected. Conformity to economic theory is taken to provide an indication that CV responses are not random but instead follow some consistent pattern and are thus theoretically valid. Most of these studies have dealt with environmental goods for which people have mainly use values and/or have a high degree of familiarity. In contrast the experiment presented in this paper explores the information effects on individual preferences and WTP for a highly unfamiliar and obscure environmental resource for which individuals have only very indirect use or non-use value, namely RMLs. The theoretical validity test is accomplished by designing a CV experiment that obtains WTP for the conservation of RMLs from different sub-groups of respondents that have been provided with different levels of information. A simple welfare theoretic model of the effects of information on individual preferences is presented. The theoretical model allows for the formation of empirically testable hypotheses that examine the effects of information on WTP.

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[2] See Larson (1992) for an alternative view on how revealed preference data could potentially be used to estimate NUVs.

[3] NUVs can also be measured by other forms of stated preference techniques such as choice experiments. Yet, their application for the measurement of NUVs has only recently been explored. In any event, the issues raised in this paper are of equal relevance to all forms of stated preference valuation techniques.

[4] Most notibaly by Ajzen et al 1996, Bergstrom et al (1985), Bergstrom and Whitehead (1998), Bergstrom et al (1990), Samples et al (1986), and Boyle et al (1989).

Though the results from such tests may enhance our understanding of the effects of information on WTP they provide little insight as to the question of the optimal level of information that must be provided. The issue of optimality is more adequately addressed by reference to some external benchmark or baseline against which to judge the outcome of the CV study (Mitchell and Carson 1989). The NOAA Panel has suggested that this can be achieved through the use of a type of external or convergent validity that "compare[s] … contingent valuation's outcomes with those provided by a panel of experts" (p.4607) as an alternative validity test for contingent valuation experiments. Some form of 'convergence' or conformity of CV responses to those obtained from an expert panel assessment would provide some external validation of the reliability of the former while the NOAA guidelines state that such a comparison "will help to check whether respondents are reasonably well informed" (p. 4607). We thus follow Boyle *et al* (1995) and interpret the NOAA guidelines as prescribing a form of external validity test for the reasonableness or optimality of the information provided. Few studies have endeavoured to follow the NOAA Panel recommendations and compare expert opinions with individual preferences (Kenyon 1998, Boyle 1996), and still fewer have focussed on the effect of information on the conformity of individual preferences with expert opinion (Kenyon 1998). None have addressed these issues in the context of non-use values, the very class of economic values for which problems of validity and information issues are most pervasive.

This external validity test is undertaken through a comparison of the CV results with those obtained from a Delphi survey. This comparison allows us to assess the credibility and validity of using CV as an input to policy decisions as opposed to relying on expert based appraisal methods. We consider a situation that is commonly encountered by policy makers: the selection for conservation purposes of a small number of sites from a larger population. Such a policy decision requires considerations of trade-offs between the attributes of sites as well as some form of rating and ranking of these sites. Budgetary restrictions dictate such a prioritisation of ecological sites. In this study we obtained the ranking of four types of RMLs from a panel of experts participating in a Delphi survey. We then compared these results with those from a CV experiment in which we obtained the implicit ranking of the same types of RMLs (through the stated WTP bids) from three different groups, each receiving a different level of information. The objective of such an ordinal comparison was to investigate whether the provision of increasing levels of information would make CV respondents provide responses consistent with those obtained from experts and to draw some conclusions on the optimal level of information that should be provided in CV studies.

Note that this is not an external or convergent validity test of the *accuracy* of CV results. This would require a comparison of CV values with values obtained from revealed preference data sets. The latter are considered as 'true' values that serve as a benchmark with which we can compare the accuracy of 'stated' or ''hypothetical' values. In this sense the validity test performed in this study, which involves an ordinal comparison between rankings of experts and lay-people, is not a strict convergent validity test in that we do not assume that expert opinion provides some 'true' value. Yet, expert panel assessments can be used as an external baseline for assessing the affects and optimality of the information provided to respondents and in this sense can serve as the basis for an external validity test on the reliability of CV studies.

The validity tests highlighted above provide guidance towards understanding the validity of stated preference techniques but also allow us to draw some more general implications for using CV and individual preference based values in environmental policy. An attempt is made to address these issues in order to guide environmental policy in general and for the particular case in hand, the Remote Mountain Lakes.

2. Resource Information and Environmental Decision Making

2.1 The Role and Effect of Information in Eliciting Non-use values

The credibility and validity of stated preference techniques have been questioned when respondents are asked to value complex environmental goods about which they have little prior information, and for which preferences may not be well formed or consistent (Munro and Hanley 2000). In such cases respondents bring prior information and beliefs to the contingent market, and these beliefs may or may not be an accurate representation of the world, nor ensure consistent preferences over choices. As a result respondents are faced with uncertainty as to their preferences, which may manifest itself in any number of distortions from the 'true' response. Moreover, if the contingent valuation is a constructive process, as some authors claim, the economic value (in other words the stated WTP) is constructed during the interview. Again this is more likely when respondents have little knowledge or experience of the environmental good to be evaluated (Ajzen et al 1996)[5]. In sum, when the good in question is predominantly not used by people, and harbours qualities which are more scientifically/research oriented, respondent familiarity becomes more of an issue, and the level of information becomes important (Munro and Hanley 2000).

To the extent that validity and credibility problems arise through lack of information there is an incentive to provide individuals with additional information concerning the environmental good being valued in order to ensure responses are built upon correct assumptions and to reduce uncertainty (Munro and Hanley 2000). From a methodological perspective information concerning environmental goods is thought to reduce the embedding effect (Arrow et al, 1993), reduce the use of 'incorrect' heuristic valuation related to core characteristics of the good (Hutchinson et al. 1995, Fischoff et al. 1980, Ajzen et al, 1996 or Blamey 1998), and fix the meaning, and the perception of the good for the respondent (Hutchinson et al 1995). Similarly, some authors have suggested that there is a need to supply additional information to individuals as a result of the public good nature of environmental assets, about which individuals are generally unaware (Sagoff 1998).

Information can affect at least three aspects of CV studies, including: i) the subjective probabilities that individuals hold for potential states of the world, ii) the credibility of the scenario, iii) the strategic bias (Munro and Hanley 2000). The resultant effect of information upon the distribution of WTP responses will depend upon the beliefs that people bring to the survey and whether the information provided is 'positive' or 'negative' (Munro and Hanley 2000)[6]. There is much evidence to suggest that the distribution of WTP responses varies considerably depending upon the amount and complexity of the information provided to individuals (e.g. Blomquist and Whitehead 1998, Bergstrom et al 1990, MacMillan 2000). In particular Ajzen et al (1996) report that additional information has a very strong impact on the stated willingness to pay and this effect is magnified when the good is of high personal relevance. Further information effects have been analysed empirically with respect to a number of different elements of the contingent market: e.g. information about the resource to be evaluated (Samples et al. 1986; Bergstrom et al. 1990), about budget constraints and other peoples' contingent values (Loomis *et al* 1994, Bergstrom et al. 1989) and about related environmental goods like the existence and the properties of complement and substitute goods (Whitehead and Blomquist, 1991). Information may also effect an increase in the participation in the contingent market (a reduction of zero responses) again affecting moments of the bid distribution (Munro and Hanley 2000). Similarly the provision of information about the relative efficiency (perceived marginal

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[5] An example of the learning process which is at work during the contingent valuation studies is provided by Sample at al (1986) where the same questionnaire is administered twice to the same two groups of people. While the first group of people is provided with more information during in the second round of the questionnaire, the second group received the same questionnaire with an unchanged amount of information. Surprisingly the average WTP of both groups changes.

[6] 'Positive' information is that which increases the subjective probabilities for good attributes: Milgroms 'good news' idea (Milgrom 1981).

efficiency) of alternative money expenditures towards achieving preservation objectives may affect reported willingness to pay (Samples et al. 1986).

Additional exogenous information for respondents is recommended in order to focus responses on some 'true' value, the suggestion being that whatever the effect of information on the distribution of WTP, it is a desirable effect. However, another problem related to providing information in contingent valuation studies is that respondents may not receive information that is suited to their individual needs. As the level of information required to make a decision will vary from individual to individual, standardised information sets, no matter how well designed, will unavoidably run the risk of leaving respondents either a) unconvinced by the simplistic nature of the questionnaire: information underload, or b) simply confused by the amount of information they have to process: information overload (MacMillan et al., 2000). Moreover, if contingent markets becomes too complex people may make hasty choices which do not reflect their true preferences, like 'yeah-saying', 'don't know' responses or 'protesting' and terminating the interview quickly, as well as resorting to heuristics (Clark et al. 2000, or MacMillan et al. 2000).

2.2 Processing of Information by Respondents

Another issue is related to how people process information; so far it has been assumed that any piece of information provided by the CV practitioners is processed in the 'appropriate' way by all the respondents. In the real world the standard level of information incorporated in a questionnaire is processed differently by different respondents according to a great number of factors the most important being the personal relevance of the good and the previous knowledge of the topic.

As pointed out by Cameron and Englin (1997), an interaction exists between exogenously provided and endogenously determined/prior information. While it is very easy to control the effect of the former on the willingness to pay, it is more difficult to check either the extent or the effect of the latter. Endogenously determined information is usually modelled as a function of past recreational habits, observed behaviour, degree of education and kind of employment, but most of the time it must be simply written off as unobserved behaviour. In most of the studies it is implicitly assumed that the endogenously determined experience (prior knowledge) does not influence the results of the questionnaire. Abstraction from this kind of knowledge may be justified in case of very obscure commodities but usually respondents already have some information about the good to be evaluated and this will influence how they process the information incorporated in the questionnaire. Unfortunately a formal model of the interaction between endogenous and exogenous information is still missing in literature.

Similarly, it has been generally assumed that information provided in contingent valuation studies is ingested by the respondents in the same way it is communicated by the investigators. In other words it is assumed that respondents process information very carefully. Ajzen et al. (1996) point out that this is not always true. According to the authors one of the most important factors in determining the way in which respondents process information is the personal relevance of the good. In the absence of personal relevance, respondents are thought to adopt a peripheral processing mode so that the final judgement is deeply influenced by factors which are unrelated to the content of the message. Such factors include relatively superficial issues, implicit moods and motivations or cognitive heuristics. Therefore, it is important not only to provide information about the good but also to be sure that respondents are processing information effectively.

2.3 The Optimal Provision of Information in CV Studies.

It is clear from the survey of the previous two sections that both the amount of information is an important issue for ensuring the credibility of CV estimates, because it directly affects the stated WTP. Similarly it is important to establish that information is being processed 'correctly'. Thus, as the possibility of information overload reveals, it is not simply *more* information that will produce credible results, it is the correct level (amount and type). The question therefore remains; what is the optimal level of information that should be provided to CVM respondents?

Several perspectives exist as to the level of information that respondents should be provided with. At the one extreme there are those that suggest the practitioner must accept the respondents' ignorance and provide only the amount of information which is necessary to create a realistic market situation. At the other extreme it is thought that the practitioner must provide complete information about the resource being evaluated, its complements, its substitutes, the perceived efficiency of the management plan to be implemented and whatever other pieces of information are considered relevant to the particular issue.

The NOAA panel recommendation for stated preference valuation techniques falls somewhere in between. It suggests analysts should "*decide […] the standard of knowledgeability of the respondents that [they] want to impose on a contingent valuation study. It is clear that it should be at least as high as that which the average voter brings to a real referendum" (p. 4607).* However, the recommendations also state that *"if contingent valuation surveys are to elicit useful information about willingness to pay, respondents must understand exactly what it is they are being asked to value*" (p. 14, Arrow et al 1993, our emphasis). A similar view argues against the extremes and for a middle way. Hoevenagel and van der Linden (1993) argue that the level of information should be less than that which causes 'information overload' but sufficient to overcome 'information thresholds'. In this framework the assumption is that there is a non-linear relationship between the amount of information and its effects on WTP such that an informational threshold exists at the point at which it is decided to participate in the contingent market, and at the point at which confusion sets in[7]. In short the question of the optimal level of information can be addressed on a case by case basis and by reference to the impacts on the distribution of WTP responses (Munro and Hanley 2000).

2.4 Information Provision through Alternatives to CV

As described above, the NOAA panel recommendation emphasises the need to ensure that respondents are at least as informed as an average voter in a real referendum, and that respondents understand exactly what it is they are being asked to value. Yet, as the discussion above suggests, conveying the appropriate level of information in a stated preference study is very difficult especially for unfamiliar and complex environmental resources. Indeed this seems to be an almost insoluble difficulty due to the very nature of CV studies. First, CV practitioners faced with a limited budget face time limitations of each interview within which the environmental good is explained, the proposed scenario described and respondents process this information in order to make their (stated) choice. This brief time allocated to each interview is clearly insufficient when dealing with complex and unfamiliar environmental resources. Second, as seen above respondents may not receive information that is suited to their individual needs (cognitive ability, prior knowledge etc). CV practitioners can endeavour to provide information that can be understood by the 'average' individual, yet the level of information required to make a decision will vary from individual to individual, leading to information over or underload in standardized information sets (MacMillan et al 2000).

Numerous studies have shown that participants in CV studies have a very poor understanding of the environmental resource in question (e.g. Chilton and Hutchison 1999) and resort to construct various heuristics or to relying on survey cues (e.g. wording) while making their choices (e.g. Ajzen *et a*l, 1996; Blamey 1998). Also, the complexity of CV settings may cause people to make hasty choices which do not reflect their true preferences[8].

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[7] It is worth pointing out that the existence of these kinds of thresholds has been widely accepted in studies about the effect of advertising for market goods and it constitutes one of the principles guiding marketing strategies.
[8] E.g. 'yeah-saying', 'don't know' or 'protesting', mentioned above (Clark *et a*l. 2000, in MacMillan *et al,* 2000).

The acknowledgement that individual preferences do have a role in environmental decision making coupled with the recognition that stated preferences techniques are dented by difficulties in conveying the appropriate information, have lead some to propose *other* methods for incorporating individual participation in environmental decision making. Most notably, the citizen jury or the similar planning cell technique have been suggested as viable alternatives (Brown et al 1995, Crosby 1995, Dienel and Renn 1995). Here we focus on their potential role in overcoming the 'informational' difficulties encountered in stated preference techniques. Respondents in citizen juries (CJs) compared to those in CV studies are much better informed about the issue because they are deliberating for several days, interviewing an array of experts, and discussing the issue among their peers to reach a consensus about the particular environmental issue (or 'charge') presented to them. Yet, CJs do not provide *economic* values associated with any particular project nor whether a particular allocation decision constitutes an efficient use of resources. These weaknesses have recently prompted economists to develop new methods that attempt to combine stated preference techniques (necessary to provide information on efficiency questions) with jury-type methods (that allow for citizens to be better informed and thus provide more meaningful choices). Examples of this work are Macmillan et al (2000) who develop the 'Market Stall' method and Kenyon and Hanley who explore the 'valuation workshop' approach.

3. Modelling resource information and willingness to pay

Blomquist and Whitehead (1998) develop a model for analysing the effect of information within the framework of consumer theory. It is within this framework that we address the effects of information upon the WTP for RML's. The model provides general insights into the effects of exogenous information upon individual WTP. They define WTP as the difference between two individual expenditure functions whose arguments are the two states or quality levels of the good, q, and a given level of utility, *u*. The perceived quality of an environmental good is a function of the 'objective' quality of the resource, θ, and the exogenous information provided in the CVM questionnaire, I. Thus the individual's perceived quality of RML *i*, under information level *k* can be modelled as:

$$q[\theta, I] = \beta\theta + \delta I \quad (1)$$

β and δ are learning parameters, β for prior information and δ for information provided exogenously in the contingent market. In entering into the contingent market individuals may have less than perfect information about the quality of the resource they must value. This may manifest itself in either under or over estimation of the perceived quality of the resource. The provision of information to the respondents is intended to correct these perceptions towards the true quality levels represented by the objective quality θ.

It is postulated that should the perceived resource quality be higher that the objective resource quality, the effect of additional information on perceived quality will be negative, bringing perceived quality into line with objective quality. This would be represented by $\delta < 0$. Conversely, where perceived quality is less than objective quality, the effect of exogenous information about the quality of the resource will be positive, again bringing perceived quality into line with objective quality[9]. This can be represented by $\delta > 0$. The WTP for quality changes in environmental resources, using the definition of perceived quality can be defined as:

$$WTP = e\left(q^1[\theta, I], u\right) - e\left(q^0[\theta, I], u\right) \quad (2)$$

[9] Clearly in the Blomquist and Whitehead additive formulation objective and exogenous information are seen as substitutes for one another.

where q^1 is the perceived quality after the change while q^0 is the original perceived quality. Substituting in the indirect expected utility, $u = v(q^0[\theta, I], m)$, (2) becomes:

$$WTP = e\left(q^1, v\left(q^0[\theta, I], m\right)\right) - m \qquad (3)$$

Given (3), the marginal effect of I on WTP is given by the partial derivative of (3) with respect to I. By the chain rule this gives:

$$\frac{\partial WTP}{\partial I} = \frac{\partial e}{\partial v} \frac{\partial v}{\partial q^0[\theta, I]} \frac{\partial q^0[\theta, I]}{\partial I} \qquad (4)$$

Assuming the marginal utility of income and the marginal utility of perceived quality are both positive, the first two terms on the RHS of (4), which represent the marginal effect of perceived quality on WTP, are non-negative. I.e, "[w]illingness to pay will increase (decrease) with an increase (decrease) in perceived resource quality since increasing quality increases the utility loss associated with degraded quality". However, as described above, the effect of exogenously provided information, I, upon WTP may be either positive or negative depending on the relationship between objective and perceived quality, i.e. whether δ is less than or greater than zero. Re-writing (4) with reference to (1) provides:

$$\frac{\partial WTP}{\partial I} = \frac{\partial WTP}{\partial q^0[\theta, I]} \frac{\partial q^0[\theta, I]}{\partial I} = \frac{\partial WTP}{\partial q^0[\theta, I]} \delta \ \begin{matrix} > \\ - \\ < \end{matrix} 0 \qquad (5)$$

Following the assertions above, it is clear from this representation that if perceived quality is less than objective quality, i.e. people currently underestimate the quality of the resource in question, information about resource quality will increase perceived resource quality, $\delta > 0$, and therefore increase stated WTP towards that associated with the objective quality. On the other hand if perceived resource quality is greater than the objective quality, i.e. people are currently overestimating the quality of the resource, information will decrease perceived resource quality, $\delta < 0$, and decrease the stated WTP, again towards that associated with the objective quality of the resource. Interpreting the objective quality as representative of the 'true' state/quality of the world, the information effect is always desirable in that the stated WTP (conditional on additional information) is closer to the WTP associated with the objective quality of the resource[10].

4. Environmental resource Information and the validity of WTP: an application to RMLs

The preceding model was employed to formulate hypotheses that were used to explore the validity tests described in the introduction. The tests were examined within a CV study on the management of Remote Mountain Lakes. RML's were chosen as the subject matter of the CV study due to the public's unfamiliarity with these ecosystems and their high non-use value component.

RMLs are defined as those aquatic ecosystems that are above the regional timberline. In Europe such lakes are dispersed in mostly remote regions far from any human settlements. Due to the harsh climatic conditions RML's host very few plant and insect species. There are no animal species present although some lakes have fish populations (largely brown trout). Human interaction with these ecosystems is

[10] Bergstrom et al (1990) draw similar conclusions. Addressing the effect of additional information oncerning the services provided by environmental assets they conclude that while the direction of this information effect is uncertain, the information effect itself is argued to be desirable, as it increases the completeness and accuracy of the evaluation of environmental goods.

minimal. In fact most lay-people have very little (if any) knowledge about these lakes. In contrast European scientists (primarily ecologists, limnologists, biologists, chemists and meteorologists) have extensively studied these ecosystems over the past couple of decades. This research has provided data that feeds into air-born pollution and climate change modelling. Their research mainly focuses on studying water chemistry as well as the condition of algae and fish populations in these lakes.[11] Scientific research has shown that acidification has taken its toll even in these remote ecosystems affecting primarily the composition of algae species.

The benefits to humans of the RML's are of the non-use type (from the knowledge that these ecosystems are preserved when no personal direct present or future use is contemplated) and of a very indirect kind (providing habitat to some algae, plant and insect species as well as providing scientific information on climate change and atmospheric pollution). Moreover the impacts of atmospheric pollution to these lakes are equally obscure to most non-experts. According to natural scientists, the sensitivity of RML's makes them particularly vulnerable to environmental change and also enables them to act as excellent indicators of both pollution and climate change. The corollary of this is that RML's are the most difficult environments for which to attain environmental standards. Research into the ecological benefits (or non-attainment costs) of adherence to ecological standards has never previously been undertaken for the RML's, and as such the implementation of environmental agreements such as the UNECE Second Sulphur Protocol has not been guided or optimised by such measures[12]. A number of studies are currently underway to redress this omission using stated preference techniques[13]. However, as argued above, questions exist as to the validity of economic valuation techniques when applied to environmental assets such as RML's, which are in general unfamiliar and complex environmental goods whose economic value to members of the public lies largely in potentially nebulous existence values.

The first validity test examined whether individual preferences would converge to that of lake experts if appropriate information was provided. This was achieved by comparing the implied ranking of types of RMLs with the ranking provided by experts. Individual preferences were ascertained within the CV study while expert opinion was obtained using the Delphi method. To investigate such external validation of CV responses we had to establish the implicit ranking, or absence thereof, of the four types of lakes asked to be valued by each individual. Hence, we were able to investigate the implicit ranking of four programmes through the pair-wise testing of the following null hypothesis:

Null Hypothesis 1: $H_0^1 : WTP_{ik} = WTP_{jk}$

for the k^{th} information level, and for RML's $i > j$, for all combinations of RML's. This comparison of WTP reduces to a comparison of perceived quality changes across lakes, which are composed of the affect of perceived changes upon the objective quality (from θ_i^0 to θ_i^1), and the level of exogenous information[14]. In terms of the model, and using (6), null hypothesis 2 can also be represented as:

$$WTP_{ik} - WTP_{jk} = e\left(q_{ik}^1, v\left(q_{ik}^0[\theta_i^0, I_{ik}], m\right)\right) - e\left(q_{jk}^1, v\left(q_{jk}^0[\theta_j^0, I_{jk}], m\right)\right) = 0 \qquad (6)$$

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[11] ALPE, MOLA, EMERGE are three major research projects funded by the European Commission over the past 10 years.

[12] Some research has been undertaken into the costs associated with acidification for different ecosystems however; see ApSimon et al (1997).

[13] See other work being undertaken for the EMERGE project by Bateman et al.

[14] It is assumed that the quality changes described in the contingent market enter through the objective quality parameter θ_i.

This hypothesis was explored for each information level, *k*, so as to examine if and how the ranking of sites varied across information groups and whether any particular level of information would make individual responses converge to those obtained from experts.

The second validity test sought to examine the effect of information on the intensity of individual preferences for such a remote and unknown environmental good[15]. Based on information from a Delphi study (see next section) as well as direct consultations with experts three levels of information about RMLs were devised. The RMLs were grouped into four types of lakes, each group containing lakes with similar characteristics and levels of services. A CV study was then designed such that three sub-groups of individuals were asked to provide their WTP for conserving each of the four types of RMLs. Hence, individuals in each of the three information groups (*k=1,2,3*) where asked to value four different types of lakes (*i=1,2,3,4*). We thus received three WTP bids for a particular group of lakes *i:* one from each individual that had access to one of the *k* levels of information. In terms of the model described above the null hypothesis testing the effect of information on WTP is given by:

Null Hypothesis 2: $H_0^2 : \overline{WTP_{ik}} = \overline{WTP_{il}}$

for information levels $k \neq l$, and for RML *i*, where, noting that the perceived quality of lake *i* at information level *k* can be written as:

$$q_{ik}[\theta_i, I_{ik}] = \beta_i \theta_i + \delta_{ik} I_{ik} \quad (7)$$

the effect of additional information on WTP for lake *i* at current information level *k* can be written as:

$$\frac{\partial WTP_{ik}}{\partial I} = \frac{\partial WTP_{ik}}{\partial q_{ik}^0[\theta_i, I_{ik}]} \delta_{ik} \quad (8)$$

Given the assumptions concerning equation (4), in effect we are testing the sign of the learning parameter for exogenous information δ_{ik}, and making no *a priori* assumptions concerning the sign of β_i in equation (6)[16]. δ_{ik} is not assumed constant across lakes within the *k* information levels, since although the information levels provide the same 'type' of information for each of the *i* lakes, naturally the actual components of the information differ for each lake. Similarly, δ_{ik} is not assumed to be constant across information levels[17].

[15] Information can have several effects on the distribution of the WTP bids, the effect on the mean being just one. Other tests might include a test of the change in the variance of bids with one alternative hypothesis being a narrowing or focussing of bids, i.e. a diminished variance. Another test might be on the number of zero bids. Both of these tests have been considered but do not provide much insight in this case.

[16] The form of the hypothesis should be noted here. The parameter δ_{ik} refers to the effect of information changes when at information level *k* . Our experiment consists of three information levels, thus three tests will be undertaken. The first will be a comparison of WTP at information level 2 with level 1, a test of δ_{i1}, then at level 3 and level 1, a test of $\delta_{i1}^{'}$, and then at level 3 and level 2, a test of δ_{i2}.

[17] θ_i and β_i remain constant for each lake over information levels as they reflect the prior knowledge or perception of the lake.

5. The Delphi Study

In this section we report on the design, implementation and results from the Delphi study. The Delphi methodology is a systematic method of collecting opinions from a group of experts through a series of questionnaires in which the feedback of the group's opinion distribution is provided between question rounds Helmer (1972). In this way a significant portion of the effort needed for experts to communicate is shifted from the respondents group to the monitoring team. The Delphi method is particularly useful when a) the decision in question does not lend itself to precise analytical techniques but can benefit from subjective judgements on a collective basis, and b) individuals who are needed to contribute to the examination of the problem represent diverse background with respect to experience and expertise (Linstone and Turoff, 1976). It is in this sense that the Delphi method may be a useful decision mechanism for environmental policy concerned primarily with non-use values of environmental resources, may provide a useful alternative to CVM, or may be used as a test of the validity of CVM preference orderings. The recommendations of the NOAA panel can perhaps be understood in this sense.

Unlike other methodologies used in environmental economics (for example CV) the Delphi method is particularly unstructured. It is the duty of the monitoring team to adapt and apply the basic rules of the methodology to the subjects being examined. The main principles of the Delphi are: i) the experts interact only through the feedback mechanisms provided by the monitor team: this is to avoid the groups dynamics which characterise face to face meetings like for example domineering personalities or unwillingness to contradict individuals in higher position, and ii) answers are anonymous to provide the experts with the greatest degree of individuality and freedom from restrictions on their expressions (Turoff, 1976).

In the current applicant we used three rounds in the Delphi study, the internal aims of which were manifold. The study was implemented during the period July-August 2001. Firstly we sought to reach a consensus between experts of different disciplines on the most important ecological criteria to evaluate the ecological importance of generic RML's (round 1 and 2). This information was used to construct the information scenarios for the CVM study described in Section 6.1. Secondly we required our experts to rank four specific RML's on the basis of their 'ecological interest' with respect to the chosen criteria (round 3).

Table 1. Composition of the Expert Panel

Ecologists	4	**Meteorologists**	1
Limnologists	6	**Chemists**	2
Biologists	6	**Physics**	1
Economists	1	**Pollution Modellers**	3
		TOTAL	**24**

Round 1 of the Delphi study started with the description of the scenario and an introduction of a management plan. The management plan focussed on the reduction of pollution as a means for conserving and/or restoring some of the regions where RML's are located[18]. It was explained that because of budgetary restrictions not all RML's could have been treated. We asked the experts for their opinions on the various criteria that could be used to choose the most suitable regions of lakes to be included in the management

[18] The main features of this management plan are:

- The pollution affecting Remote Mountain Lakes (RML's) can be only vaguely tracked to the source.
- It is almost certain that the pollution coming from a specific region affects more than one region of RML's (for example the pollution from the Ruhr district in Germany may affect the RML's in both South Norway and on the Tatra Mountains).

plan[19]. In order to help the experts assess the criteria and in order to provide a framework for their judgement we introduced an importance scale which is shown in Appendix 1.

Round 2 of the Delphi questionnaire provided the experts with each criterion's average mark and variance of the mark and asked them to evaluate the criteria again. The results from round 1 and 2 of the Delphi questionnaire are summarised in Table 2. It is worth pointing out that the ranking of the criteria obtained in the round 2 is substantially different from the one obtained in round 1. Moreover, it seems that knowing the opinion of the other fellow members of the panel allowed scientists to reduce uncertainty about their judgement as represented by the general drop in the value of the variance. In sum round 2 of the Delphi shows a deeper consensus compared to that of round 1.
In *Round 3*, following Kenyon et al (1998), the expert panel were asked to rank the 4 RML's according to their 'ecological interest', as defined by the scientific criteria shown in Table 1. Prior to this measurable scientific information about the criteria deemed important from the findings of rounds 1 and 2 were collected for the four RML's to be ranked in round 3. The RML's considered in this section of the questionnaire were chosen on the basis that they were distinct from one and other. As the difficulty of the ranking process is thought to be inversely proportional to the similarities among the areas, we required the maximum possible diversity among the lakes in order to make the ranking exercise as straightforward as possible[20].

There are a number of criticisms levelled at the Delphi method. The lack of clear guidelines for the development of the questionnaire: e.g. the ecological criteria to assess in ranking environmental sites, and selection of members for expert panels are high among them. With regard to the former criticism, we follow Kuo and Yu (1999) by ensuring that the ecological criteria introduced in our questionnaire were well known in previous research on natural reserves and national parks and the ecological literature[21]. We predicted that this would limit both the need to provide definitions and any potential misunderstanding between the monitoring team and the expert panel.

With regard to the latter criticism, the experts in our case have been automatically provided by the participation to EMERGE project. It seems plausible to say that it would have been difficult to select people with a better understanding of RML's. Moreover, choosing EMERGE scientists as expert panellists for this study has ensured that the level of involvement and of interest in our study has been particularly high. As pointed out by May and Green (1990) involvement and interest in the study are the most influential variables on the response rate. The composition of the panel of experts is shown in Table 1.

Table 2 describes the results of the feedback process of rounds 1 and 2 of the Delphi study. In general these results suggest that the expert panel are more concerned with conserving these lakes and ascertaining their scientific value than their potential amenity value (criteria 12, 15, 16 and 17)[22]. These attributes were consistently ranked in the bottom 5.

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[19] This is literately the question asked to the experts: In the case you were asked to suggest the region of lakes to be selected for this management plan, how important in formulating your consultation would the following criteria be?

[20] We were concerned about the possibility that the experts did not accept the scientific plausibility of the ranking exercise. According to some of the literature (see for example Tans, 1974), a very large amount of information is required to rank different areas. Asking scientists to comment on our study anonymously is thought to be one of the few methods we had to verify their judgement on the scientific value of the ranking exercise. The responses we received made us confident that our approach was acceptable.

[21] We chose this branch of natural science literature because of the similar rationale between choosing where to set a natural reserve and the question asked in our Delphi questionnaire.

[22] Clearly this list of criteria is not exhaustive. Indeed several criteria related to the single components of pollution were dropped from the study. The expert panel was asked whether they preferred to evaluate pollution as a single item or consider its main components individually. As only 6 out 21 experts chose the latter, we decided not to include the individual criteria in the second round.

Table 2. Round 1-2: Ranking of Ecological Criteria in Defining the Ecological Importance of RML's

Ecological Criteria	Rank in Round 2	Mean Round 2	Variance in Round 2	Rank in Round 1	Mean in Round 1	Variance in Round 1
Pollution already present in the lake	**1**	1,33	0,24	3	1,6	0,48
Sensitivity	**2**	1,43	0,37	2	1,47	0,48
Naturalness	**3**	1,52	0,47	1	1,43	0,38
Species, Habitat and Community Diversity	**4**	1,9	0,6	4	1,79	0,78
Species Rarity	**5**	1,95	0,79	5	1,79	1,21
Isolation of the RML	**6**	2,75	1,14	11	2,42	1,7
Recorded data	**7**	2,79	0,39	7	2,36	0,82
Geographical location across Europe	**8**	2,79	0,87	6	2,18	0,89
Potential for Research	**9**	3,00	0,83	9	2,41	1,03
Presence of nearby natural park	**10**	3,06	0,78	10	2,42	0,78
Geological nature of the catchment	**11**	3,17	0,88	8	2,38	1,61
Accessibility of the RML	**12**	3,21	0,87	12	2,54	1,21
Topography of the catchment	**13**	3,34	1,03	14	2,82	1,51
Morphology of the RML	**14**	3,38	0,72	13	2,66	1,39
Landscape attractiveness	**15**	3,42	0,79	15	2,83	1,36
Amenity value or beauty of the sight	**16**	3,61	1,31	16	3,08	1,35
Proximity to other RML's	**17**	4,02	0,79	17	3,08	1,35

Curiously a low level of importance was given to some criteria considered extremely important in the literature on RML's: e.g. morphology of the lake (criterion 14), and geological nature of catchment (criterion 11). Clearly this could be an issue of a panel composition in which ecologists and biologists made up only half of the panel. Indeed the number of members with a specialisation in chemistry and physics, in other words the scientist which might have better appreciated the criteria mentioned above, were respectively 1 and 3. The final ranking of RML's based on these attributes arising from round 3 is shown in Table 3. The columns 3-6 report the number of times each lake has been ranked while the second reports the final ranking of the lakes.

Table 3. Round 3: Ranking of the Lakes by the Expert Panel

Lake	Ranking	1	2	3	4	Total
Osvre Neådalsvatten (Norway)	**1**	13	5	3	3	**24**
Loch Nagar (Scotland)	**2**	4	9	9	2	**24**
Lago Paione Inferiore (Italy)	**3**	2	7	6	9	**24**
Dlugi Staw Gasienicowy (Poland)	**4**	2	4	8	10	**24**

The Delphi experiment shows how, in cases where environmental assets are remote and obscure, decisions concerning conservation and other environmental policies can be made by reference to panels of experts closely associated with the good in question. The recursive nature of the method employed meant that in this case a degree of consensus is reached between panel members concerning the important attributes of RML's. Subsequently, panel members were able to provide ordinal preferences concerning the four RML's in consideration, thereby acting as a guide to policy makers. The Delphi method can be seen as one of various decision making tools that can provide relevant information to policy makers due to its ability to prioritise the focus of policy by reference to expert opinion (Kontoleon, Macrory and Swanson 2002).

6. Ascertaining WTP for Remote Mountain Lakes.

The CVM survey was undertaken to elicit the non-use values held by UK individuals for RML's in the UK. Three separate focus groups (of about 30 members) were used over a period of three days during August-September 2001. All interviews were undertaken in London. The moderator used visual aids to describe the information levels and the scenarios to be valued while respondents were guided through the questionnaire in a highly structured and controlled manner. No interaction between respondents was allowed although private consultations (for further clarifications) between individual respondents and the moderator were permitted. Each experimental session had a duration of 1.5 hours which is considerably above the average time spent on most personal face-to face CV studies. An augmented survey time was rendered necessary so that respondents could assimilate the information provided. Moreover, following NOAA guidelines we allowed for a zero WTP answer and used the willingness to pay instead of the willingness to accept format. Furthermore, respondents were informed that due to governmental budgetary constraints only one of the four conservation programmes would be implemented. That is, the conservation programmes were emphasised as being mutually exclusive. Finally, following the work by Bateman *et al* (2001) we attempted to minimise ordering effects and warm glow bias by providing advanced warning to respondents of the size of the choice set instead of describing the four possible scenarios in a step wise manner. The questionnaire used followed closely that used in previous studies concerning the RML's undertaken by the EMERGE Socio-economic research group (see Bateman et al 2002). The questionnaire is attached as an appendix to this document.

6.1. Information Levels

In order to test the effect of information on the stated WTP three versions of the questionnaire were designed, each with a different information level. The information levels were progressively increased in the three versions such that the first version contained only information level 1, the second contained information levels 1 and 2, and the third contained all three levels of information. The information scenarios were constructed using the results from our consultations with European lake scientists as well as from the results of the Delphi study.

The *first* information level defined the RML's, and explained the effect of acid rain on the RML's using the 'acidity ladder' (see Appendix 2)[23]. For comparability with the Delphi study, four types of lake were addressed. The following attributes were described for each type of lake: i) presence of a conservation area surrounding the lake, ii) use of lake by tourists, iii) walking time from the closest road, iv) level of acidity, and v) a list of algae, macro-invertebrates, aquatic plants, fish and birds present in each type of lake was provided.

In the *second* information level we added an ecological description of the RML's incorporating i) the degree of biodiversity present in RML's, ii) the role of nutrients in supporting the fauna and flora of lakes, and iii) the biological effect of increasing acidity. We made it explicitly clear that the services and functions arising from these kinds of lakes may include recreational use services as well as other services related to preservation of ecosystems, habitats and species diversity. In addition for each group of living organisms we provided a qualitative evaluation of the status of the fauna and flora described in the first level of information, and distinguished between acid and non acid-sensitive species.

In the *third* information level, in addition to the above, we added a description of the scientific services and functions arising from RML's. We then explained that this function is related to the fact that some species

[23] This level of information coincided with the format of the CV questionnaire used by an accompanying study looking into the non-use values for RML's

living in RML's may act as bioindicators[24] both for pollution and climate change. We also provided a qualitative assessment (derived from the Delphi study) of each lake's importance both for scientific research and as indicator of past and present level of pollution and climate temperature.

6.2. The Contingent Market

After providing information about RML's, the scenario for the contingent market was presented. Initially we referred to the threats these ecosystems are facing. For reasons of simplicity we focused on the threats from the increase in acidity levels from air pollution from the generation if electricity. We used the acidity ladder shown in Appendix 2 to describe the two main effects from increasing acidification: i) effects on plants and animals found in RML's that will result in the complete disappearance of fish and acid sensitive algae, plant and macro-invertebrates species. This will reduce the quality of recreational and species habitat services provided by these lakes and ii) negation of the science-related benefits. The latter was only described in information level three. Subsequently, the scenario stated that scientists had grouped all the 400 UK Remote Mountain lakes into four types or groups of lakes. It was stated that each type/group of lake contained lakes roughly the same number of lakes and that the lakes within in each group have similar characteristics and provide similar levels of services. The characteristics and level of services of each group of lakes was then described. Respondents were then told how the actual level of acidity is expected to reach the same levels in each of the four groups of lakes in years time. Individuals were then presented with a programme of liming that aimed maintaining the level acidity at its current level. The introduction of a fixed supplement[25] to every UK household's electricity bills for the next 10 years was used as our payment vehicle.[26]. Three WTP questions were presented to each individual (one for each type/group of lake) in which they were asked to state the maximum amount of money they would be willing to pay in order to avoid the increase in acidity level.

Note that the scenarios offered to lay-people in the CV and to experts in the Delphi study were purposefully designed to differ (primarily with respect to the location of lakes, the nature of grouping, and the management scenario). This was done so as to make the scenarios more believable, plausible and relevant to each type of respondent[27]. Yet, the comparability of the results from the two studies is not jeopardised by this deviation since the purpose of the experiment was to examine whether individual preferences would converge to the opinions of experts given appropriate information.

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[24] "All organisms have evolved to exist in different environmental conditions, some tolerating a very wide range of conditions while others tolerating a very narrow range. The latter are called bioindicator as their distribution and numerosity of the community is quickly affected when the environmental conditions of the habitat where they live change: these environmental conditions include physical and chemical factors, soil conditions and other organisms"(Carvalho and Anderson, 2001).

[25] We defined "fixed" as same per household and same amount for each of the 40 quarters.

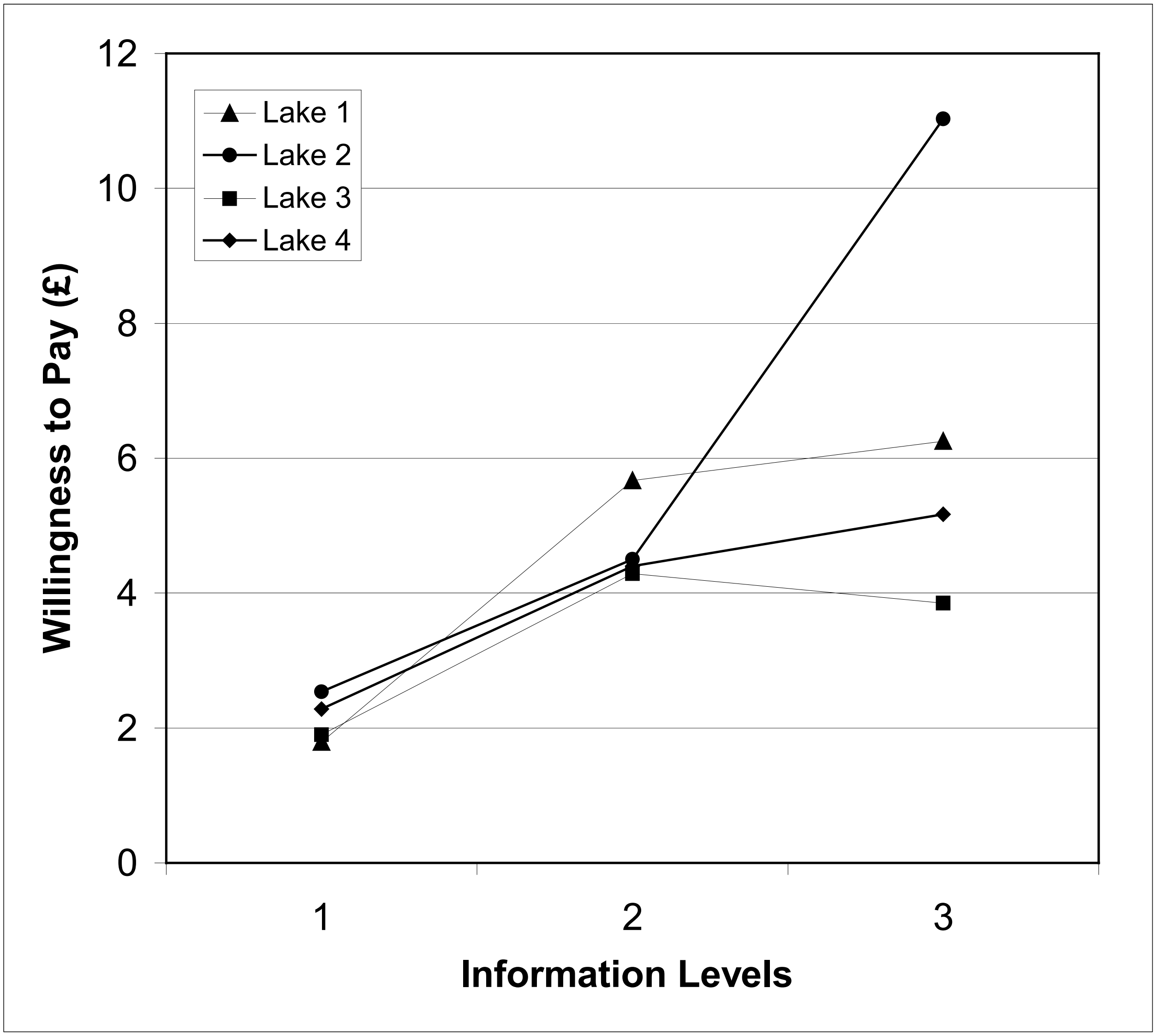
[26] In order to make the plan accountable, we specified that the fixed supplement would be listed as a separate item on people's bills. The Electricity Companies would pass this money on to the Department of the Environment who would only use it for liming the lakes. Any excess funds collected would be rebated to customers.

[27] Indeed Boyle et al (1995) point out that "[i]mplementing such a validity test is easier said than done, and the NOAA panel provides no guidance regarding the composition of an expert panel nor how contingent valuation responses might be compared with experts opinions".

7. Results

The mean and standard error of WTP for each RML are shown in Table 4 while Figure 1 provides a visual comparison of both the ranking of the lakes in terms of mean WTP, and of the effect of information on the mean WTP for the 4 RML's[28]. An initial inspection of these results suggests that increased levels of information on the scientific service flows from RMLs have a positive effect on stated WTP. Yet, more formal hypothesis testing is required to fully understand this informational effect as well as to explore the statistical significance of the implicit ranking of the various types of RMLs.

Figure 1. The Evolution of WTP Bids for the Remote Mountain Lakes over Information Levels



[28] We defined fifty pounds as the maximum acceptable bid. All the bids with a higher value were considered outliers and reduced to the next highest bid level.

We have two different families of hypotheses to test. Null hypothesis 1 amounts to a test of whether or not a statistically significant implicit ranking can be established for the lakes for a given level of information: i.e. a comparison of the mean WTP of each RML across information sets. Null Hypotheses 2 represent tests of the effect of information on WTP bids.

Table 4. Mean WTP for the RML's across Information Scenarios (£).

Remote Mountain Lake		First Information Level	Second Information Level	Third Information Level
		Mean (Standard error)	Mean (Standard error)	Mean (Standard error)
Lake 1:	**Loch Nagar (Scotland)**	1.79 (2.17)	5.67 (9.30)	6.25 (6.83)
Lake 2:	**Osvre Neadalsvatten (Norway)**	2.54 (3.25)	4.50 (9.48)	11.03 (12.13)
Lake 3:	**Dlugi Staw Gasianiconwy (Poland)**	1.90 (2.25)	4.29 (4.73)	3.85 (6.52)
Lake 4:	**Lago Paione Inferiore (Italy)**	2.28 (3.10)	4.40 (7.17)	5.17 (6.92)
Sample size		27	27	26

7.1 The Test for Implicit Ranking of Lakes and Comparison with Expert Ordering

The responses made by the same individuals over the four lakes within each information set cannot be assumed to be independent. Therefore a paired-sample test is required for the comparison of bids under the following alternative hypothesis:

Alternative Hypothesis 1 $H_1^1 : \overline{WTP}_{ik} > \overline{WTP}_{jk} : i > j$

The classical t-test employs parametric assumptions concerning the distribution of the WTP bids, i.e. it assumes they are normally distributed. The Anderson-Darling test for normality revealed that these normality assumptions are not credible for the observed WTP responses and thus the use of non-parametric tests should be employed[29]. The Wilcoxon paired signed rank test is often a more efficient and powerful test for paired samples such as those within information groups. The null hypothesis for this test is that the population underlying the samples is identical. The results of the non-parametric tests are shown in Table 5[30].

[29] The Anderson-Darling statistic for WTP for each lake was never less than 1.7, compared to the critical value of 0.752, at 5% significance. The null hypothesis that the bids are normally distributed is thus rejected.
[30] The associated t-tests are shown in Appendix 3. There is a close similarity between the two sets of tests, although it is clear that some of the results of the t-test are driven by the parametric assumptions.

Table 5. Wilcoxon Paired Signed Rank Test for Paired Samples within Information Groups[31]

Null Hypotheses (1)[32]	First Information Level		Second Information Level		Third Information Level	
	W-stat	P-value under Ha	W-Stat	P-value under Ha	W-Stat	P-value Under Ha
$WTP_{1k} = WTP_{2k}$	**30.5**	**0.083†**	**35.0**	**0.992****	**129.5**	**0.028***
$WTP_{1k} = WTP_{3k}$	29.5	0.419	80.5	0.586	**57.5**	**0.962***
$WTP_{1k} = WTP_{4k}$	**55.0**	**0.025***	**19.5**	**0.996****	**31.0**	**0.992****
$WTP_{2k} = WTP_{3k}$	24.0	0.880	135.0	0.131	**58.0**	**0.993****
$WTP_{2k} = WTP_{4k}$	88.5	0.285	92.0	0.388	**44.5**	**0.988***
$WTP_{3k} = WTP_{4k}$	**95.0**	**0.0813†**	80.0	0.727	143.5	0.433

** refers to significance at a 1% level, * at the 5% level and † the 10% level.

The results in Table 5 allow us to examine the implicit rankings of the lakes under the different information scenarios[33]. Under the first information scenario, strict preference orderings over all the lakes are not revealed. If we assume a strict preference requires a disparity of mean bids at a 10% significance level, lake 2 and lake 4 are both strictly preferred to lake 1. Similarly, lake 4 is strictly preferred to lake 3. It should also be noted that there appears to be a 'weak' preference for lake 2 over lake 3, at something approaching a 10% significance level.

In the second information scenario, the preference ordering is even less clear and, in places, contrary to those revealed under first information scenario. At the 10% significance level, it is only possible to establish strict preferences for lake 1 over lake 2 and lake 4. Clearly the preferences are reversed for lakes 2 and 4 over lake 1 when compared to the first information scenario. In the third information scenario, a clear preference ordering is revealed. Lake 2 is strictly preferred to lake 1, 3 and 4, whilst lake 1 is strictly preferred to lake 3 and 4. Respondents were indifferent between lakes 3 and 4, perhaps having a weak preference for lake 4. But for the apparent indifference between lakes 3 and 4 this represents a strict preference ordering over all lakes.

The third level of information revealed a preference ordering for lake 1 and 4 which agreed with that revealed in the second information scenario, but a reversal of preference ordering for lake 1 and lake 2 compared with the second information scenario. For all the other pair-wise comparisons under null hypothesis 1, the third increment of exogenous information seems to have allowed respondents to form strict preferences, which accord with certain principles of rationality. In sum, respondents seem to be initially unfamiliar with these RML's and cannot develop strict preferences over the lakes until they are provided with sufficient information concerning their characteristics. It appears that the second level of information concerning details about the ecological attributes of the lakes served only to weaken the preference ordering, allowing only lake 1 to be revealed as strictly preferred to the others. Lastly, the third level of information concerning the scientific value of the lakes seems to have exceeded some cognitive threshold for respondents, allowing them to make distinct choices over the lakes. One reason for this might be that

[31] The p value comes from a test which is corrected for the number of ties in the ranked differences. This entails an assumption that the ranked differences are distributed normally, rather than the observations themselves.

[32] The null hypothesis for the non-parametric test is no longer a test of the equality of mean WTP, but as stated a test of the distribution of the bids across lakes Wonnacott and Wonnacott (1995).

[33] Where the p-value is close to one and the t-statistic is shown to be significant at some level, this represents rejection of the null hypothesis when faced with an alternative hypothesis with a strict inequality in the other direction to that posited above. I.e. **Alternative Hypothesis 1'**: $\overline{WTP}_{ik} - \overline{WTP}_{il} < 0 : k > l$. It is necessary to take this approach in order to establish a strict ranking.

this information enabled respondents to 'contextualise', or digest the previous ecological information. In addition, the scientific information may increase the 'relevance' of the goods, in the sense of Ajzen (1996). The implicit ranking that arises from the Wilcoxon paired signed rank test undertaken above is shown in Table 6.

Table 6. Preference Ordering of RML's According to Stated WTP

Lake	First Information Level	Second Information Level	Third Information Level
	Rank	Rank	Rank
Lake 1: Loch Nagar	2	1**	2
Lake 2: Osvre Neådalsvatten	1*	2	1
Lake 3: Dlugi Staw Gasienicowy	2	2	4^
Lake 4: Lago Paione Inferiore	1*	2	3

*these lakes are both strictly preferred to the others. ** there is a weak preference for these lakes over at least one other. ^ weakly not preferred.

In the contingent valuation experiment we obtained an implicit ranking form the elicited WTP values from each group of respondents (operating under different information levels) while in the Delphi study the experts (operating under high levels of information) provided a direct ranking of the four representative RML's in accordance ecological criteria. The results from the pair wise test in tables 5 suggest that we only obtained a clear ranking from the third information level. More importantly, as shown in Table 6, this ranking coincides with that obtained from the expert panel.

7.2 Testing the Effect of Information on the Mean Willingness to Pay for RML's

The groups facing different information levels were independent, and thus a test for independent samples was undertaken. Again the Anderson-Darling test for normality revealed that these normality assumptions are not credible for the observed WTP responses and thus the use of non-parametric tests should be employed[34]. A Mann-Whitney test was employed under the following alternative hypothesis:

Alternative Hypothesis 2 $$H_1^2 : \overline{WTP}_{ik} > \overline{WTP}_{il} : k > l$$

for information levels ($k = 1,2,3$), and for lake *i*. That is, under this alternative hypothesis the provision of exogenous information has a positive effect on mean willingness to pay for lake *i*. This alternative hypothesis was used under the assumption that on the whole individuals would be unfamiliar with RML's, and that the incremental information provided essentially concerned 'positive' attributes of the individual lakes (in the sense of Munro and Hanley 2000). In terms of the model described in Section 3 this is a test of the sign of δ_{ik} , the learning parameter associated with exogenous information. This suggests that we can conclude that overall individual's perceived quality concerning RML's was less that the so-called objective quality, and that the provision of information in the contingent market moved people towards the higher objective quality, and hence, given the assumptions contained in equation (3), increased WTP. The results of the Mann-Whitney test are shown in Table 7.

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[34] The Anderson-Darling statistic for WTP for each lake was never less than 1.7, compared to the critical value of 0.752, at 5% significance. The null hypothesis that the bids are normally distributed is thus rejected.

Table 7. Mann-Whitney Test of Median WTP Differences of Lakes across Information Scenarios

Null Hypothesis (2)	First Lake		Second Lake		Third Lake		Fourth Lake	
	U-stat	P-value	U-Stat	P-value	U-Stat	P-value	U-Stat	P-value
$WTP_{i1} = WTP_{i2}$	**497.5**	**0.010****	375.0	0.573	**262.5**	**0.038***	301.5	0.188
$WTP_{i1} = WTP_{i3}$	**512.5**	**0.002****	**206.5**	**0.005****	314.0	0.254	306.5	0.213
$WTP_{i2} = WTP_{i3}$	310.5	0.235	**219.5**	**0.009****	408.5	0.848	340.0	0.515

P-values represent the normal approximation corrected for ties in all cases. ** refers to significance at a 1% level, * the 5% level and $^{+}$ the 10% level.

The Mann Whitney test indicates that only in 5 cases out of 12 is the null hypothesis rejected, i.e. information is seen to have significantly positive effect on WTP bids. The comparison of the mean WTP for lakes between information level 3 and 1 reveals that the null hypothesis is rejected at a 10% significance level lakes 1 and 2. This comparison represents the largest difference between information levels. If we assume that each of the independent samples are representative of the same population, something can be said about the magnitude of the information effect by reference to the more defined yet changing preference orderings shown in Table 6 above. For example, we notice that the preference ordering for lakes 1 and 4 is reversed between information scenarios 1 and 3, suggesting that the information was relatively more 'positive' for lake 1, than for lake 4. This is borne out by the level of significance of the positive information effect on lake 1. Indeed it can be seen that the preference ordering is driven by the significant information effect on lakes 1 and 2[35].

When differences between information levels 1 and 2 are compared, we reject the null hypothesis only in the cases of lake 1 and lake 3. To some extent this explains the change in the preference ordering over information scenarios 1 and 2 between lake 1 and 2, and lake 1 and 4 shown in Table 6. The information provided in scenario 2 is particularly 'positive' for lake 1. Similar changes in preferences are noted for lake 3 as a result of information level 2, suggesting the information was relatively 'positive' for lake 3 also. Lastly, in the third information scenario the null hypothesis is only rejected in the case of lake 2, for which the information concerning the scientific indicator value is most 'positive'.

8. Discussion and Concluding Remarks

The paper examined the effects of resource information on the validity of WTP for non-use values as obtained from contingent valuation studies. Following NOAA Panel guidelines two tests of validity of WTP were explored: a theoretical validity test that examined whether varying degrees of information affected WTP in a manner consistent with a basic welfare theoretic model and an external validity test which examined the optimal level of information that should be offered to respondents by reference to a benchmark level of information provided by an external panel of experts. We explored these tests with the aid of a controlled CV experiment and a Delphi study on the management of Remote Mountain Lakes. The choice of environmental resource was made on the basis of the high unfamiliarity and predominantly non-use nature of the good.

The results of the Delphi study suggests that experts can provide useful information as to the important attributes of RMLs that can be utilised in the formation of the 'information package' provided to CV participants. Moreover, the expert panel was able to provide an ordinal classification of four representative RMLs. The input from the Delphi study was subsequently used to design a controlled CV experiment that provided three different levels of information to three sub-groups of respondents. All information was provided in a highly controlled and structured manner by experienced moderators and with the aid of visual and presentational material. The first group received information about the recreational possibilities of these remote ecosystems and a brief listing and description of their fauna and flora. The second group received

[35] There is clearly no control for group differences here however.

the first level of information but was also provided a much more detailed description of the ecology, water chemistry and biodiversity of the lakes. The third level of information provided the information from the first second levels but also included a description of the scientific services and ecosystem functions arising from RMLs. The study focused on UK lakes which were grouped into four types of lakes that corresponded to the representative lakes that pre-occupied the Delphi study. The four lake groups differed with respect to their attributes and level of services they provide. A scenario was presented in that all lakes would be further acidified in the next 10 years causing a reduction in the level of the services that each type/group of lake provides. A conservation programme involving liming was described that would prevent such a damage form occurring. Respondents in each information group were asked to provide their WTP for each of the four types of lakes.

With respect to the effect of information we see that its impact is twofold. First the results clearly suggest for resources with low familiarity (i.e. $\beta < 1$) increasing the quality of information is associated with an increase in mean WTP, suggesting a positive value of the learning coefficient for exogenous information δ. This results is consistent with those found in Blomquist and Whitehead (1998) and Bergstrom et al (1990). The WTP for each type of lake increased as we went from the base-line to the higher information levels. Second, the study showed that differences between the stated WTP within groups for different types of lakes were not statistically significant in the first and second levels of information. In contrast, the individuals presented with the third level of information were able to focus on the scientific value of the RML's, acknowledge the *relative* importance and difference between types of lakes and provide a subsequent ranking. In combination the results suggest that the effects of information were found to be consistent with a basic welfare theoretic model of individual choice which supports the theoretical validity of our results.

Moreover, the results suggests that the information in the first two groups was not sufficient for respondents to provide a full ranking of the four types of lakes while respondents receiving the third level of information were able to provide a full ranking of the four sites, while providing such information resulted in a convergence between individual and expert opinion. We can conclude that the third level of information provides sufficient information for individuals to distinguish between ecological sites and to make decisions which are consistent with those of experts. Further, the results suggest that information from panel of experts can be used as an external benchmark to provide validity and reliability to CV estimates in the manner suggested by the NOAA panel.

In closing a few caveats are worth considering. First, some doubts may arise as to the meaning of the comparison of WTP bids from respondents that have received different levels of information. These primarily have to do with whether additional information changes the nature of the good itself. This remains an unresolved issues amongst CV practitioners. The crux of the debate concerns how we define q in equation 2. The assumption made in this study follows that in Bergstrom, Stoll and Randall (1990) and Blomquist and Whitehead (1995) where characteristics of the environmental resource itself are objective while the type and level of services they provide/support are subjective. This reasoning can better be understood within Lancaster's household production framework in which (objective) environmental resource characteristics combined with divisible market resource make up the final (subjective) services or flows (both use and non—use) people receive. In this sense, providing additional information of the type offered in this study alters the subjective services and not the environmental good itself. In terms of the model of Section 3, by providing additional information *I* the analyst affects the perceived resource quality, *q*, to approximate the objective resource quality θ.

Second, studies as the one considered here involving issues of information and NUVs raise interesting issues concerning the aggregation of these values. The NOAA recommendations suggest that one of the responsibilities of the survey designer is to ensure that the information brought to the survey by the respondent reflects the level of information that the average voter brings to the referendum. The study has shown that it is possible to provide respondents with a sufficient quantity of information about a previously unfamiliar public good, for which non-use values are the predominant class of resource values, such that there preference ordering over these goods will coincide with a panel of experts. However, although this process appears to validate the CVM in the sense of the NOAA recommendations, it brings to light the question as to whether or not the level of information that effects the coincidence of the preference ordering still reflects that of the average individual, the preferences of whom should essentially be driving decisions made on the basis of CBA/CVM analyses such as these. These points has been raised by numerous authors. For example, Dunford *et al* (1997) and Johnson *et al* (2001) have argued that people with no or poor knowledge about the resource and/or its injury in fact do not have true non-use values. That is, the lack of such demand for information tells us something about the true preferences of these individuals. NUVs are defined as being a matter of conception, which in turn, their argument goes, involves some prior knowledge. Information acquisition activities involve opportunity costs are thus are indicators of ones interest in (or intensity of and preferences for) a particular natural resource. Respondents in CV studies that have not (endogenously) acquired such information nevertheless receive (exogenous) information from the study itself. The authors in essence are claiming that expressed non-use values from individuals with no prior or no intended demand to acquire information are somehow "induced'', constructed, "hypothetical" or even "fictional" preferences and that the subsequent estimated losses would not have occurred if the respondent had not been sampled. Hence, attempts to measure *aggregate* losses in NUVs over informationally unrepresentative sub-samples of larger populations may be inconsistent with the *revealed* knowledge and concerns of that population (Johnson *et al* 2001, p.61). In our case, the CV participants provided induced responses that cannot be generalised to the rest of the population that has very poor, if any, prior information about RMLs. Hence, using such estimates for aggregating non-use values for RMLs from individuals who may be argued that they have been driven into behaving like experts may not be representative of societal preferences, and thus may lead to prescribing socially sub-optimal resource allocations. There are various counter arguments to such a critique which are beyond the scope of this paper (see Swanson and Kontoleon 2002 for a discussion). Here, it suffices to say that the resolution of issues of the validity of providing information to CV respondents may depend on what the analysis intends to do with the results. It may be reasonable to argue that supplying information to respondents makes good sense in "traditional" non-use value studies designed to help policy makers evaluate the potential benefits of *policy alternatives*. These are *ex ante* studies of proposed changes and thus neither the entire number of constituents of a society nor the sample used in a stated preference study can have knowledge of the proposed changes. Yet, supplying information to respondents when the CV is to be used for *damage assessment* is much more questionable and the arguments raised by Dunford at al (1997) and Jonson et al (2001) are not easily addressed. Hence, it does note appear to be necessarily valid to provide additional information (such as that from experts) when assessing *ex post* compensation for actual welfare losses from a sample of respondents representing the general population (Dunford *et al* 1997) while it may be considered reasonable to provide such information for *ex ante* studies intended for policy evaluation.

Third, all of the additional information provided in this study was 'positive' or 'beneficial'; i.e. information about positive attributes of the lakes was provided in successive information levels. The theoretical validity of the effect of information on WTP estimates should be further explored by providing 'negative' information.

Finally, Boyle *et al* (1996) have recognised that "a lack of comparability between CV estimates and expert opinions does not refute the validity of CV. Experts are a self-selected group and there may be very good reasons why their opinions might differ from those of a sample of individuals responding to a CV survey". Yet, a comparison between CV and expert panel could trigger investigation as to the reason for this difference. There are many reasons why individual and expert opinions may differ. For example, one reason for such a divergence can be attributed simply to different preference structures between the two groups. In addition, Kuitinen and Törmälä (1994) and Kuo and Yu (1999) have empirically demonstrated that experts and uninformed lay-people focus on different attributes when evaluating the same environmental good. It is therefore likely that the ranking of ecological sites and/or environmental goods would produce a different order from the two sets of respondents. In the current study, however, we have seen that individual preferences and expert opinion coincided for the third information levels, i.e. when the information concerning the overall scientific interest was provided. Clearly the observed convergence is suggestive of a coincidence of the attributes considered important to individuals and experts. Table 2 suggests that the expert panel are more concerned with conserving these lakes and ascertaining their scientific value, almost exactly the information that was provided in level three of the CVM. This is likely to be driving the coincidence of the preference ordering. This results complements that found in Kenyon and Jones (1998) in which additional information about the ecological characteristics and services of ecosystems allowed individual preferences to coincide with expert opinion. Hence, using such auxiliary information from expert studies enhances both our understanding of how CV participants respond to survey questions as well as the credibility of the overall contingent valuation method. Clearly further research as to the importance of providing information about the ecological and systemic functions of environmental resource is warranted.

References

Ajzen I., Brown T. C., Rosenthal L. H., 1996. Information Bias in Contingent Valuation: Effect of Personal Relevance, Quality of Information and Motivational Orientation, Journal of Environmental Economics and Management, 30, 43-57

Anderson J. E., 1991. A Conceptual framework for Evaluating and Quantifying Naturalness, Conservation Biology, 5(3), 347-532, Elsevier, London.

Bergstrom J. C., Stoll J. R., Randall A., 1989. Information Effects in Contingent Markets, American Journal of Agricultural Economics, 71(3), 685-691.

Bergstrom J. C., Stoll J. R., Randall A., 1990. The Impact of Information on Environmental Commodity Valuation Decisions, American Journal of Agricultural Economics, 72, 614-621

Blamey R. K., 1998. Decisiveness, Attitude Expression and Symbolic Responses in Contingent Valuation Surveys, Journal of Economic Behaviour and Organisation, 34, 577-601.

Blomquist G. C., Whitehead J. C., 1998. Resource Quality Information and Validity of Willingness to Pay in Contingent Valuation, Resource and Energy Economics, 20, 179-196.

Boyle K. J., 1989. Commodity Specification and the Framing of Contingent Valuation Questions, Land Economics, 65, 57-63.

Boyle K. J., Welsh M. P., Bishop R. C., Baumgartner R. M., 1995. Validating Contingent Valuation with surveys of Experts, Agricultural and Resource Economics Review, October, 247-54.

Cameron T. A., Englin J., 1997. Respondent Experience and Contingent Valuation of Environmental Goods, Journal of Environmental Economics and Management, 33, 296-313.

Carvalho L., Anderson N. J., 2001. *Lakes*, in Warren A., French J. R., Habitat Conservation – Managing the Physical Environment, John Wiley and Sons, Chichester, England.

Chilton S. M., Hutchinson W. G., 1999. Exploring Divergence between Respondent and Researcher Definitions of the Good in Contingent Valuation, Journal of Agricultural Economics, 50(1), 1-16.

Cooper C. F., Zedler P.H., 1980. Ecological assessment for regional Development, Journal of Environmental Management, 10(3), pp.285-296

Edward-Jones G., Edward-Jones E. S., Mitchell K., 1995. A Comparison of Contingent Valuation Methodology and Ecological Assessment as Techniques for Incorporating Ecological Goods into Land-use Decisions, Journal of Environmental planning and Management, 38(2), 215- 230.

Fischoff B., Slovic P., Lichenstein S., 1980. Knowing What You Want: Measuring Labile Values, in Cognitive Process in Consumer and Decision Behaviour (ed Wallstein T. S.), Lawrence Erlbaum Associates, Hillsdale, New Jersey.

Freund J. E., Williams F. J., Perles B. M., 1988. Elementary Business statistics, Prentice-Hall international editions, Englewood Cliffs, New Jersey.

Friday L. E., 1988. The Conservation and Amenity Value of Ball-clay Ponds in the Isle of Purbeck, Dorset, Uk, Biological Conservation, 43, 165-180, Elsevier, London.

Fuller R. J., 1980. A Method for Assessing the Ornithological Interest of Sites for Conservation, Biological Conservation, 17, 229-239, Applied Sciences Publishers Ltd., England.

Gehlbach F. K., 1974. Investigation, Evaluation, and Priority Ranking of Natural Areas, Biological Conservation, 8, 79-88, Applied Science Publishers, England.

Goldsmith F. B.,1975. The Evaluation of Ecological Resources in the Countryside for Conservation Purposes, Biological Conservation, 8, 89-96, Elsevier, London.

Harrison G. W., Lesley J. C., 1996. Must Contingent Valuation Surveys Cost So Much?, Journal of Environmental Economics and Management, 31, 3179-3195.

Helliwell D. R., 1969. Valuation of Wildlife Resources, Regional Studies, 3, 41-47.

Helmer O., 1972. On the future state of the Union, Report 12-27, Institute for the Future, Menlo Park, California.

Hoevenagel R., van der Linden J. W., 1993. Effects of Different Descriptions of the Ecological Good on Willingness to Pay Values, Ecological Economics, 7, 223-238

Hoole A., Milne G., 1995. Defining the features of Sustinable Development for a Developing Country. The Zimbabwe Case. Journal of Environmental Planning and Management, 38(4), Newcastle upon Tyne, England.

Hutchinson, G.W. Chilton S. M., Davis J., 1995. Measuring Non-use values of environmental goods using the 0contingent valuation method: problems of information and cognition and the application of cognitive questionnaire design methods, Journal of Agricultural Economics, 46 (1), 97-112.

Kaplowitz M. D., Hoehn J. P., 2001. Do Focus Groups and Individual Interviews Reveal the same Information for Natural Resource Valuation?, Ecological Economics, 36, 237-247.

Kenyion W., Edward-Jones G., 1998. What Level of Information Enables the Public to Act like Experts when Evaluating Ecological Gooods?, Journal of Environmental Planning and Management, 41(4), 463-75.

Kenyon W., Edward-Jones G., 1998. What Level of Information Enables the Public to Act Like Experts when Evaluating Ecological Goods?, Journal of Environmental Planning and Management, 4184), 463-75.

Kenyon W., Hanley N., 2001. Economic and Participatory Approaches to Environmental Evaluation, mimeo.

Kontogianni A., Skourtos M. S., Langford I. H., Bateman I. J., Georgiou S., 2001. Integrating Stakeholder Analysis in Non-market5 valuation of Environmental Assets, Ecological Economics, 37, 123-138.

Kontoleon A, Swanson T M and Macrory (2001). 'Individual Preferences, Expert Opinion and Environmental Decision Making: An overview of the issues'. Paper presented at the Symposium on Law and Economics of Environmental Policy, UCL, 6-7 September 2001.

Kreisel W. E., 1983. Representation of the Environmental Quality Profile of a Metropolitan Area, Environmental Monitoring and Assessment, 4, 25-33.

Kuitunen M., Törmälä T., 1994. Willingenss of Students to favour the Protection of Endangered Species in a Trade-off Conflict in Finland, Journal of Environmental Management, 42, 111-118.

Kuo N-W., Yu Y-H, 1999. An Evaluation System for National Park Selection in Taiwan, Journal of Environmental Planning and Management, 42(5), 735-745.

Lazo K. J., Schulze W. D., McClelland G. H., Doyle J. K., 1992. Can Contingent Valuation Measure Nonuse values?, American Journal of Agricultural Economics, ??, 1126-32.

Linstone H. A., Turoff M., 1976. The Delphi Method, Techniques and Applications, Addison-Wesley Publishing company, London.

Ludlow J., 1976. Delphi Enquiries and Knowledge Utilization, in Linstone H. A., Turoff M., The Delphi Method, Techniques and Applications, Addison-Wesley Publishing company, London.

MacMillan D. C., Hanley N., Philip L. and Begona A., 2001. Valuing the Non-market benefits of Wild Goose Conservation: a Comparison of Individual Interview and Group-based Approaches, mimeo.

MacMillan D. C., Harley D., Morrison R., 1998. Cost-effectiveness analysis of Woodland Ecosystem Restoration, Ecological Economics, 27, 313-324.

Margules C., Usher M. B., *Criteria Used in Aseessing Wildlife Conservation Potential: a Review,* Biological Conservation, 21, 79-109, Applied Science Publishers, England.

May G. H., Green D. H., 1990. Planning for the Future: the Application of the Delphi Techniques to the Unitary Development Plan Process, CUDEM Working Paper Series: 7, Metropolitan Leeds University, Leeds.

Ratcliffe D. A., 1971. Criteria for the selection of Natural Reserves, Advancement of Science, 27, 294-6, Elsevier, London.

Richey J. S., Mar B. W., Horner R. R., 1985. The Delphi Technique in Environmental Assessment I. Implementation and Effectiveness, Journal of Environmental Management, 21, 135-146.

Roosen J., Hennessy D. A., 2001. Capturing Experts' Uncertainty in Welfare Analysis: an Application to Organophosphate Use Regulation in U.S. Apple Production, American Journal o0f Agricultural Economics, 83(1), 166-182.

Samples K. C., Dixon J. A., Gowen M. M., 1986. Information Disclosure and Endangered Species Valuation, Land Economics, 62(3), 306- 312.

Spash C. L., Hanley N., 1995. Preferences, Information and Biodiversity Preservation, Ecological Economics, 12, 191-208.

Spellerberg I. F., 1992. Evaluation and Assessment for Conservation: Ecological Guidelines for Determining Priorities for Nature Conservation, Chapman and Hall, London.

Spellerberg I. F., 1996. Conservation biology, Longman Group, Harlow.

Tans, W. 1974. Prority ranking of biotic natural areas, Michigan botanist, 13, 31-9, Michigan Botanist, University of Wisconsin, Oshkosh.

Tubbs C. R., Blackwood J. W., 1971. Ecological Evaluation of Land for Planning Purposes. Biological conservation, 3 (3), 1971, Elsevier, London.

Tversky A., Sattath S.,Slovic P., 1988. Contingent Weighting in Judgement and Choice, Psychological Review95, 371-384.

Whitehead J. C., Blomquist G. C., 1991. Measuring Contingent Values for Wetlands: Effect of Information about Related Environmental Goods, Water Resources Research, 27, 2523-2531.

Wonnacot T. H. and Wonnacot R. J. 1995. Introductory statistics, John Wiley and sons, Canada.

Wright D. F., 1977. A Site Evaluation Scheme for Use in the Assessment of Potential Nature Reserves, Biological Conservation, 11, 293-305, Elsevier, London.