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Contributed paper:

Establishing a benefits transfer database for biosecurity decision making on indigenous biodiversity

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Establishing a benefits transfer database for biosecurity decision making on indigenous biodiversity

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Key words:

Benefit transfer, database, biosecurity, biodiversity, decision support system

Abstract:

An imbalance of quantitative information on pest and disease impacts hampers biosecurity decision-making; there is relatively good information about impacts on industry, but relatively poor information about how society values the impacts on indigenous biodiversity. A benefits transfer process based on a database of choice experiments could help to redress this imbalance. This paper: briefly reviews four choice experiments that will be the foundation of a database; reviews benefit transfer literature; and sets out framework ideas for a Decision Support System (DSS), which will incorporate biodiversity values via a process for benefit transfer to facilitate more informed biosecurity decisions.

[1] Brian Bell is a Director, and Charlotte Cudby and Michael Yap are Consultants in Nimmo-Bell & Company Ltd; a Wellington based firm (www.nimmo-bell.co.nz).

Table of Contents

1. Acknowledgements

Nimmo-Bell & Company Limited is part of a wider team involved in this project, including Lincoln, Waikato and Auckland Universities. This paper in particular has also benefited from comments from Dr Geoff Kerr of Lincoln University for which we are very grateful.

2. Objective of paper & outline

This paper is one step in a wider project to develop a decision support system (DSS) to be used by Biosecurity New Zealand (BNZ) that will incorporate values of indigenous biodiversity into decisions on whether to respond to new pests.

We are at a crossroad in the project having successfully completed four choice experiments (CE) and reviewed benefit transfer literature; we are at the stage where we need to meet with BNZ to summarise what we have learned to date, and clarify their information needs for decision-making. But first we thought it useful to seek feedback and ideas from experts in this field here at AARES to inform that discussion (the primary aim of the paper).

The paper is set out as follows:

1. We introduce biosecurity decision-making and outline the problem that the DSS is set up to solve.
2. We summarise the four CE that were conducted in representative New Zealand ecosystems.
3. We note what we learned from our review of benefit transfer literature relevant to the DSS.
4. We describe current BNZ processes and how the DSS will interface with them.
5. **We outline some concepts for the DSS that we would like to discuss at AARES.**

3. Introduction

Biosecurity is defined as "the exclusion, eradication or effective management of *risks* posed by pests and diseases to the economy, environment and human health" (Biosecurity_Council 2003, p5). It is "a means to achieve outcomes such as the protection of primary production systems, human health, *indigenous flora, fauna and biodiversity* from harmful organisms and to maintain or improve ecosystem health" (Parliamentary Commissioner for the Environment 2000) (p.9 emphasis added).

In New Zealand, BNZ is the government agency responsible for dealing with pest incursions at the national level. They are guided by an Integrated Risk Management Framework (IRMF), based on formal risk management standards (AS/NZS 2004). It is an interdisciplinary process with a strong economic focus. BNZ's challenge with the IRMF is to balance economic, social/cultural and environmental aspects in their decisions for net social benefit.

But BNZ face an imbalance of quantitative information on pest and disease impacts that hampers their decision-making. There is relatively good information about market impacts, but relatively poor information about environmental values, particularly how society values impacts on indigenous biodiversity. It is the nature of decision making that quantitative information seems to receive greater weight than qualitative information and thus the imbalance is likely to result in decisions that under invest in areas where the benefits are difficult to quantify.

And so this project was born. At the outset, the project anticipated that marginal values of biodiversity would be sourced from a database of benefit transfer values covering a range of ecosystems at risk and possible pests. For new pest incursions, decisions need to be made quickly about allocating funds to combat a new pest or disease before it becomes established. This need for rapid decision-making initially provided the rationale for the use of benefit transfer as often there is not the time or funding to conduct original CE.

4. Four choice experiments

Four CE were carried out to begin populating a database of biodiversity values[2]; they were conducted in representative New Zealand ecosystems:

- High country (Kerr and Sharp 2007)
- Marine (Bell, Menzies, Yap and Kerr 2008)
- Beech forest (Kerr and Sharp 2008)
- Freshwater (Bell, Yap and Cudby 2009)

The study sites and pests were carefully selected in consultation with BNZ to ensure that the CE delivered information that would be useful for broader policy questions.

[2] Future CE may be conducted in the future to expand on the database.

The four CE used a common CE methodology and data collection method across all case studies, and they were conducted by the same team:

- Ecologists were consulted to ensure clear links between the pest incursion and what would be expected to happen in each ecosystem.
- Focus groups were used to identify salient attributes and levels, including for the money variable. Attributes were mainly passive existence values (e.g. for birds, fish, vegetation), but some were recreational use values important to the community (e.g. children able to paddle in the water).
- Data collection was done using face-to-face meetings organised by community groups (who were specifically asked to seek balanced representation in key socio-demographic (SDC) characteristics; e.g. gender, income, education, population, ethnicity). These meetings began with a background presentation by members of the project team to bring participants up to a common level of understanding about the key issues.
- Prior convenience sampling was used to test the questionnaire and improve the efficiency of the experimental design (using C-efficiency methods; e.g. see Scarpa and Rose 2008). Using this process statistically significant results were obtained from small survey samples.
- Sample locations were located near the study site, and away from the study site, and in a mixture of rural and urban locations to investigate whether distance decay effects were present.
- In each case the standard Multinomial Logit (MNL) model was used initially to analyse results. Further statistical models were then employed in an attempt to improve model fit and the statistical significance of the attributes; these included Heteroscedastic Extreme Value (HEV), Latent Class (LC) and Mixed Logit (ML) or Random Parameter Logit (RPL).

In the interests of space, this paper doesn't go into the details of the CE or the results but you are welcome to contact the team if you are interested (contact details in Section 8). Figure 4 (Section 7.1) briefly illustrates some selected results, in the context of developing the DSS components.

5. Review of benefit transfer

This section summarises some key points relevant to the project from an extensive review of benefit transfer literature[3].

Benefit transfer describes the use of information from previous research to inform decisions, and providing a formal process for this (Rosenberger and Loomis 2003). Desvousges *et al.* (1992) defined benefit transfer is the process where non-market values gained from a 'source study' can be used in some way to predict economic values at a 'target site' (transfer values). Decision-makers want to improve their decisions but are limited by time and cost. So transfer values for environmental attributes are in demand by decision-makers (Wilson and Hoehn 2006).

5.1. Types of benefit transfer

There are two broad types of benefit transfer:

- **Value transfer** – involves the direct application of point estimate summary statistics (e.g. willingness to pay (WTP) values) from the study site to the target site.
- **Function transfer** – involves the transfer of entire (demand, benefit or WTP) functions to the target site. These functions define relationships between vectors of data collected at the study site (Rosenberger and Loomis 2003). This type of benefit transfer results in new values have been adjusted for variations in site and population characteristics between the source and target site ((Kirchoff *et al.* 1997) and (Brouwer 2006)).

Meta-analysis can also be used for both types of transfer noted above. This is about synthesising a series of past studies, and the results used as inputs to the benefit transfer process (Wilson and Hoehn 2006). Meta-analysis, because it draws on many studies rather than just one, could be expected to result in more accurate benefit transfer; however, where a source study has measurement errors the benefit transfer process merely transfers these inaccuracies to the policy site (Brookshire and Neill 1992). Meta-analysis in this case could compound the transfer error.

In addition, the use of Bayesian methods has been suggested for benefit transfer, first by Atkinson *et al.* (1992) and has since been touched upon in other literature (Morrison and Bergland (2006), Rolfe (2006), Leon-Gonzalez and Scarpa (2008)). To our knowledge it has not yet been developed into a

[3] The reference and bibliography list (Section 9) includes all the literature reviewed even if the sources are not specifically cited in the paper.

workable model for practical use; a key reason being that the method is so complex it is not well handled by standard statistical packages (Rolfe 2006). Nevertheless, the concept continues to be explored by theoreticians and shows much promise to improve value estimates and benefit transfer processes in the future.

5.2. Reliability of benefit transfer

Loomis and Rosenberger (2006) note that differences between the source and target site create problems for the reliability and validity of benefit transfer. These differences can be categorised into three groups:

- Commodity aspects (physical differences between sites, and the impacts upon it);
- Market area aspects (people-related differences, e.g. SDCs, location of respondents relative to study site, demand preferences); and
- Framing issues (scope and scale differences, differences in welfare measure aspects[4], wider contextual issues such as politics, policy, seasonal/weather conditions).

All these differences may compound or offset each other so the resulting estimate is an approximation, at best.

Function transfers can partially account for differences in site and population. This is done by using the study site parameter/attribute coefficients[5] in the function/model while utilising summary statistics from the policy site (Rosenberger and Loomis 2003). Rosenberger and Loomis (2003) note that function transfers are <u>generally</u> considered to perform better than value transfers and this is backed up by empirical evidence. In addition, function transfers can be also be time-consuming and complex and the errors on function transfer can still be very large.

Many studies have been undertaken to test the validity of various benefit transfer approaches[3]. The most common approach is to compare a study site with a transfer site where the values for the transfer site were already known through previous CE. The general conclusion we found was that while benefit transfer can result in accurate transfer values, in most cases transfer errors (the difference between the transfer value and true value) were high, sometimes in the order of hundreds of percent value differences. Having said that, Colombo *et al.* (2007) suggest a first step is to understand what level of

[4] For example, WTP versus WTA constructs, payment vehicles, survey methods, statistical modelling methods.
[5] These represent the population's preferences for a given set of environmental conditions.

accuracy is required from the policy-makers perspective. A value transfer error of up to 30-80% may be considered acceptable particularly when the benefits clearly outweigh the costs (p148).

Benefit transfer is still an evolving discipline, and for choice modelling based benefit transfer is still relatively new. Benefit transfer processes are complex, and the literature does not provide authoritative advice on what constitutes accurate benefit transfer because the theoretical issues are still being worked through. As the following example shows, various studies often reach contradictory conclusions; in exploring the impacts of scope differences van Bueren and Bennett (2004) found significantly higher values at the regional level compared with national levels (up to 26 times, depending on the attribute measured). Windle and Rolfe (2007) conversely found some evidence that marginal values at the state level were higher than those from the regional surveys, but the differences were not statistically significant.

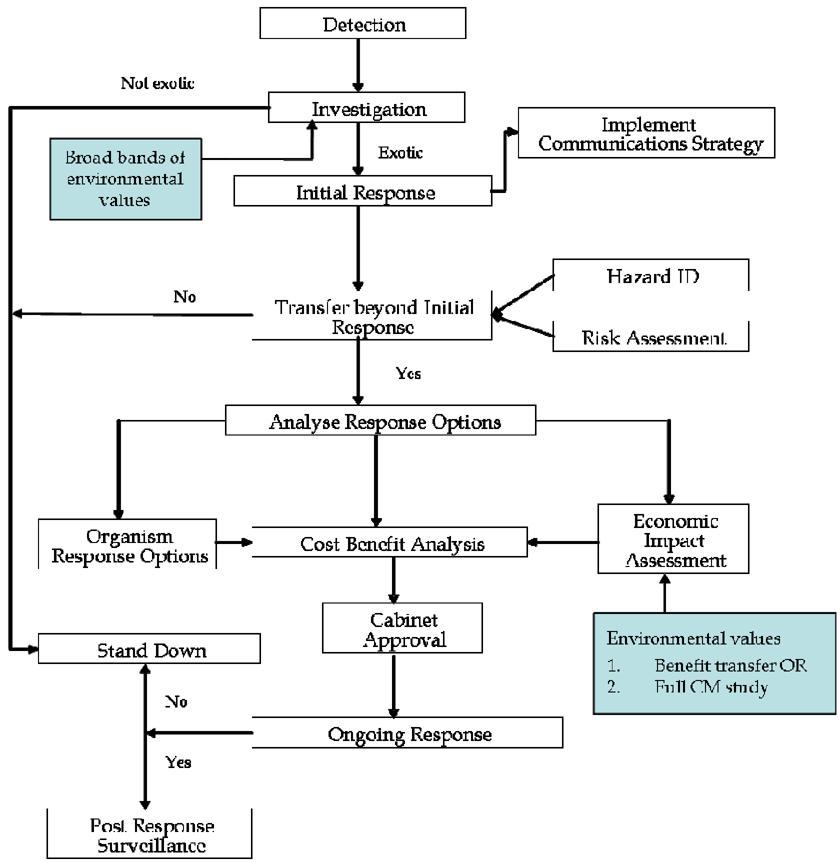
Uncertainly is and will always be fundamental to policy-making. McCollum (2003) emphasises the role for CE and benefit transfer is to contribute to more informed decisions. Yes, there are still uncertainties in the discipline, but the information generated is only one component of the decision-making process, sitting alongside a range of other information (scientific, market, etc). Non-market values help by clarifying trade-offs, identifying magnitudes of directions and effects, and providing new insights (e.g. identifying new stakeholders). So long as state-of-the art methods are used and any limitations are clearly identified and communicated, the decision-making process will be improved.

So what does all this mean for developing an operational DSS for BNZ that incorporates values of indigenous biodiversity? First let us look at how BNZ currently make decisions.

6. Current BNZ decision process

Figure 1 (over the page) is a high level flow diagram of the current BNZ decision process (based on the IRMF) used by analysts to guide them through decisions when a new pest is detected. The two additional shaded boxes are proposed new steps, which will be discussed later in Section 7.

Figure 1: BNZ decision process for new pest



SOURCE: Adapted from (MAF 2004)

The steps we are concerned with are:

- ***Detection*** - A new pest or disease is detected in New Zealand
- ***Investigation*** – A preliminary view is formed on the risks imposed by the incursion; this assessment is done quickly and is based on existing and readily available information.
- ***Initial response*** - A decision point informed by the ***investigation***. A decision must be made quickly so that funds can be allocated to rapidly combat a new pest or disease before it becomes established.
- ***Economic impact assessment*** and ***cost benefit analysis*** **–** these steps involve significantly more detailed analysis than ***investigation***, and lead to a cabinet decision about whether an ongoing pest management response will be funded. BNZ will only reach this stage if the risks to New Zealand are considered sufficiently high in relation to other risks (e.g. other pest impacts, other threats to the environment) that political decisions about these trade-offs are needed.

7. Incorporating biodiversity into BNZ decisions

Key requirements for building biodiversity into the DSS are that any new process:

- should interface with and augment the current BNZ response process; and
- should be able to be operated by BNZ staff who mostly have science backgrounds, but with some economic skills although they are resource constrained.

Initial discussions with BNZ support Freeman (2003) who contended that decision-makers want to know about the relative magnitude of benefit and cost estimates, the relationships between different environmental attributes, and the extent of uncertainty in the information, rather than the precise point estimates of value. Ultimately any changes to the existing DSS design will be driven by needs and capacity of BNZ.

Therefore as a priority the next step is to consult with BNZ about:

- *what are information needs of BNZ decision-makers* in terms of the policy questions they face every day? For example, what frame (scope) will decisions be made in (local, regional, national, all of these)? What spectrum of attributes and impacts will be important?
- *what level of specificity and accuracy is required in biodiversity values for confident decisions* to be made (both for ***initial response***, and ***economic impact assessments)***, recognising the time and cost trade-offs for decreasing uncertainty? In other words, how significant will the biodiversity values be in influencing a 'go'/'no go' investment decision?
- *what level of complexity is acceptable* in the new DSS considering the average analyst's background and capacity (mainly scientific backgrounds rather than economics, resource constrained (time and money))?
- To *what extent* should the DSS *link into BNZ's existing IT programmes*?

7.1. Input to Investigation

At the early stage of the response process ***investigation*** needs to be rapid with no time for primary research (such as conducting a CE). Reliance must be made on existing information. We suspect that conducting benefit transfer at this stage may well be too complex, costly and time-consuming. At this stage, all that is needed is an initial first order estimate of the value lost to inform the preliminary view about the possible quantum of impact on biodiversity and how the majority of society feels about that.

A concept – grouping similar attribute impacts into broad value bands

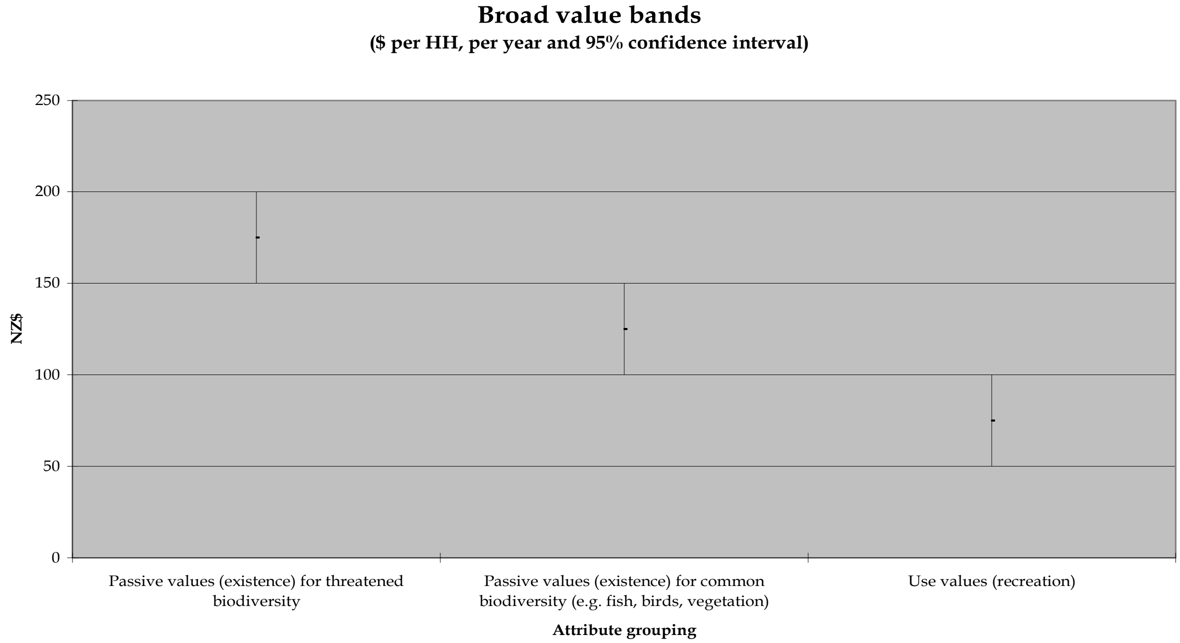
As the body of CE and benefit transfer research grows, we are starting to see trends emerging in the environmental values that have been measured. For example, use values tending to reduce the further away from the study site, as opposed to existence values having less variation. There are many more examples in the literature, but as far as we can tell the research tends to be case specific rather than exploring the existence or not of generic trends across attribute types.

Our concept is whether values for certain types of environmental attributes can be categorised and grouped into **broad bands.** This grouping exercise could be done where the values and their confidence intervals are significantly greater than zero. We contend that where rapid decisions are imperative, such broad value bands would provide sufficient information for high level decisions to be made, bearing in mind economic values are but part of the information required for informed decisions, albeit an important part.

These broad bands would represent the orders of magnitude for societies' values about certain pest **impacts on biodiversity**. Benefit transfer literature emphasised a focus on impacts rather than the environmental asset in question (Rolfe 2006, van Bueren and Bennett 2004). Van Bueren and Bennett (2004) in particular suggested that "provided the physical impacts in the source study are similar in type to those at the target site, these attribute values can be transferred to a target site and reassembled to produce an estimate of the total welfare impact at the target site". Such an approach would open up the scope of relevant CE to those that measured impacts on biodiversity more broadly, rather than a narrow focus on pest impacts,.

Figure 2 (over the page) provides a simple illustration of the idea. These broad bands should be further distinguished by scope (e.g. local versus national frame).

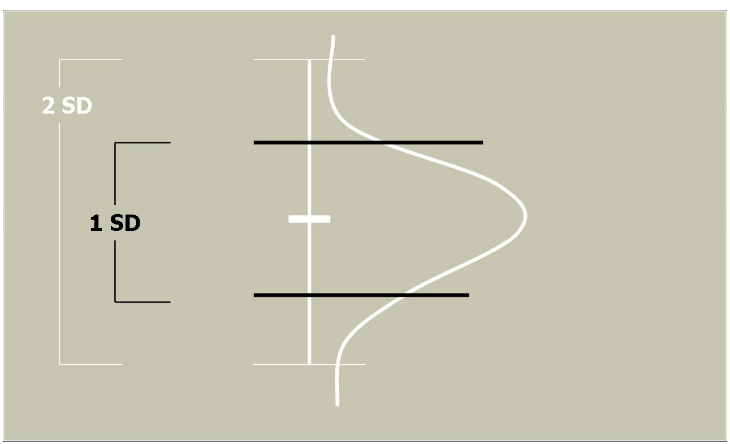
Figure 2: Broad value bands (simple example of concept)



What constitutes the 'majority' opinion in BNZ's view?

BNZ needs to know the range of biodiversity values held by the 'majority' of the community. Given the diversity in the population, this is best represented by a confidence interval - not just a WTP - assuming preferences are normally distributed. Refer to Figure 3; the question is whether BNZ consider the 'majority' opinion as being represented by one, two or even three standard deviations (SD). The trade-off being that while narrow confidence intervals are useful for making decisions, they may not reflect a wide enough range of community views.

Figure 3: 'Majority' opinion represented by confidence intervals

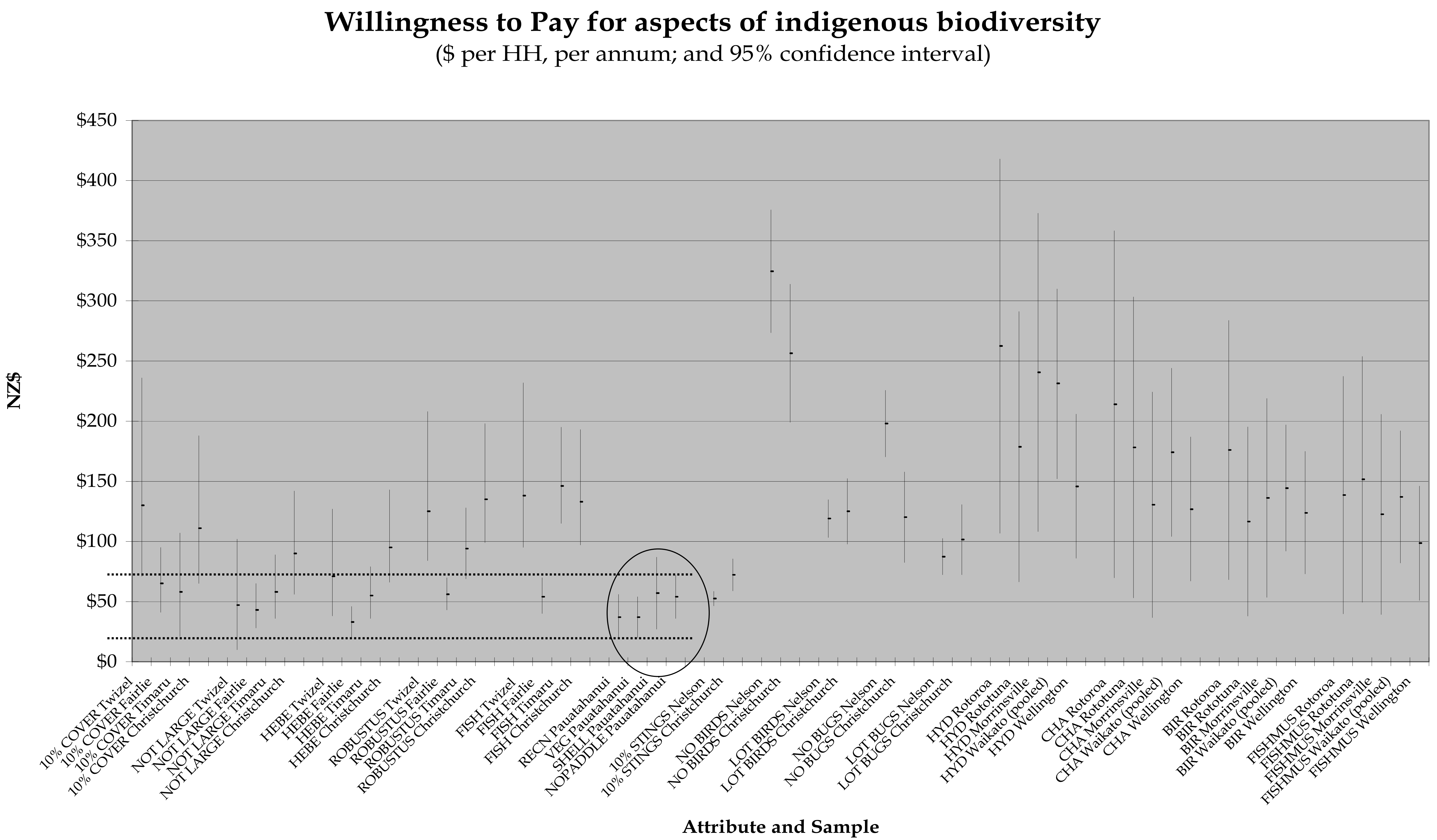


Grouping the data from our four CE

Figure 4 (over the page) presents a graph with some selected results from our four CE. To develop this idea for broad value bands, we need to see whether any of these WTPs can be grouped together. As an example, look at the circle drawn around the coastal marine data case study data. The WTP confidence intervals for those attributes are relatively similar (they all overlap). In particular we have drawn a **band** through the two recreational attributes – fishing (left side) and children paddling in the water (right side) – representing the upper and lower 95% confidence limits. We could say in this case that **coastal marine biodiversity for recreational use** is worth somewhere between $20 and $70.

As we include more studies in this analysis over time, we expect to have increasing confidence in the broad bands that are developed. The broad value bands could be further developed / tested by drawing on other existing CE using benefit transfer methods (e.g. meta-analysis of other studies impacting on biodiversity). In addition, expert and stakeholder testing may improve the concept.

Figure 4: Willingness to pay for aspects of indigenous biodiversity



Important to ensure the data is comparable first

But to develop this concept the first step is to ensure our data is comparable. The four CE were indeed designed to be comparable; as described in Section 4 earlier, a common methodology and data collection method was used across all case studies, and they were conducted by the same team, over similar timescales where economic conditions were buoyant.

Nevertheless, there are a range of other factors that need to be looked at:

- The *comparability of the econometric models*; and what are the tradeoffs we make by looking at MNL versus Mixed Logit, for example. While some models have greater explanatory power, they can have much wider confidence intervals. What is most important here for BNZ?
- The *units of measurement*. For example, can we compare attributes that measured many birds (which represents abundance) with more precise numbers of species facing local extinction? Also, we will need to look into the range of attribute changes over which the estimates are valid.
- *Adjusting data for differences in payment vehicle timeframes*; for example, the WTP values in Figure 4 represented values per household per year for five years in all case studies except the Coastal Marine, which used three years.

  > One approach could be to use present values. But we would then need to consider what discount rate to use – would a 10% New Zealand treasury rate be justified given the uncertainty involve and level of risk acceptable to New Zealanders in regard to biodiversity impacts?

- Dealing with *different attribute impact timeframes.* For example, the High Country case study looked at impacts on biodiversity over 20 year timeframes, because wilding pines (the case study pest) grow over long time periods. On the other hand, the other three case studies used five year timeframes for impacts.
- Could we develop a *simple coding system on ecological impacts to help with 'categorising' the information* and also to understand the types of sites the information could be transferred to (Clayton pers. com. 2008)? For example with the Freshwater case study, we measured a Lake that was most at risk from the pest, Hydrilla, an underwater weed. That and similar lakes could be rated 5 (worst impact) versus other lakes where Hydrilla's impacts may not be so bad (e.g. deep glacial lakes) could be rated 1.

How would this idea work in practice?

Returning to the example given earlier on page 13; '**coastal marine biodiversity for recreational use'** broad band with a range of $20-$70 per household per annum: Say a pest was detected in New Zealand which impacted on this broad attribute type. BNZ would first consider the extent of those impacts; how many estuaries around New Zealand would be impacted (i.e. local impact, regional impact, national impact). If the impact was expected to be localised, to five estuaries for example, then the broad value band could be extrapolated to determine a national value (because our CE were local in scope). However, the final figure would only represent New Zealanders views about impacts to those five estuaries.

An outstanding question if we are to operationalise this idea, is whether scale will be important in this extrapolation exercise. Much of the benefit transfer literature noted that scale impacts were not significant when considering – for example – catchments of different sizes (e.g. Windle and Rolfe 2007). Would this not also apply to impacts over five estuaries being not statistically different from impacts on one estuary, so long as the utility function can realistically be assumed to be linear (no diminishing marginal utility)? The flip side to this is that one would expect values to show increasing marginal utility when the impacts on biodiversity became sufficiently large (national level impacts, for example).

So if the pest was expected to have national impacts, then extrapolating broad value bands developed in the local frame would not be appropriate. What we don't know is what constitutes 'sufficiently large biodiversity impacts'. One option (budget permitting) could be to re-do some or all of the case study samples in the national frame – an idea worth floating with BNZ in the next stage of our work.

7.2. Input to Economic Impact Assessment

Following the ***investigation*** stage, an ***economic impact assessment*** is conducted to quantify pest impacts in dollar terms for the ***cost benefit analysis***.

The key question for BNZ is whether the information generated by the broad bands idea is sufficient for this stage, or will more detailed biodiversity values be needed? If the latter, then there are two options for this stage of the DSS:

- Use benefit transfer (where values are not available from previous CE); and/or
- Conduct a full CE.

Even if BNZ would prefer to conduct benefit transfer (over a full CE), benefit transfer methods may not necessarily be appropriate for a variety of reasons (e.g. lack of studies, problems with study quality, different impacts and scales measured, framing differences).

Likewise, if benefit transfer can be appropriately conducted, a decision will also be needed about whether the non-market value information is adequate for cost benefit analysis or whether a full CE should be undertaken. The criteria to make this judgement call include whether:

- The uncertainty in the value falls within the acceptable range from a policy perspective
- The value transfer information is comprehensive enough to cover the range of relevant non-markets benefits and/or costs
- The benefits clearly outweigh the costs or visa versa, and
- There is time and money available to carry out a specific non-market study.

Depending on BNZ's needs and capacity, they may be able to carry out the benefit transfer or CE internally, but it is more likely given capacity and time constraints that the work would be contracted out.

Guidelines will be required whichever option is preferred

For either conducting benefit transfer or a full CE, we would propose developing guidelines to ensure state-of-the-art theory and practice are followed, and also to ensure that interpretations across analysts can be as consistent as possible. It will be important that any new studies not only generate robust value information, but also contribute to any key gaps in the policy requirements of BNZ, and contribute to future benefit transfer processes.

Indeed, much of the literature calls for standardisation of CE and benefit transfer processes and/or the development of good practice protocols that could reduce variability in their application (e.g. Bateman *et al.* (2000), Brouwer (2000), Rosenberger and Loomis (2003), Bergstrom and Taylor (2006), Rosenberger and Stanley (2006)). Summarising some of the ideas put forward, a benefit transfer protocol should include:

- Standardised minimum set of variable categories to be reported with clear definitions and using the same scales for those variables; for example:

- Attributes: indirect/passive and active use, and within those (for example), existence value types (e.g. endangered species versus commonly found biodiversity) and recreational use types.
- SDCs: gender, age categories, household income, dependent children, occupation and educational level, ethnicity, distance between respondent's home to the site
- Attitudinal indicators: for e.g. household composition, relationship with the environment (leisure, passive), relative importance of environmental issues, support for community interests.

- Guidelines for data collection, analysis and reporting, including standardised forms to ensure consistency between studies.
- Clearly defined steps for conducting benefit transfer (directing analysts to the state-of-the-art theory and models that should be used), including specific decision-support guidance on:
  - The practical steps in assessing the study site and policy site context;
  - The appropriate **type** of benefit transfer to be used;
  - Testing and adjusting for framing effects.
- Use of a common global database for non-market valuation (NMV) studies.
- Methodologies for dealing with uncertainty in a range of areas; including but not limited to physical environmental impacts, inter-temporal aspects, and the use of sensitivity analysis.
- Interdisciplinary collaborations e.g:
  - Working with ecologists (and psychologists) to ensure the link between output variables and policy variables is accurate, and uncertainty in natural science information is appropriately taken into account.
  - Involving stakeholders in verifying transfer values and to achieve buy-in to the benefit transfer process. Where NMV and benefit transfer are contracted out, this will especially include the decision makers and policy analysts.

To our knowledge formal, agreed protocol(s) still do not exist today; however, the raw material exists for standardised and best practice CE and benefit transfer processes (e.g. in Rosenberger and Loomis (2003), Rolfe and Bennett (2006)), but it needs to be brought together in <u>one</u> easily accessible place and in an appropriate form for <u>practical use</u> by all analysts working in the field.

In addition, care needs to be taken in explaining the decision makers how to interpret value estimates such analysis such that conservative estimates remain realistic.

7.3. Benefit transfer database

At the outset of the project it was envisaged that biodiversity values for decision-making would be drawn from a 'biodiversity value database'. After a thorough internet search we now believe this may not be necessary. There are number of existing databases around, and the CE and benefit transfer literature makes a plea to researchers to use them more extensively as a way of helping develop the discipline.

In particular, the Environment Canada/US EPA Environmental Valuation Reference Inventory™ (EVRI™; available at http://www.evri.ca/) appears to be the main global repository for NMV studies with a key purpose being to facilitate benefit transfer[6].

So rather than duplicate this resource the DSS could interface with it in some way; e.g. an analyst/contractor could simply access the database manually or there may be a way to link existing BNZ information technology (IT) systems with the database through software. Having said that, we expect there would still be significant work required to convert the current web-interface to something useful for policy analysts and decision-makers in their everyday work; we would need to discuss this with BNZ's IT team.

8. Conclusion and next steps

This paper represents a work in progress. We are in the last year of a project to develop a DSS based on a database of biodiversity values. We have successfully completed four CEs and are now exploring the state-of-the-art in benefit transfer.

The next priority step is to clarify a number of issues with BNZ (identified throughout the paper) around; decision needs, level of detail and accuracy in the values, the acceptable level of complexity in any new processes, and any operational requirements (e.g. IT related).

[6] There are two key modules; one to search for available studies, and one to screen those studies for benefit transfer. The database organises study information in a consistent and comparable format, using eight major data areas; Geographic, Population, Environment, Timescale of data, Economic measure, Estimated values, Abstract and Complete study.

But first we took the opportunity to present this paper at AARES to seek feedback on some of our high level ideas before meeting with BNZ – particularly the broad value bands concept.

Please feel free to contact the authors of this paper to share your views[7]:

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9. References & bibliography

AS/NZS (2004) Risk Management. (Ed. SAaSN Zealand). (AS/NZS 4360:2004).

Atkinson S, Crocker T, Shogren J (1992) Bayesian exchangeability, benefit transfer, and research efficiency. *Water Resources Research* **28**, 715-722.

Bateman IJ, Day B, Georgiou S, Lake I (2006) The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP. *Ecological economics* **60**, 450-460.

Bell BA, Yap M & Cudby C (2009) Assessing the marginal dollar value losses to a freshwater lake ecosystem from a hypothetical aggressive weed incursion. Nimmo-Bell & Company Ltd, Working Paper No. 6, Wellington.

Bell BA, Menzies S, Yap M, & Kerr GN (2008) Assessing the marginal dollar value losses to an estuarine ecosystem from an aggressive alien invasive crab. In 'AARES 52nd Annual Conference' p. 32 Canberra ACT).

Bennett J (2006) Choice Modelling and the Transfer of Environmental Values. In 'Choice Modelling and the Transfer of Environmental Values'. (Eds J Rolfe, J Bennett) pp. 1-9. (Edward Elgar Publishing Limited: Cheltenham).

Bergland O (2006) Benefit Transfer: A Hierarchical Bayesian Approach. (Asia-Pacific School of Economics and Government, The Autralian National University, Canberra.

Bergstrom JC, Taylor LO (2006) Using meta-analysis for benefits transfer: Theory and practice. *Ecological economics* **60**, 351-360.

Biosecurity_Council (2003) *Tiakina Aotearoa* Protect New Zealand: the Biosecurity Strategy for New Zealand.

Brookshire DS, Neill HR (1992) Benefit transfers: Conceptual and empirical issues. *Water Resources Research* **28**, 651-655.

Brouwer R (2000) Environmental value transfer: State of art and future prospects. *Ecological economics* **32**, 137-152.

Brouwer R (2006) Do stated preference methods stand the test of time? A test of the stability of contingent values and models for health risks when facing an extreme event. *Ecological economics* **60**, 399-406.

Brouwer R, Bateman IJ (2005) Benefits Transfer of Willingness to Pay Estimates and Functions for Health Risk Reduction: a Cross-Country Study. *Jouranl of Health Economics* **24**, 591-611.

Brouwer R, Langford IH, Bateman IJ, Crowards TC, Turner RK (1997) A Meta-Analysis of Wetland Contingent Valuation Studies. Centre for Social and Economic Research on the Global Environment, UK Economic and Social Research Council, CSERGE Working Paper No. GEC 97-20, London.

Brunsdon C, Willis K (2002) Meta-analysis: a Bayesian approach. In 'Comparative Environmental Economic Assessment'. (Eds P Nijkamp, K Willis, R Florax) pp. 208-231. (Edward Elgar: Cheltenham, UK).

Colombo S, Calatrava-Requena J, Hanley N (2007) Testing Choice Experiment for Benefit Transfer with Preference Heterogeneneity. *American Journal of Agricultural Economics* **89**, 135-151.

Desvousges WH, Naughton MC, Parsons GR (1992) Benefit transfer: Conceptual problems in estimating water quality benefits using existing studies. *Water Resources Research* **28**, 675-683.

Freeman AMI (1984) On the tactics of benefit estimation under Executive Order 12291. In 'In Environmental policy under Regan's Executive Order: The role of Benefit-cost Analysis'. (Ed. VK Smith). (The Univ. of North Carolina Press: Chapel Hill, NC).

Freeman AMI (2003) Economic Valuation: What and why. In 'A primer on nonmarket valuation'. (Eds PA Champ, KJ Boyle, TC Brown) pp. Ch1, 1-25. (Kluwer Academic Publishers: Dordrecht, The Netherlands).

Jiang Y, Swallow SK, McGonagle MP (2005) Context Sensitive Benefit Transfer Using Stated Choice Models: Specification and Convergent Validity for Policy Analysis. *Environmental and Resource Economics* **31**, 477-499.

Johnson FR, Kanninen BJ, Bingham M, Ozdemir S (2007) Experimental design for stated choice studies. In 'Valuing enviromental amenities using stated choice studies: a common sense approach to theory and practice'. (Ed. BJ Kanninen) pp. 159-202. (Springer: Dordrecht).

Kerr GN, Sharp BMH (2007) The Impact of Wilding Trees on Indigenous Biodiveristy: A Choice Modelling Study. AERU, Research Report No. 303, Lincoln.

Kerr GN, Sharp BMH (2008) Biodiveristy Management: Lake Rotoiti Choice Modelling Study. Agribusiness & Economics Research Unit, Research Report No. 310, Lincoln, New Zealand.

Kirchoff S, Colby B, LaFrance J (1997) Evaluating the performance of benefit transfer: an empirical inquiry. *Journal of Environmental Economics and Management* **33**, 75-93.

Leon-Gonzalez lR, Scarpa R (2008) Improving Multi-Site Benefit Functions Via Bayesian Model Averaging: A New Approach to Benefit Transfer. *Journal of Environmental Economics and Management* **56**, 50-68.

Leon C, Vasquez-Polo F, Guerra N, Riera P (2002) A Bayesian Model for Benefit Transfer: Application to National Parks in Spain. *Applied Economics* **34**, 749-757.

Leon C, Vazquez-Polo, Leon-Gonzalez lR (2003) Elicitation of Expert Opinion in Benefit Tranfer of Environmental Goods. *Environmental and Resource Economics* **26**, 199-210.

Loomis JB (1992) The evolution of a more rigorous approach to benefit transfer: benefit function transfer. *Water Resources Research* **28**, 701-705.

Loomis JB, Roach B, Ready R (1995) Testing the transferability of recreational demand models across regions: a study of Corps of Engineers reservoirs. *Water Resources Research* **31**, 721-730.

Loomis JB, Rosenberger RS (2006) Reducing barriers in future benefit transfers: Needed improvements in primary study design and reporting. *Ecological economics* **60**, 343-350.

Louviere JJ (1991) Experimental Choice Analysis: Introduction and Overview. *Journal of Business Research* **23**, 291-297.

MAF (2001) Biosecurity Council - Policy statement on responding to an exotic organism incursion. (Ed. MBN Zealand) p. 17.

MAF (2003) The Biosecurity Strategy for New Zealand. (Ed. MBN Zealand).

MAF (2004) Biosecurity integrated risk management framework. Ministry of Agriculture and Forestry, Guide No., Wellington.

McCollum D (2003) Nonmarket Valuation in Action. In 'A Primer on Nonmarket Valuation'. (Eds PA Champ, KJ Boyle, T Brown). (Kluwer Academic Publishers: Dordrecht).

McFadden D (1986) The Choice Theory Approach to Market Research. *Marketing Science* **5**, 275-297.

MOH_and_MAF (2000) Food administration in New Zealand: a risk management framework for food safety.

Morrison M, Bennett J (2004) Valuing New South Wales Rivers for use in Benefit Transfer. *Australian Journal of Agricultural and Resource Economics* **48**, 591-611.

Morrison M, Bennett J, Blamey R, Louviere JJ (2002) Choice Modeling and Tests for Benefit Transfer. *American Journal of Agricultural Economics* **84**, 161-170.

Morrison M, Bergland O (2006) Prospects for the use of Choice Modelling for Benefit Transfer. *Ecological economics* **60**, 420-428.

Parliamentary_Commissioner_for_the_Environment (2000) New Zealand under siege: a review of the management of biosecurity risks to the environment.

Ready R, Navrud S (2006) International benfit transfer: Methods and validity tests. *Ecological economics* **60**, 429-434.

Rolfe J (2006) Theroretical issues in using choice modelling data for benefit transfer. In 'Choice modelling and the transfer of environmental values'. (Eds J Rolfe, J Bennett). (Edward Elgar: Cheltenham, UK).

Rolfe J, Bennett J (2006) 'Choice Modelling and the Transfer of Environmental Values.' (Edward Elgar: Cheltenham, UK).

Rosenberg, Loomis JB (2001) Benefit transfer of outdoor recreation use values: a technical document supporting the forest service strategic plan (2000) revision. US Department of Agriculture Forest Service, Rockey Mountain Research Station
Gen. Tech. Rep. No. 72, Fort Collins, CO.

Rosenberger RS, Loomis JB (2003) Benefit transfer. In 'A primer on nonmarket valuation'. (Eds PA Champ, KJ Boyle, TC Brown) pp. Ch.12, 445-482. (Kluwer Academic Publishers: Dordrecht).

Rosenberger RS, Phipps TT (2001) Improving the validity of benefit transfers: a site correspondence model and meta-analysis transfer. West Virginnia University, Regional Research Institute and Division of Resource Management, Morgantown, WV.

Rosenberger RS, Stanley, T.D. (2006) Measurement, generalisation, and publication: Sources of error in benefit transfers and their management. *Ecological economics* **60**, 372-378.

Scarpa R, Rose JM (2008) Design efficiency for nonmarket valuation with choice modelling: how to measure it, what to report and why. *Australian Journal of Agricutural and Resource Economics* **52**, 253-282.

Shrestha RK, Loomis JB (2001) Testing a meta-analysis model for benefit transfer in international outdoor recreation. *Ecological economics* **39**, 67-83.

Smith V, Van Houtven G, Pattanayak S (1999) Benefit Transfer as preference calibration. Resources for the Future, Discussion Paper No. 99-36, Washington DC.

Spash CL, Vatn A (2006) Transferring environmental values estimates: Issues and alternatives. *Ecological economics* **60**, 379-388.

van Bueren M, Bennett J (2004) Towards the development of a transferable set of value estimates for environmental attributes. *Australian Journal of Agricutural and Resource Economics* **48**, 1-32.

VandenBerg T, Poe GL, Powell J (2001) Assessing the accuracy of benefits transfers: evidence from a multi-site contingent valuation study of groundwater quality. In 'The Economic Value of Water Quality'. (Eds J Bergstrom, KJ Boyle, GL Poe). (Edward Elgar: MA).

Wilson, M. A., Hoehn JP (2006) Valuing environmental goods and services using benefit transfer: The state of the art and science. *Ecological economics* **60**, 335-342.

Windle J, Rolfe J (2007) Developing a benefit transfer database for environmental values in Queensland. In '51st Annual Australian Agriculture and Resource Economics Society Conference'. Queenstown, New Zealand p. 21p.

Woodward RT, Wui Y-S (2001) The economic value of wetland services: a meta-analysis. *Ecological economics* **37**, 257-270.