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Valuing natural assets

Essential for decision making

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Key points

New Zealand producers and consumers get much value from natural assets. Much of this value is intangible. This is a fundamental reason to make special effort to measure the value of natural assets, to make sure we make the right decisions about their use and conservation.

But a key barrier to using economic valuation is the cost and uncertainty of values obtained from the variety of techniques being used. This is a real issue, to the extent that doubts are being expressed in resource management cases whether economics has much to add when considering environmental effects.

To remove this barrier, valuations need to be cheaper and easier to compare. A standardised technique could provide relative values for different types of natural asset or service. This would make economic value estimates from across a range of natural asset settings more consistent.

Developing a practical, reliable standardised technique would involve:

- building on studies done to date, showing how much economic activity depends on natural assets in a robust and comparable way
- carrying out a meta-analysis, to obtain consistent and comparable value estimates for a range of ensure economic activities from economic impact studies done to date
- learning how biophysical cause-and-effect relationships translate into economic value, to identify the sensitivity of economic activity to changes in natural assets, such as biodiversity
- commissioning a stated preference study of the value of broad categories of natural assets, as a starting point for identifying value in specific situations.

Decision-makers need to understand how and where economic valuation can support their decisions. Providing them with explanatory materials will help.

It is important to make progress. There is currently a gap in the knowledge about the full contribution of natural assets to New Zealand's economic well-being. This creates a risk that natural assets will be undervalued. Ecosystems and the valuable services they provide may be lost or damaged.

Economic valuation of environmental assets can fill the knowledge gap. To date, non-market valuations in New Zealand do not appear to have been used much to make management choices in conservation, whether those relate to responding to pest incursions or to economic development.

A less ad hoc approach to weighing up the value of natural assets can make treatment of natural assets more consistent in decisions, and increase the efficiency of use of natural resources.

A better approach is needed so studies inform policy and decisions about New Zealand's natural assets. Our proposed approach could improve understanding of the value of natural assets—giving them more consistent weight in decisions, and improving the way we manage them.

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1. Development decisions need proper economic valuation

Decisions over whether or not to allow development of natural resources can have a major impact on peoples' lives. For some, a new development means job prospects and a higher standard of living. For others it means pollution, loss of native wildlife and a lower standard of living.

Regardless of whether a development goes ahead someone is likely to be worse off. Decision-makers need to be able to weigh relative impacts, costs and benefits, to determine whether or not conservation or development will be beneficial overall. This means conducting proper economic evaluation of choices and trade-offs.

This report lays out the case for proper economic valuation of resource decisions including their impacts on the environment and provides recommendations for how that should be done.

1.1. The record to date has been poor

In New Zealand, decisions are often made without proper economic valuation. The Resource Management Act (RMA) routinely requires the weighing of proposals aimed at enhancing job prospects against the effects on the physical environment. Yet it is common for economists and legal teams to confine themselves to tangible matters that can be easily measured – jobs, wages, and tax payments. This leaves those presiding over hearings to weigh up the balance between economic gain and environmental harm, relying on implicit rather than explicit valuations.

The Government is considering RMA reform, in part because of the problems that arise when the judiciary is left to determine values or policy, a role more appropriately played by publicly accountable, elected representatives. The idea is that more policy guidance and less judicial judgement will reduce costs associated with uncertainty in resource management decisions.

The Government's goals in RMA reform are important but most of the problems with the RMA relate to execution rather than design, or from a lack of guidance on execution. There has been:

- considerable uncertainty about what's required to give effect to the Act's requirements and resulting inconsistency in economic methods used
- a reluctance to use techniques to assess the relative economic value of adverse effects on the environment and potential mitigation and remedies.

This situation is not peculiar to the RMA. They arise in other areas related to natural assets.

Conservation supports prosperity in New Zealand, which at present is difficult to show beyond pointing to revenue earning activities from the DoC estate, such as from tourism, providing film backdrops and occasional mining.

The Department of Conversation (DoC), as the country's largest landholder with nearly a third of its terrestrial area under its control, is particularly exposed to development proposals that encroach on its areas. It is thus vulnerable to the lack of a standardised approach to assessing the economic value from conservation.

Debates related to natural areas often consist of polar opposite perspectives with little attempt to conduct a reasoned evaluation of the economic issues at hand including the value of services provided by New Zealand's conservation estate, who should pay for those services, and whether funding is being directed to best use.

1.2. Proper valuation goes beyond GDP

Debates about the economics of a resource development decision often focus on an activity's contribution to gross domestic product (GDP), per capita income, or unemployment rates. This is a very limited interpretation of the issues involved in development decisions and of economics. Proper valuation goes beyond GDP to consider market and non-market impacts.

Conventional 'economic impact analysis' of a development, in terms of effects on output, income and employment, does not fully reflect effects on consumer welfare from negative environmental effects, whether in terms of pollution, species loss or loss of the range of valuable services provided by natural areas, such as pollination or water quality.

Proper valuation means a decision-supporting framework such as cost benefit analysis, designed to gauge effects on welfare. This requires non-market effects to be valued and brought into analysis wherever feasible to do so.

1.3. Comparability and consistency are key

In weighing up the consequences of resource use choices, some things are more readily measurable than others. Focussing on the more tangible matters, by omission of the less tangible, distorts decisions on resource use.

When a prospective development or land use has commercial market value, such as a wind farm or mining development, the value of that development is often quantified in terms of job opportunities or export value. The costs of development, whether in terms of pollution or depletion of natural resources, are more often than not evaluated on an entirely different basis.

This lack of comparability in the way that impacts are assessed dramatically increases the prospects for capture of policy and regulatory processes by groups involved in the decision making process. It also means that decisions are likely to depend on the subjective sympathies of decision-makers for one particular set of values over another – whether they be conservation or development values.

Under these conditions decision making becomes a lottery.

Often, money is a very useful metric for comparing trade-offs. Although people value the natural environment in many ways and for different reasons, describing this value in monetary terms, where possible, provides a common yardstick of the weight of people's preferences for comparison with other uses of resources.

1.4. This is core government business

Valuation which goes beyond GDP should be core government business. The private sector is much better placed than government in dealing with the GDP side of the ledger – generating jobs and judging return on investment. At the same time, people's well-being depends not just on tangible matters like GDP but also on intangible aspects of quality of life, including the condition of the natural environment and its effects on human activity. If governments want to improve well-being they must go beyond GDP.

Government is one of the better placed entities for maximising the value of intangible contributions to quality of life. These intangibles are not necessarily safeguarded by private sector interactions because they suffer from coordination problems and market failures.

They may not be subject to market exchange, but they still have economic consequences. For instance, although outdoor recreation on beaches and in forests may be "free", its pursuit still entails participants spending money and time. So a loss of opportunity affects well-being by denying their preferences and requiring them to spend more to find equivalent recreation elsewhere.

These non-market benefits are likely to be given little weight by private bodies that cannot recover the value from those benefits. Consequently, the market will under-supply them. This is an age-old economic policy insight and one which demands that proper evaluation of development decisions is a core part of government business.

Getting this right is one way in which government can facilitate improved economic performance.

New Zealand's natural environment underpins its economy, it is the source of its primary production and attracts tourism. But without the valuation techniques described in this report, the value of New Zealand's natural assets is not known. Only a small part of value is apparent in the common economic accounting measures. Natural assets like parks and reserves appear to be worth less than other activities that convert such assets to some other use than conservation.

1.5. Difficulties do not excuse poor valuation

Economic valuation is not straightforward. This does not justify doing away with analysis and assuming that judgement is the only way forward. Unfortunately, conventional wisdom seems to take the opposite view.

There is a widespread view among practitioners (including some economists) in the Environment Court and resource management hearings that uncertainties in economic valuation mean economists have nothing to add to the consideration of environmental effects. This view surfaced in recent Court decisions on the Denniston Mine and the Mount Cass Windfarm.

As cases taken for determination by these hearings can have serious implications, the uncertainty over economic valuation is a problem needing remedy rather than an issue to be excluded from consideration.

Economics and economists won't always have something useful to say on the value in the environment. Or they may only be limited to offering qualitative analysis and judgement. But that should not prevent us from at least valuing natural assets where we can and making decisions about resource use in an ordered and evidenced manner.

Economic valuation is not going to replace judicial judgements with the tyranny of technocrats. In practice, judges will still be left making decisions which, implicitly or explicitly, determine competing values and interests for natural resources. If adjudicating over a consent dispute over damming a river valley for hydro-generation or leaving it in its current form, the decision one way or the other inevitably says something about the relative value of the river in its natural state or converted for electricity generation. Such decisions are difficult to make because there are no market values for all of the community benefits provided by the river, for fishing, kayaking or just as habitat for watchable wildlife.

This does not mean we should ignore these judgements about value. When made in a knowledge vacuum, such decisions can be widely variable with respect to apparently similar situations, reflecting the experience of the different decision-makers and their interpretation of each case.

1.6. What would it take to improve?

This paper provides an outline of how to improve economic valuation of development decisions and policy making which affects the natural environment.

We start from a conceptual basis, laying out the case for viewing the natural environment in terms of natural assets, as a means of focussing the mind on the intangible values in the environment.

Section 2 discusses the range of values that come into play when thinking about the environment and natural resources as a collection of 'natural assets'. Values captured by economic valuation of natural assets reach well beyond simple product and commodity values, though this is often overlooked by policy makers and a sceptical public.

Section 3 gets down to brass tacks, discussing methods for valuing natural assets in practice. None of these are perfect. Section 3 provides guidance on the relative strengths and weaknesses of methods and their usefulness for decision-making. Readers who have little interest in practical application should skip this section.

In Section 4, we return to the policy and political landscape and describe the institutional, operational, and ethical issues which have raised barriers to proper economic valuation of natural assets.

With a mind on improving policy practice, the concluding section of the paper sets out steps that should be taken to improve the valuation of natural assets and ensure that development decisions are made on the basis of proper economic valuation.

2. The value in natural assets

This section explains:

- how to think about the value we obtain from natural assets
- why natural assets are so important for New Zealand
- why we must make the right decisions about conserving or using our natural assets.

'Natural assets' include land (or fragments of land) in an unmodified natural state, rivers, lakes and marine foreshores, and the species found on them. It includes highly tangible resources such as mineral deposits and less tangible resources such as clean air.

Viewing things as 'assets' is partly semantic but it has the important function of focussing the mind on natural resources as stocks or stores of value. They have value because they produce beneficial services. It underscores that, like other assets, they can be built up (invested in) or depleted or destroyed and that often times multiple assets come together to provide value that is greater than the sum of its parts.

2.1. Value comes from the services provided

The value of these assets is best explained in terms of the 'services' they provide.[1] When viewed from the perspective of service provision it is clear that natural assets have an economic value. They produce commodities that are valued in markets, or perform functions that would be costly to obtain in the absence of their ecological provision.

It is relatively straightforward to identify the value of services when they are reflected in prices of goods and services traded in markets. But in the environmental area there are often no readily observable prices.

Non-market valuation techniques have been devised to fill that gap that market valuations do not cover. Methods for valuing natural assets have been well-established in the economics profession for many years.

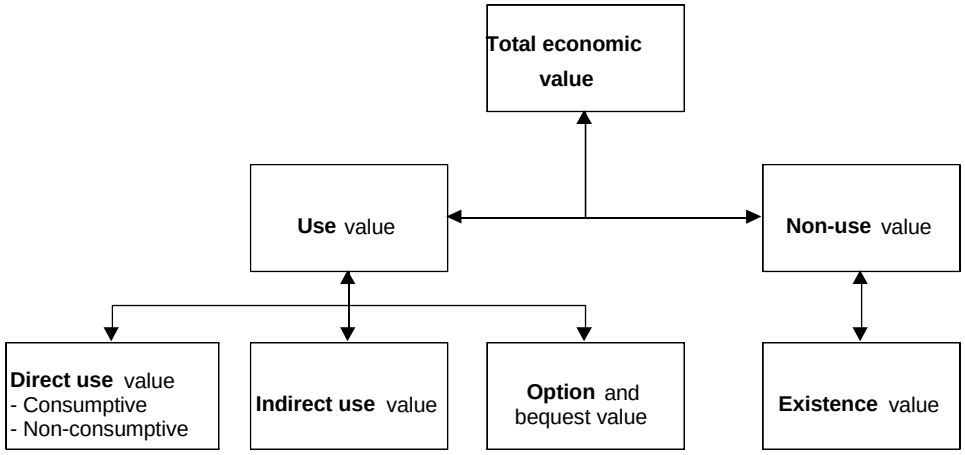
2.2. More than just money

A *natural assets perspective* does not restrict the value of ecosystem services to the kinds of values found in money and markets. The value to people of natural assets and ecosystem services can take a number of forms (Figure 1). Furthermore, these values are not often separable.

The overall value or "Total Economic Value" of natural assets comprises use values, future use values and non-use values.

[1] This approach has been widely adopted following publication of the Millennium Ecosystem Assessment (MEA) in 2003, by the United Nations. The MEA assesses the consequences of ecosystem change for human well-being and establishes the scientific basis for action needed to enhance the conservation and sustainable use of those systems. This involved more than 1,360 experts worldwide whose findings, contained in five technical volumes and six synthesis reports, provide a state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide.

Figure 1 Total Economic Value comes from use values, future use values and non-use values



Source: NZIER, Pearce & Warford 1993, Pagiola 2004

2.2.1. Use values

Use values reflect the benefit from using an asset. This use can be:

- direct use, whether commercial (e.g. timber and tourism) or non-commercial (e.g. recreation, health and safety)
- indirect use (functional) values, most often related to environmental services that support or protect economic production, consumption, or assets (i.e. regulating services).

2.2.2. Future use values

Future use values reflect the value of retaining an asset without using it (yet). They include:

- option value: the value of retaining the option of using a resource in the future, including potential increases in value due to e.g. increasing scarcity or new technology
- quasi-option value: the value of retaining a resource until future information reduces uncertainty over its potential value
- bequest value: the value of retaining a resource not in anticipation of future use but for passing on to future generations.

2.2.3. Non-use values

Non-use values (sometimes called passive-use values) reflect the enjoyment derived from an asset's existence (e.g. cultural benefit of heritage protection).

Non-use existence values include the regret felt when landscape elements, species or their habitats are irretrievably lost, whether motivated by aesthetic, cultural or ethical concerns for other species and future generations.

We can use these aspects of value to understand the trade-offs between environment conservation and development.

A development will not proceed unless it is expected to deliver net commercial value, and this provides a tangible market value in support of the proposal. Any impact on the environment may cause some loss of market value, but much of the environmental benefit is non-market value, which is less tangible.

Including non-market values in the impact estimate will focus on aspects that can be easily valued. In some cases that may be sufficient to demonstrate that the proposed development is not such a good prospect after all, if it creates environmental cost that offsets its commercial benefit.

Economic valuation may not provide a complete or definitive answer for all difficult choices affecting use of the natural environment, as it is not always feasible to convert all environmental effects into dollar values. Some effects are difficult to value because of insufficient knowledge about ecosystems, or uncertainties over long term impact and recovery.

Decision-makers will unavoidably resort to weighing these effects in non-monetary ways, but the more that can be valued, the greater the likelihood that the decision is good for society, and consistent across decisions.

Box A takes a closer look at one generic natural asset – biodiversity.

Box A: Biodiversity an example of a natural asset

Biodiversity is important both because of the services it provides and its role as an indicator of broader environmental well-being.

Biodiversity is the variety of life, and can be observed at a number of levels:

- diversity of genetic material within living organisms
- diversity of species present within a particular territory
- diversity of natural communities of species and functioning ecosystems.

In essence, biodiversity is a measure of the health of natural systems or quality and quantity of natural assets. Biodiversity preservation is important to human well-being because: (i) people derive utility from seeing wildlife and other components of biodiversity (direct use value), or knowing that it survives somewhere (existence value); (ii) biodiversity contributes to resilience of ecosystems and to the sustained yield of ecosystem services (indirect use value); (iii) biodiversity contains genetic material sources for food and pharmaceuticals (direct use value) or potential future commodities (future use value).

A loss of genetic diversity or biodiversity in nature could mean a loss of new pharmaceuticals. Large numbers of existing pharmaceuticals are derived directly from natural products, such as aspirin – derived from Willow bark – and the anti-cancer drug paclitaxel – derived from yew trees (TEEB, 2011).

Biodiversity issues in New Zealand are characterised by endemic species, susceptibility to pests and predators, and protection of areas that are mostly less 'useful'.

New Zealand has a high degree of endemism, i.e. species which have evolved to a form found nowhere else. This underpins the priority accorded to indigenous species (DoC & MfE 2000). Protecting indigenous biodiversity also contributes to global biodiversity and New Zealand's obligations under international agreements

Endemic species' evolution over long periods of isolation often makes them susceptible to introduced pests and predators. This means it is insufficient to simply reserve areas and await their reversion to biological diversity. Provision needs to be made for their on-going management.

Faced with limited resources to deploy against multiple threats, it is important to allocate resources against different threats to maximise the overall benefits.

This is a role that economic valuation can serve in assessing biosecurity activities against unforeseen threats and incursions by pests. It can equally be used to weigh up the importance of potential encroachments onto natural assets by deliberate developments. To date, however, non-market valuations in New Zealand do not appear to have been used much for the purpose of prioritising of action in such areas.

See Appendix A for a snapshot of New Zealand's biodiversity.

3. A primer on valuation methods

This section outlines different valuation methods, drawing on recent international literature. It looks at the benefits and drawbacks of each method, and which situations they are useful for.

A range of methods can be used for valuing natural assets.[2] Most of these methods relate to values that are difficult to measure—non-commercial use values and non-use or existence values. Most often estimates of economic value reflect attempts to measure people's willingness-to-pay (WTP): what people give up to secure something provides a lower bound indicator of what the particular goods and services are worth to them.

Valuation methods can be grouped into:

- economic impact estimates
- market-based and cost-based methods
- non-market methods
- benefit transfer techniques.

3.1. Economic impact estimates

Economic impact estimates track the effect of an injection of funds for an environmental purpose in a local economy (e.g. from conservation agency spending or the spending of tourists visiting natural areas). They trace the way the initial stimulus flows through to subsequent spending and enhanced demand for other sectors in the economy.

Economic impact estimates – commonly associated with the value of national parks or other facilities – do not address the total economic value of these natural assets. They are useful for showing the inter-linkages within the economy and the way in which activity on natural assets stimulates business in other sectors that supply or service those assets, measured as additional outputs, value added or employment numbers.

But these economic impact estimates take no account of externalities that may detract from the beneficial stimulus, and commonly do not measure consumers' surplus. With respect to individual natural assets, impacts are most significant at the local than at the national level.

[2] There is an extensive literature on environmental valuation in general, and on conservation in particular. The literature reviews state-of-the-art applications (OECD 1994) relates it to economic impact and efficiency analysis techniques (Peterson et al 1992), and examines particular applications to environmental issues (de Fries and Pagiola 2004). Early recognition of the sources of positive value for unpriced environmental resources (Krutilla 1967) led to consideration of the way in which such values change over time (Fisher et al 1974) and a range of refinements in techniques to estimate such values.

3.2. Market methods

Measuring value of ecosystem services is relatively straightforward when they produce goods and services with a market value.

There are many market-based and cost-based methods. They include:

- valuing marketable produce at market prices
- estimating a production function for how the value of outputs varies with change in the input of an environmental factor
- valuing an ecosystem service at the value of the next best alternative source of the same service (e.g. natural pollination valued at the cost of applying artificial pollination)
- valuing an ecosystem at the cost of replacing it with an ecosystem of equivalent function at some other location.

However, such methods do not cover all of the non-use and non-commercial values of ecosystem services, and hence understate total economic value of natural assets.

Cost-based methods also understate the total value of resources, for similar reasons. But non-market valuation looks beyond the market measures to assess the economic surpluses for both consumers and producers associated with the services from the natural asset.

3.3. Non-market methods

Non-market valuation methods fall into two groups: revealed preference methods which infer a value for a good or service from the value of associated marketed goods and services, and stated preference methods which use questioning to elicit people's values.

The three main methods for **revealed preference** valuation are:

- travel cost analysis, inferring the value of specific recreational sites from analysis of actual travel costs incurred from those using the site
- hedonic pricing, which applies regression analysis to house prices to isolate a variable premium for some environmental quality (like proximity to parks)
- hedonic travel cost method, which infers the value of sites for recreation from statistical analysis of travel costs to a variety of sites from a given origin.

The two main kinds of **stated preference** technique are:

- contingent valuation which elicits preferences for a single bundled environmental feature
- choice modelling, which elicits preferences for variations in attributes of an environmental feature, yielding relative values for each attribute.

Stated preference studies are adaptable and widely applicable. But they are complex in execution, and there are questions over their validity. Stated preference does not connect well to people's actual well-being or welfare because they do not reflect actual choices and trade-offs.

Stated preference studies are unlikely to be adopted more widely unless they can be improved. It may be necessary to steer the focus of these studies away from individual sites or species to examining public willingness-to-pay for broad classes of natural resources within the conservation area, and using this to frame questions about specific sites (Dixon 2008).

The process of non-market valuation received wider recognition following the 1989 Exxon Valdez oil spill. A panel of experts (including two Nobel laureate economists) concluded that stated preference methods could be useful in certain conditions:

> *These require that respondents be carefully informed about the particular environmental damage to be valued, and about the full extent of substitutes and undamaged alternatives available...*[3]

The panel provided a set of recommendations for valuations suitable for use in judicial settings (NOAA 1993). But such valuations do not come cheap, and the practical usefulness of such methods divided opinion at the time (Diamond & Hausman 1994, Portney 1994), and continues to do so (Carson 2012, Haussman 2012, Kling et al 2012).

This is not to say these techniques have no uses, but rather that they have limitations that need to be taken into account when interpreting their results. These limitations influence the way they can be used.

For instance, the value of natural assets for recreation depends on the local markets they serve, the tastes, preferences and income of the people they attract and the availability of substitute recreation spaces nearby. These are factors that non-market valuation does not handle consistently, so it is unrealistic to expect such studies to yield values for recreation that are valid across the country. More widely valid results requires a collection of studies that apply consistent techniques across a variety of sites that can be subjected to meta-analysis to isolate the effects of different influential variables.

3.4. Benefit transfer

Because of the complexity and expense of undertaking environmental valuation, interest has grown in what is known as 'benefit transfer'. This entails applying an economic value estimate from one site to a similar project at a different site.

The simplest approach is transferring unit values (such as a value per visitor day). Studies have shown, though, that people may have quite different values for different sites.

An alternative is to estimate a demand function from one site and transfer that to the new site with local variables appropriate to that site. For example, recreation value could be a function of local population, distance from the site and the availability of alternative sites. This function can be transferred from one site to the next to reflect differences in these contextual characteristics.

The importance of site context points to the danger of relying on results from international studies to infer value for a local resource. Conditions, tastes and opportunities may be quite different between countries.

[3] Source: http://www.darrp.noaa.gov/library/pdf/cvblue.pdf.

3.5. Data requirements and practical limitations

The different environmental valuation techniques have different data requirements, as summarised in Table 1 below. This table outlines the approach of each technique, the applications for which it is most suitable, its data requirements, its limitations, and the type of services it can cover.

Economic valuation depends on a firm biophysical basis on which to set the scenarios. This makes overcoming deficiencies in that area a higher priority than expanding the range of monetary valuations based on hypothetical questioning.

Until the limitations with stated preference studies are overcome, there is probably some mileage in revisiting simpler cost-based valuations. In some cases of marginal choices, cost-based valuations may be all that's required to demonstrate a positive value for protecting natural assets against transformation.

Cost-based valuations also have a role in comparing the costs of biodiversity offsetting against the cost of damage being incurred. They should also be considered for the supply side of the choices that need to be made.

At present, biodiversity offsetting is beset by the problem of ecological equivalence. Improved understanding of what's required to achieve equivalence and sustain it could remove some of the uncertainty around offsetting proposals.

Table 1 Valuation methods: uses, requirements and limitations

Methodology	Approach	Applications	Data requirements	Limitations	MEA Applications
Market methods					
Value of outputs	Estimate volume and value of marketable output	Any marketable output: timber, hunting rights, water rights, tourist services	Sales volume and representative prices	Confined to marketable goods and services	Provisioning
Cost based methods					
Productivity change	Trace impact of change in environmental services on goods produced	Any impact that affects production of goods and services	Change in service; impact on production; net value of goods and services produced	Data on change in service and link to impact on production often deficient	Provisioning
Cost of illness; human capital	Trace impact of change in environmental services on morbidity and mortality	Any impact that affects health (e.g. air or water quality) or the likelihood of accident	Change in service; impact on health (dose-response function); cost of illness; value of life	Dose-response functions often lacking; under-estimates by omitting health preferences	Regulating
Replacement costs (and variants e.g. Relocation cost)	User cost of replacing the lost good or service; next best alternative	Any loss of goods or services	Extent of loss of goods or services; cost of replacing them; risk of less than full success in replacing service	Tends to over-estimate actual value in many circumstances especially if building in contingent for risk	Provisioning, Regulating, Supporting, Cultural
Revealed preference methods					
Hedonic pricing	Extract effect of environmental factors on price of goods that reflect those factors	Property price analysis with respect to air quality, scenic beauty, open space, cultural benefits; also analysis of risk premiums in wages	Prices and characteristics of goods	Requires large data sets to control for all variables influencing the price; very sensitive to model specification	Regulating, Cultural

Methodology	Approach	Applications	Data requirements	Limitations	MEA Applications
Travel cost analysis	Derive demand curve from data on actual travel costs between origins and a single site	Recreation	Survey site users to collect monetary and trip time costs and distance travelled	Limited to recreational benefits; problematic when applied to multi-site trips	Cultural
Hedonic travel cost method	Derive demand curve from data on actual travel costs between an origin and several sites	Recreation (or any other origin-destination travel)	Data on travel patterns and costs across the district of interest	Requires extensive data on both travel activity and characteristics of different sites that affect their demand	Cultural
Stated preference methods					
Contingent valuation method	Ask respondents directly their willingness-to-pay for a specified service (e.g. Protection of species, landscape, water supply)	Any service	Survey that presents scenario and elicits willingness-to-pay for specified service	Many sources of bias in responses; guidelines exist to improve reliability, but critically depends on framing the right question	Provisioning, Regulating, Supporting, Cultural
Choice modelling (and variants like con-joint analysis, contingent ranking)	Ask respondents to choose their preferred option from sets of multi-attribute alternatives to derive a price for each attribute	Any service	Survey of respondents that presents the options and variation in key attributes	Analysis of data generated is complex; critically depends on how the question is framed	Provisioning, Regulating, Supporting, Cultural
Other methods					
Benefits transfer	Use results obtained in one context in another similar setting	Any for which suitable comparison studies are available	Valuation exercises at another similar site; using any of the above methods	Can be wildly inaccurate as many factors can vary even when contexts seem similar	Provisioning, Regulating, Supporting, Cultural

Source: NZIER, adapted from de Fries and Pagiola, MEA (2003)

3.6. Choosing amongst approaches

Different questions all require slightly different valuation approaches, although there are certain common threads between them in how they account for different effects associated with the natural environment.

As indicated earlier, economic valuations can be useful in addressing four broad categories of question:

- the total value contribution of environmental assets to the national economy
- the net benefits in value terms of a change in environmental condition
- how the costs and benefits fall on different stakeholders due to changes in environmental condition
- the value of environmental condition to those with most interest in its upkeep.

Identifying the value contribution of natural assets such as the network of national parks generally requires an estimated aggregate value of economic activity associated with those assets. However, this doesn't tell us how much that contribution would change if the configuration of the parks were changed (e.g. some area converted to other economic activities).

Such choices require a marginal valuation of the likely changes, which falls into the area commonly addressed by an economic cost benefit analysis. The last three bullets are focussed on marginal changes and could be informed by a cost benefit analysis.

3.6.1. The total value contribution of natural assets

Total value contribution can be addressed narrowly or broadly—in terms of the national economic accounting framework, or a more complete picture of impacts on human well-being. The linkage between human well-being and national accounting is not straightforward. GDP includes both consumption of produced goods (yielding direct benefits for current well-being) and investment in physical capital (yielding future benefits for well-being).

Many factors, including the enjoyment of environmental amenities, are not captured in the value of consumption recorded in the national accounts. But recent advances in the theory of environmental accounting show that there is a direct link between the change in the value of all assets (including produced and natural assets) and the present value of social well-being. Declining asset values, measured at current shadow prices, imply future declines in social well-being (de Fries & Pagiola 2004).

Economic impact and multiplier studies provide a base from which to assess total value contribution (DoC 2006). They estimate the *direct* expenditures associated with the natural assets that are injected into the local economy, and further *indirect* economic activity stimulated as demands for inputs and uses for outputs flow through the economy. The flow-on effects are summarised in economic multiplier coefficients. The direct impacts include the spending on providing facilities and maintaining natural assets, and those of businesses whose operations depend on them. These activities are principally tourism-related, but also include other resource-related activities such as fishing.

Such economic impact and multiplier studies give a snapshot of natural assets' contribution to measured economic activity. But they give little guidance on the likely results of changes in the management or availability of the natural assets. This is because, unless the change is very small, there are likely to be also changes in the demand for, and price of, inputs in the local economy resulting from a change in natural assets. This will result in resource inputs being reallocated across sectors and changing the input-output relationships on which multipliers are based. The multipliers then over-state the net gain in flow-on effects.

Supporting and regulating ecosystem functions from natural assets also contribute to other economic sectors (such as agriculture) by relieving them of some costs they would otherwise incur. While in principle it is possible to estimate these benefits and add them into an extended contribution to the measured economy, in practice this is not so easy.

For example, a natural area's contribution to reducing flooding, reduces the measured GDP contribution of sectors that deal with flood recovery. But in practice, it also enables those who avoid flood damage to increase their consumption or investment in other areas. So it is difficult to determine these relationships across sectors and in different areas, and difficult to estimate their total contribution. These wider contributions are more readily examined as marginal values of specific changes in the natural assets.

3.6.2. The value of changes in environmental condition

Assessing the value of changes in natural assets moves from the frame of economic impact analysis to cost benefit analysis. Looking at these changes (e.g. a change in the area covered by such assets or in the management practice), specification of a "do nothing" baseline and an alternative is an essential part of the analysis. Cost benefit analysis is concerned with the economic surpluses generated over time from a change. Cost benefit analysis looks beyond expenditures to economic welfare components and draws on the full range of valuation techniques described in this report.

Table 2 illustrates the range of different techniques applicable to different ecosystem services derived from natural assets. Those at the top are grounded in observed market behaviour, but the link becomes weaker moving down the table. This shows stated preference techniques are most versatile.

Table 2 Matching of valuation method to ecosystem services

		Provisioning					Supporting					Regulatory				Cultural				
		Food	Fibre	Water	Minerals	Soil formation	Nutrient cycling	Pollination	Soil erosion	Water quality	Water flows	Micro-climatic	Carbon sequestration	Recreation activity	Tourism activity	Amenity	Biodiversity	Scientific/education	Cultural/spiritual	
Valuation techniques	Market prices	●	●		●								●		●					
	Productivity change					●	●	●	●	●	●	●			●					
	Cost based	●	●	●	●	●	●	●	●	●	●	●								
	Revealed preference - travel cost													●						
	Revealed preference - hedonic pricing															●				
	Contingent valuation	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
	Choice modelling	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	

Source: NZIER

3.7. An analytical and empirical framework

Table 3 provides an organising framework to show what's currently known about the economic values associated with natural assets, to identify gaps, and to identify ways of filling them most effectively.

One step in applying the framework is to compile information consistent with the system of national accounts—identifying the measureable outputs and inputs associated with natural assets such as parks and reserves. Existing studies by DoC of selected national parks and facilities provide a starting point for this. Extending this across the entire portfolio of conservation lands will give a better handle on the level of economic activity associated with these assets.

Another step is to extend the information to cover two more factors that are not directly covered by the national accounting measures—the externalities associated with these assets, and the non-market consumer benefits from non-commercial provisioning and recreational access. The externalities can be both positive or negative. The value of these can mostly be estimated using productivity or cost-based approaches, but they are critically dependent on the biophysical information about the effect of changes.

The valuation of non-market consumer benefits can also be used to address the value of externalities (such as public preferences for retaining natural features). However, these techniques need to be used in a different way than has been common in the past—to avoid sources of bias and to provide answers to a different set of questions.

In particular, valuation techniques need to:

- estimate public willingness-to-pay for broad classes of conservation assets, rather than specific sites and species
- present realistic options for the choices being considered, such as the effect on natural attributes' chances of survival, rather than willingness-to-pay to "save" a species
- show that respondents are aware of alternative uses of their money when framing their responses, rather than focusing on a single issue
- test the robustness of the survey results, such as by subjecting some responses to deliberative processes to verify the numbers stated in survey responses.

This may mean commissioning specific non-market valuation studies. These need to be carefully designed so they provide information with the widest possible application for policy purposes. They must focus on policy usefulness rather than the requirements of academic achievement.

The process also requires assembly of reliable biophysical data to guide 'with/without' scenarios. Both cost-based and stated-preference valuations will depend on these scenarios.

Table 3 Our framework for compiling valuation data

	Ecosystem services			
	Provisioning	**Supporting**	**Regulating**	**Cultural**
	Grazing & timber, mining, sphagnum moss, water collection, generation & transmission facilities etc.	Nutrient cycling, pollination, water cycling	Water flow moderation, sediment and run-off control, micro-climate	Tourism & recreation, film backdrop, Science & education, Heritage
SNA components ($M)				
Value of Outputs $	30			30
- Value of Inputs $	17			15
= Value Added $	13			15
Comprising				
Employee compensation	2			7
Fixed capital consumption	3			2
Indirect taxes	1			2
Concession fee	2			1
Operating surplus	5			3
Welfare components				
Positive externalities (avoided costs)		Pollination, soil replenishment	Reduced cost of flood damage and water treatment	
Non-market consumer surplus	Non-commercial collection			Non-commercial access
- Negative externalities (pest harbourage etc.)	Cost on adjacent activities			Loss of pure preference
Supply components				
Operational costs	8			5
Capital costs (annual)	5			3
Cost recovery (fees etc.)	-2			-1

Note: Some cells can be filled more readily than others; provisioning and cultural services often have specific outputs and fit relatively easily in the SNA frame.

Supporting and regulating services often enhance other sectors' output and are much more complex to measure and place into this type of framework.

Source: NZIER

4. Barriers to better valuation

There are three principal barriers to better valuation in New Zealand:

- **limited empirical evidence on non-market values which is useful** for policy development and decision-making
- **insufficient institutional incentives** for policy makers and officials to seek new information or refine existing information which is useful for non-market valuation
- **ethical objections** from a range of stakeholders which limits the political usefulness of economic valuation.

All three barriers are mutually reinforcing and need to be overcome if we are to improve the state of valuation in New Zealand.

4.1. Limited evidence on non-market values

Lack of valuation studies is often cited as a gap in policy development documents. This is only partly true. The number of studies conducted in New Zealand is low in absolute terms (see Figure 2). On a per capita basis, however, New Zealand has a high number of valuation studies.

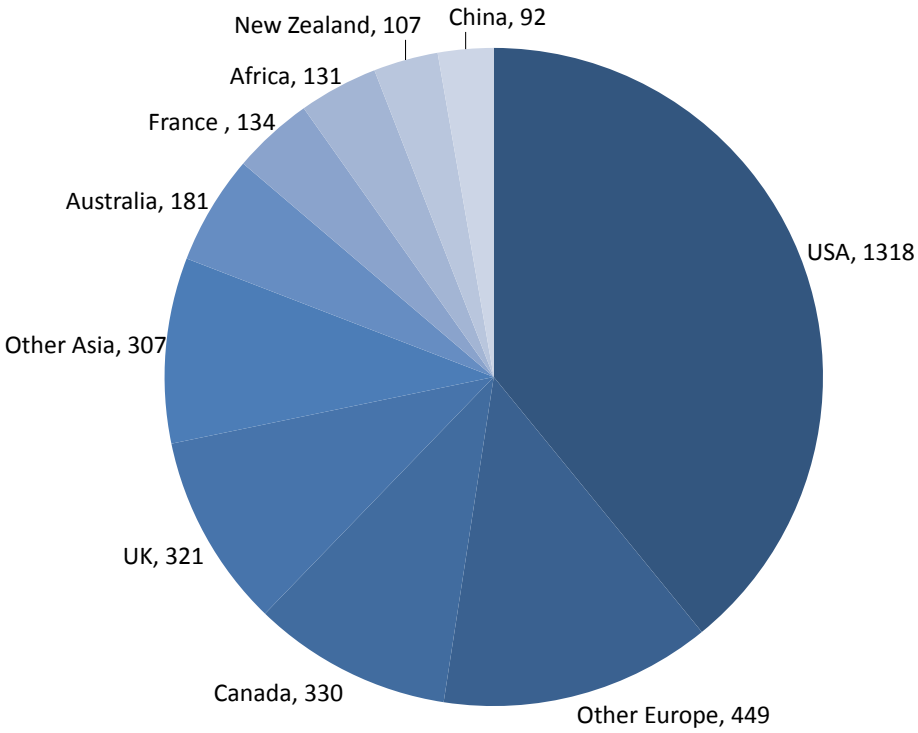
It is questionable how influential these studies have been (and whether they have been read outside of commissioning agencies, academia and Crown Research Institutes).

The key issue is that there are few studies conducted for the purposes of policy development and consequently the size of the evidence base which is useful is much smaller the absolute size of the evidence base (see Appendix B for a summary of valuation experience in New Zealand to date).

At a working level, the key barrier to valuation work specifically for policy development purposes is limited budgets and tight timelines. A robust valuation study will often cost in excess of $100,000 and may take six months to complete. For many government departments, this is a large investment into information that may be seen as being uncertain and possibly controversial.

Limited budgets and tight timelines are, however, a matter of poor strategic judgement and prioritisation of resources. Based on interviews conducted for this work and the experience of the authors, the key driver for non-market valuation studies has not been a strategic decision to improve information in this area. Instead, it tends to be enthusiastic individuals within central government departments, local government and academia. As a result, the commissioning of valuation research is ad hoc depending on the staff of those organisations.

Figure 2 Number of non-market valuation studies



Source: NZIER, using data in Environmental Valuation Reference Inventory (EVRI)

In terms of per capita resource devoted to studying non-market values it may be that we have not done too badly at all and perhaps our small population simply means we are resource constrained.

Irrespective of resource constraints (on which there is more below), per capita numbers of studies don't get us very far. New Zealand has many unique environmental attributes and the value of our environment is very local.

In the case of biodiversity valuation progress in New Zealand has been limited with Green and Clarkson noting in their 2005 review of the Biodiversity Strategy that:

> *There has been limited progress in valuing biodiversity, including attaching an economic value of ecosystem services, although there is a growing amount of international literature on the subject that could be drawn on.*

Ultimately, the problem appears to be poor coordination and an absence of sufficient strategic planning needed to build expertise and a consistent evidence base which can be used to conduct non-market valuation.

4.2. Insufficient institutional incentives

An important question is whether the valuation of natural assets will make a difference to policy and/or project decisions. The policy framework that decisions are made within is well-established. It is informed by legislation and a reasonable depth

of case law (for example, the Resource Management Act 1991, Environment Act 1986, Conservation Act 1987, and Biosecurity Act 1993). The late eighties and early nineties were a key period for establishing the current policy settings which have not encouraged approaches that would lead to more use of valuation.

The adversarial nature of institutional settings such as Resource Management Act processes means that it is often in the interest of applicants or appellants to emphasise the uncertainty associated with valuation estimates. New Zealand has yet to reach the heights of US-style 'valuation litigation' (as seen in the Exxon Valdez compensation case).

Pitching economist against economist in hearings or Court focuses consideration of economics in these settings on the least controversial issues—production, employment and incomes—with limited reference to non-market values and how these may inform the decisions being made.

A characteristic of current decision making frameworks is that decisions have been devolved to a level where there is little capacity to undertake valuation of natural assets, given the high cost of individual studies.

The cost and uncertainty of values obtained from current techniques arise from the variation in techniques and the situations they have been applied to. This uncertainty appears to be a key barrier to the wider use of economic valuation of the natural environment.

Decisions based on use of local natural resources will always need to take account of local contextual factors that affect the value. But a part of each resource's value is more constant and predictable from a national perspective.

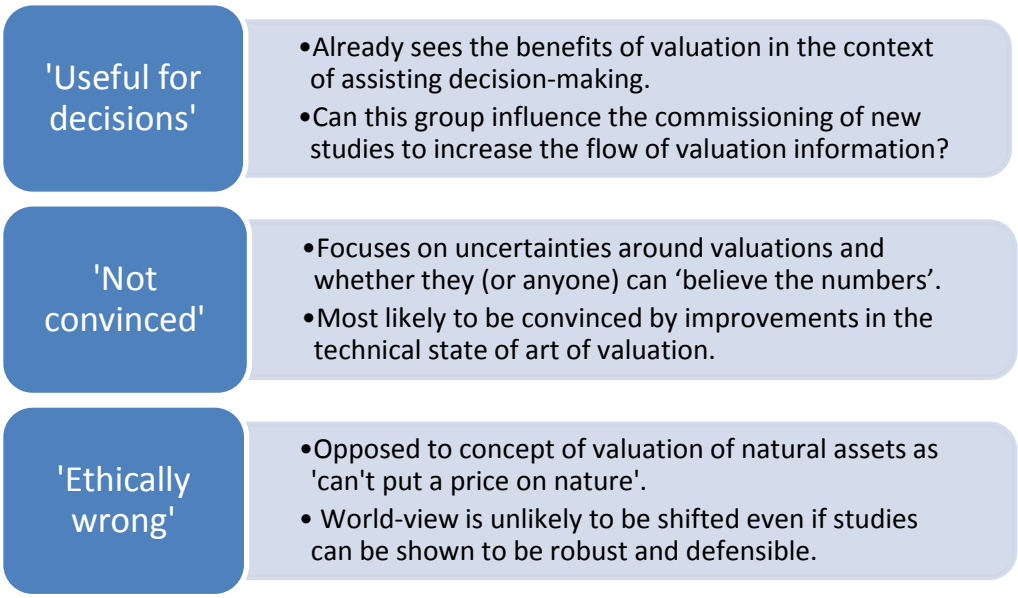
Wider use of economic valuation depends on developing a standardised technique for estimating this predictable or national part of the value for different types of natural asset or service.

Such estimates will give a partial economic value across a range of natural asset settings. Using this technique, decision-makers should become more familiar with the valuation approach and its uses in narrowing some of the scope and uncertainty around the non-economic weighing up of different outcomes.

4.3. Ethical objections of stakeholders

Stakeholders commonly fall into three camps according to their attitudes towards economic valuation. The three camps are described below.

The 'ethically wrong' group in particular is often vocal and influential in the perception of uncertainty surrounding these types of valuations. This experience is certainly not unique to New Zealand. Valuation studies can be controversial depending on their subject matter and the country affected.



Some of the in-principle objections are:

- "commoditising" the environment (Lowe et al 1993), which leads to exploitation
- the weakness of assumptions about commensurability and substitutability of all items in people's choices (Beckerman & Pasek 1997)
- systematic exclusion of a section of the public who operate on a 'rights-based' approach which rejects the relative welfare arguments of economics (e.g. by treating non-responses as zero willingness-to-pay bids, rather than a deliberate protest against the valuation process) (Spash 1997)
- the possibility of ethical and other motivations that are not commensurate with other values raised by environmental preservation.

The philosophical issues raised by the plurality of values do not remove the need for economic valuation. Rather, they acknowledge there are fundamental questions about the ethics of guiding resource allocations to collective resources as if they were just accumulations of private purchase decisions.

Ethical objections place undue emphasis on the idea of value residing in objects, rather than being attached to the resource use choices themselves. They don't answer the crucial, yet unavoidable, economic valuation question: how much is society prepared to forgo to save a space for nature conservation?

There are parallels here with the economic valuation of health and safety measures, which has also used non-market valuation techniques such as hedonic pricing and contingent valuation. The policy-relevant value in that context is public willingness-to-pay to reduce the risk of accidents or fatalities occurring to anonymous individuals in the future. That means valuing lives saved in a statistical sense (Jones-Lee 1990).

The corresponding value in conservation terms is public willingness-to-pay to reduce the risk of extinction or decline of ecosystems and their constituent species in future. This is a question which could be asked of the public without expecting them to have a detailed knowledge of how to achieve the respective risk changes.

A broad indication of public willingness-to-pay for successive reductions in risk of loss, and fully-costed, expert-determined options for achieving successive reductions in risks, provides useful guidance on maximising a measure of return from the various resource allocations to conservation.

Ultimately, there will never be a consensus over the validity and accuracy of natural asset valuation and valuation techniques. Not least because ascribing values to natural assets ventures into realms of generic ethical and moral philosophical debates that are unlikely to ever be 'resolved' – such as the clash between consequentialist and rules-based (deontological) views. It is hard to see how they will then be resolved in the context environmental and cultural values.

These philosophical debates cannot and should not be dismissed. Neither should technical shortcomings be ignored. However, decisions which impact on people's lives will continue to be made and they need to be as well made as possible. Dwelling on philosophical and academic debates in the hope of perfecting the decision making process is likely to prevent any improvement at all.

There is currently a gap in the knowledge about the full contribution of natural assets to New Zealand's economic well-being. This creates a risk that natural assets will be undervalued. Ecosystems and the valuable services they provide may be lost or damaged.

Economic valuation of environmental assets can fill the knowledge gap. But a better approach is needed so studies inform policy and decisions about New Zealand's natural assets.

5. Conclusion

5.1. Natural assets in a nutshell

The natural environment is an asset. It provides valuable services

The environment provides a range of services. These can be direct services, such as space for recreation, or inputs into production, such as insect pollination or clean water. People value financial or physical assets by the services they provide. In the same way, we can understand the value of the natural environment—by estimating the services an environmental asset provides, now and in the future.

Decisions that affect the natural environment rely on how we judge the value of environmental resources

This value depends on the different ways these resources could be used. That means we need to better understand the trade-offs between different ways of using natural resources. Otherwise, we risk making poor decisions about conserving and using the natural environment.

Economic valuation can help by making our judgements more consistent

Most value judgements measure direct market value and only assess other factors in vague qualitative ways. 'Non-market' economic valuation techniques can help us quantify how people benefit from natural assets. More tangible, more consistent valuations give decision-makers a richer set of information to work with. This helps them make better decisions.

We can measure the value of natural assets using a range of techniques

Each valuation technique is better suited to some questions than others, and no technique is ideal. The techniques currently used to value natural assets include:

- estimates of the natural assets' effects on market goods production
- estimates based on the next best alternative for obtaining the services
- revealed preference methods that infer value from associated marketed goods
- stated preference methods that infer value from questioning of respondents
- economic impact analysis
- deliberative processes using panels of affected stakeholders
- benefit transfer – use of values obtained in one setting to similar settings elsewhere.

There are three principal barriers to better evaluation in New Zealand:

- **limited empirical evidence on non-market values which is useful** for policy development and decision making
- **insufficient institutional incentives** for policy makers and officials to seek new information or refine existing information which is useful for non-market valuation
- **ethical objections** from a range of stakeholders which limits the political usefulness of economic valuation.

All three barriers are mutually reinforcing and need to be overcome if we are to improve the state of valuation in New Zealand.

5.2. Recommendations

The best ways to improve the quality and use of economic valuation are to:

- use legislative and regulatory requirements for evidence based policy decisions rather than ad hoc judgements
- establish a function within a government department that could:
  - monitor and evaluate the state of knowledge on non-market valuation
  - provide practical guidance and advice on how to use the information
  - guide research and resources towards filling knowledge gaps of strategic importance
- ignore ethical objections that come without compromise and take you nowhere.

To improve the valuation of natural assets in practice, we have six recommendations for the tasks that need to be completed:

- show what economic valuation can, and can't, achieve
- promote monetary valuation and standardised approaches to make valuations more comparable
- show, in a robust and comparable way, how much economic activity depends on natural assets
- show how sensitive this economic activity is to changes in the natural assets it depends on
- provide value estimates for a range of economic activities that depend on natural assets
- educate decision-makers about how they can use economic valuation.

Show what economic valuation can achieve

Determine the priority situations for using economic valuation and understand the prerequisites for using it properly. This involves explaining the different purposes economic impact studies and economic valuations can serve.

Promote standardisation to make valuations more comparable

Overcome the limited comparability of the methods used to date, by using techniques that are standardised, repeatable, and comparable. Filter out, or control for, the differences between studies.

Show, in a robust and comparable way, how much economic activity depends on natural assets

Identify how much economic activity depends on natural assets. Build on the selection of impact studies that have already been undertaken, using further analysis to present the results in a more comparable way. Use these results to illustrate the level of activity likely in other similar areas.

Show how sensitive this economic activity is to changes in the natural assets it depends on

Identify the sensitivity of this economic activity to changes in natural assets. The services derived from natural assets also include provisioning, supporting, regulating, and cultural services. Build a new framework for tracing the dependencies. We recommend three steps for building this framework.

(a) Compile what's known about the biophysical relationships between environmental condition and useful services.

(b) Find any clear cause-and-effect relationships. Estimate the value associated with different levels of environmental condition as it improves or declines.

(c) Identify any tipping points that limit how we extrapolate from studies.

Focus on situations where the economic value at risk is likely to be greatest (such as downstream land-uses at risk of losing regulatory services).

Provide value estimates for a range of economic activities that depend on natural assets

Provide value estimates for a range of economic activities. These estimates will work together with the framework that shows their sensitivity to environmental change.

(a) Commission a stated preference study of the public willingness-to-pay for retaining broad categories of natural assets. This study should find the ranges within which the value of more specific assets will lie.

(b) Develop a general picture of the costs of damage and restoration of different types of natural asset. This review of existing information should indicate the range of avoidable cost for changes in asset condition.

(c) Compile a database of estimates specific to different environmental contexts. The most appropriate estimates may be cost-based, productivity-based, or other types of estimate. These estimates will complement the existing Lincoln University database of non-market valuations.

Educate decision-makers about how they can use economic valuation

Prepare educational material for decision-makers. The material should explain what economic valuation can achieve. It should explain available methods and the

situations they are most useful in. It should explain how the three types of valuation fit together:

- market valuation
- non-market economic valuation
- non-economic judgement.

Explain the benefits of increasing the use of non-market economic valuation but also situations where other methods may be more appropriate.

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Appendix A Snapshot of New Zealand biodiversity

In 2002, more than 13.3 million hectares of New Zealand's land was covered by native land cover, as estimated by the Land Cover Database 2. This equates to 49.6 percent of New Zealand's total land area (26.9 million hectares). The area of native vegetation (excluding other native land cover, such as permanent snow and ice) equates to 43.7 percent (11.7 million hectares) of New Zealand's total land area, but this is predominantly montane forest and scrubland, and other land cover in the lowlands is under-represented to secure the probability of its survival.

Between 1997 and 2002, it is estimated that native land cover decreased by 16,500 hectares (0.12 percent). Changes either occurred through conversion of land to other uses, or as a result of natural processes.

The vegetation types that have experienced the greatest loss are broadleaved native hardwoods, mānuka and/or kānuka, tall tussock grassland, and native forest. Changes recorded by the Land Cover Database 2 show broadleaved native hardwood land cover was mainly converted into exotic forestry (83 percent), or cleared for pasture (12.5 percent). Similarly, mānuka and/or kānuka stands were converted into exotic forestry (52.5 percent), or pasture (46 percent).

The changes in native forest cover shown in Table 4 were largely due to harvesting (82.5 percent) and some conversion to exotic forestry (11 percent). All the tall tussock grassland cover that experienced land-use change was converted into exotic forestry.

Table 4 Changes in native vegetation and land-cover

Estimated hectares

Native land cover	1997	2002	% change
Alpine grass/herbfield	224,400	224,400	0
Broadleaved native hardwoods	546,200	539,600	–1.22
Depleted grassland	250,500	250,500	0
Fernland	51,800	51,700	–0.15
Flaxland	6,500	6,500	0
Grey scrub1	72,500	72,400	–0.06
Herbaceous freshwater vegetation	88,800	88,700	–0.13
Herbaceous saline vegetation	19,300	19,200	–0.45
Native forest	6,459,400	6,457,000	–0.04
Mangrove	26,000	26,000	0
Mānuka and/or kānuka	1,191,600	1,186,200	–0.45
Matagouri2	29,500	29,500	–0.02
Sub-alpine shrubland	385,400	385,400	0
Tall tussock grassland	2,397,100	2,394,600	–0.10
Total native vegetation cover	**11,748,900**	**11,731,700**	**–0.15**
Alpine gravel and rock	698,000	698,100	0.01

Coastal sand and gravel	51,300	51,300	–0.07
Estuarine open water	92,500	92,500	0
Lake and pond	356,800	357,500	0.2
Landslide	17,000	17,000	–0.26
Permanent snow and ice	111,000	111,000	0
River	81,900	81,900	0
River and lakeshore gravel and rock	179,700	179,700	0
Total other native land cover	**1,588,400**	**1,589,100**	**0.04**
Total native land cover	**13,337,300**	**13,320,800**	**–0.12**

Source: NZIER, Ministry for the Environment

Within the current regulatory framework, the **main threats** to biodiversity conservation in New Zealand are:

- **habitat change and loss**. Local authorities or DOC attempt to restrict the uses of private land where they believe there are grounds to protect native flora and fauna under section 6 of the RMA. The opportunity cost of such restriction to landowners is readily calculated, but protection can be frustrated by the lack of information on the economic worth of restrictions for conservation e.g. whether the conservation goals are best served by restricting mānuka clearance on private land, or allowing clearance to proceed in exchange for investment in a biodiversity offset measure
- **pest and weed incursion** is an on-going threat to native species and their ecosystems. Eradication of pests and weeds is rarely practical because marginal costs of pest control usually rise with the level of suppression. The economically optimal level of pest control will be less than full eradication. Finding the optimal level of pest control, and knowing how resources can be best deployed across the whole portfolio of natural assets, needs to be informed by comparing the marginal cost of pest control and the marginal value obtained from suppression
- **climate change** presents an uncertain and significant threat to biodiversity. Increases in temperature, changes in rainfall patterns, increased thermal extremes would all impact negatively on the indigenous flora and fauna. The degree of that impact is uncertain and some species may adapt and thrive while others may diminish
- **hunting of species** has largely been brought under control under the 1953 Wildlife Act and other measures, though there continue to be localised disputes over e.g. cultural harvest of endangered species.

Appendix B Valuation methods

B.1 Market values

Measuring the value of products and services using market values is comparatively straight forward. It implies using the market value of traded goods and services to value flows of ecosystem (provisioning) services and relating these back to natural asset values.

These market-based methods can cover both direct uses of products and services (product value and productivity analyses) and also indirect uses, such as production support services downstream provided by reduced risk of flood disruption on other activities. However, they do not cover all of the non-use value or non-commercial value derived from ecosystem services, and hence, understate total economic value.

Market methods can cover consumption or consumer values as well as production values. However, analysing consumption values via demand analysis does require some form of market pricing or user-pays charges (e.g. park access fees) before these can be used and prices are not widely applied to the consumption value in natural assets.

Cost-based methods also understate the total value of the resource at issue, for similar reasons to market-based techniques above. These are commonly regarded as lower bound value estimates because they are not true demand measures and they exclude the welfare components of consumer surplus, but some methods (like replacement cost) can conceivably exceed what the asset would be worth if it could be valued on the basis of public willingness-to-pay. Cost-based methods can understate the value of the resource by omitting all effects not traded in markets (e.g. externality effects).

When proposals are made to modify or make use of natural assets for some development, attention is often drawn to the economic impacts of such developments, in terms of the value of their outputs and the jobs created during their construction stage and to a lesser extent during their operation.

Critical variables on these local economic impacts are the capital cost (and its staging over the construction period), the on-going expenditures (particularly those on services and supplies that can be procured locally), and the direct jobs created in both the construction and operation phases of the development. Such measures of the 'worth' of a development are readily calculated and related to aggregate measures of economic activity such as Gross Domestic Product.

B.2 Non-market methods

Because not all environmental effects are traded in markets, non-market valuation techniques have arisen to infer values comparable to those for market-based goods and services. If an area of natural land can be converted to some other use such as agriculture or housing, how much would be lost to the community and how does that value compare to the net gain from converting to the other use?

Non-market valuation looks beyond the market measures of price and quantity and uses the welfare economics basis of cost benefit analysis to identify the economic surpluses associated with the natural asset. Non-market valuation explicitly focuses on the consumer surplus derived from the natural asset, the value obtained in excess of what people actually pay to use the asset (which in many cases is next to zero). It has also broadened the idea of value to the concept of Total Economic Value, encompassing both direct and indirect value derived from current use of the resource, the option value of retaining the resource for future use, and non-use value in retaining it for the future for its own sake rather than for any expectation of utilisation.

B.2.1 Production values: cost-based methods

Cost-based techniques derive from the idea that a non-market resource must be worth at least as much as its next best alternative for obtaining the same goods and services, including estimates of replacement cost of a damaged resource, defensive expenditures and the cost of averting loss of goods and services.

These methods have very broad uses and have been therefore widely used, especially for the valuation of indirect use values for regulating ecosystem services such as filtration, flood control or pollination. The TEEB synthesis report (TEEB 2010) provides a useful example here of forest ecosystems which estimated values for different types of ecosystem service.

Cost-based valuations, although incomplete as measures of benefit in economic theory because they fail to capture all the aspects of consumer surplus, option and existence value, have more practical applications. They may be useful in estimating future restoration and recovery projects, and can be influential in compensation payments to participating landowners. They may also be used for calculating depreciation of natural stocks in environmental accounts. At present, there are relatively few documented studies of costs of conservation management, and those that exist show great variability in results (Willis, Garrod & Shepherd 1996).

The economic literature on valuation of wild areas and wildlife is dominated by the quest to identify the public demand for these features. However, in a policy setting this is only half the answer, for even where demand is strong, if the costs of achieving what is being demanded are excessive, society may be better off by diverting expenditures to other outcomes which have a demand which can be met at lower cost. It is the benefit net or cost which is critical for decisions at the margin, so the development of conservation supply functions is a necessary corollary of valuing conservation outcomes.

Public demand is the subject of non-market valuation techniques which impute values for unpriced or intangible effects, either directly by getting people to state how much they would be willing to pay in the hypothetical case that they had to; or indirectly by inferring revealed preferences from observed expenditures on activities associated with the intangible (sometimes called “surrogate market methods”).

All estimate a consumer surplus (or equivalent measure) generated by the subject of the valuation under current conditions, from which an average per head or per

household can be calculated and extrapolated to give total value of the asset in question.[4]

Consumers' surplus is a monetary measure of the excess utility provided by current consumption, either measured in its Marshallian form as the difference between willingness-to-pay (the demand curve) and amount actually paid (the price line), or through measures such as equivalent variation or compensating variation. It is widely used as an approximate measure of changes in welfare, but an agency can collapse in the face of investments in consumer surplus that do not return funds to the agency.

That means economic efficiency at the societal level needs to be complemented by financial viability at the agency (supply level), or if supported by taxpayer funding, with a clear expectation that the value of positive externalities or public goods obtained is commensurate with the additional resources put into supporting them. In the context of this report, maximising the welfare contribution of conservation is constrained by society's willingness-to-pay for it, through taxes, user charges, private sponsorship or other regulatory or voluntary restraint incurring opportunity cost for the benefit of conservation.

B.2.2 Revealed preference techniques

Revealed preference techniques infer a value for an environmental attribute from observed expenditures on some related marketable service, the most common of which are hedonic pricing of house prices to derive a price premium on neighbouring environmental conditions, and travel cost analysis to infer willingness-to-pay for recreation at specific locations from analysis of money and time costs spent travelling to the site.

The three main methods for evaluating revealed preference are:

- **Travel cost analysis (TCA)**: a method that uses sample surveys of actual expenditures of visitors to a recreation site to derive a demand curve for that site
- **Hedonic pricing method (HPM)**: uses statistical regression analysis to isolate the effect of non-market variables (e.g. environmental quality or safety risk) from market prices which reflect a variety of attributes (e.g. house prices or wage rates)
- **Hedonic travel cost method (HTCM)**: uses statistical regression analysis of the choice of recreation site from given origin areas, to reveal the marginal value of the specific attributes which exist in varying degree in each site accessible from each origin. The more characteristics there are to value, the more sites must be available to people at each origin to generate sufficient variation from which inferences can be drawn. This technique has both practical and theoretical limitations and has been rarely applied.

Revealed preference techniques (travel cost analysis, hedonic pricing) have been most widely applied to recreation or amenity situations and have limited application

[4] Consumer surplus reflects the notion that at whatever price people acquire goods and services, there will be some who obtain it at less than their willingness-to-pay and hence earn a surplus on their consumption. Formally, it is calculated by estimating a demand curve that reflects willingness-to-pay and estimating the difference between that and the price paid. For non-market goods, there is no formal price paid, but valuation techniques infer a demand curve and implied price to enable the consumer surplus to be estimated.

to conservation issues (species or site loss) because they do not yield future or non-use values.

B.2.3 Stated preference techniques

Stated preference techniques, directly ask people (survey respondents) about their willingness-to-pay to secure particular environmental attributes. These are the only methods which can cover the full range of use and non-use values for a resource.

There are two main kinds of methods for measuring value via stated preference techniques:

- **Contingent valuation methods (CVM)**: specify an environmental change which respondents state their willingness-to-pay for. The objective is to elicit (stated) preferences for non-market goods or services, ranging from recreation sites, species preservation to health and safety
- **Choice modelling experiments (CM), con-joint analyses, and contingent ranking** are related stated preference techniques. Unlike CVM, respondents are given a set of choices over various environmental attributes, so respondents define their preferred package of attributes as well as stating a willingness-to-pay for it.

Stated preference techniques are subject to some well-documented sources of bias and a number of techniques have been devised to avoid them. These include starting point bias (when a suggested starting point for bids unduly influences responses), aggregation bias (when the surveyed sample is inappropriately scaled up, as when results for a local resource are extrapolated across the entire national population) and part-whole bias or the embedding problem (when the stated values for a small environmental gain is not much different from that for a much larger gain for the same environmental resources, as when respondents appear to be willing to pay the same to protect a colony of 2,000 birds as they are protect 20,000).

The focus of academic research into environmental valuation in recent years has been on stated preference techniques. The purpose of such research has been to elicit an expression of public willingness-to-pay for retaining a resource whose loss would in some sense be irreversible (usually a site or a species), which captures the option (future use) and existence (non-use) values associated with it. Ultimately, this is intended to demonstrate the economic value of biological resources in contexts where the values are often not reflected in market transactions and prices. This is intended to counteract the tendency to under-value and over-exploit these resources, and provide a more explicit and standardised approach to their value assessment than by treating each decision on its merits and implying a value through the decision made.

While innovation and continuous refinement of applied techniques may improve the reliability of the individual estimates, they have not improved the credibility of stated preference results as indicators of what people would actually pay for different conservation outcomes if they had to. A more policy-relevant method, consistently applied to yield information about relative preferences for different environmental features, even if there is doubt about the absolute values obtained, has yet to emerge.

Studies to date are also dominated by spectacular sites and 'charismatic mega fauna' (highly visible, appealing creatures) and there have been relatively few which attempt to establish public willingness-to-pay for incremental increases in species richness or diversity. Combined with the problem of credibility surrounding values without payment, these characteristics suggest stated preference valuations have some way to go before being accepted as persuasive in resource use decisions.

Revealed preference techniques are sometimes regarded as being more 'objective' because there are actual markets at work revealing the preferences, as distinct from the hypothetical questioning in stated preference surveys. Stated preference methods are more controversial but have been accepted in legal contexts in the United States, subject to caveats. They are the only valuation methods which can elicit the future use and non-use values that can be significant for some environmental resources.

But they are also subject to well-documented sources of bias and distortion, and the suspicion that stated willingness-to-pay will be more than actual willingness-to-pay. They can also be expensive techniques to apply, particularly if following the National Oceanographic and Atmospheric Administration Guidelines, established in the United States judicial setting in the wake of compensation claims following the Exxon Valdez oil spill. In some decision settings, no economic analysis may be better than bad economic analysis.

For practical purposes, cost-based valuation techniques could be most readily applied to conservation and biodiversity issues e.g. a particular site or habitat under threat could have a potential loss of benefit which included:

- loss of direct monetary benefit from the habitat (e.g. forest offtake)
- loss of support services manifested in reduced indirect benefits (e.g. increased flood incidence consequent on upstream vegetation removal).

Both of these categories could be valued using cost-based techniques. These may understate the Total Economic Value because they omit the consumer surplus, but they may be considered as lower bound estimates. In reality, this measure may not reflect accurately how society values the asset. Alternatively, the cost of restoring a damaged environment to its previous condition, or of recreating a damaged habitat in some other location (a 'shadow project' estimate) could be considered to be measures of economic depreciation, given an objective of maintaining natural assets in a constant state.

B.3 Benefit transfer techniques

Because of the complexity and expense of undertaking environmental valuation, in recent years interest has grown in so-called 'benefit transfer', which entails applying an economic value estimated for one site to a similar project or policy at a different site, and using this for estimating the economic value of the new site. This approach is now routinely used with respect to recreation facilities in the United States, expressed as standard values per visitor day for activities such as angling, boating, camping or general sightseeing.

The simplest approach is in transferring unit values (such as a value per visitor day) from other studies, but this faces the problem that individuals in the new site may

not value activities the same way as the average individuals at the study sites on which the unit values are based.

This may be because the people are different in their tastes, income, and other socio-economic characteristics affecting their demand, or even if their preferences are the same, the opportunities in the new site may not be because, for instance, there are already other substitute sites readily available. To allow for this, benefit transfer values are frequently adjusted in various ways.

An alternative to transferring unit values would be to transfer the entire demand function from the study site to the conditions at the new site; in other words, applying the coefficients in the original demand function to characteristics of the new site to predict the value of the new site. This has potential to be more accurate than transferring unit values because a demand function has consistent assumptions on unit value and visit rate, and it more readily reflects changes in the distribution of population around the different sites in question (OECD 1994).

Benefit transfer methods can only be used to value outcomes or attributes that have already been estimated elsewhere, and have limited uses until a well-documented and extensive record of valuation studies has been built up. Academic journals serve this purpose to only a limited extent because important details are often not discussed in journal articles, and comparison of the results may need recourse to the original data sets. So it may be difficult to find a previous study that closely resembles the issues – policy, user demographics, site characteristics – at the new site.

A consensus appears to be emerging in the literature that benefit transfer can provide valid estimates under certain conditions, such as close similarity between the commodity or service being valued in the original and comparative situation, and the original estimates being transferred themselves being derived by a reliable application. However, there are many examples of benefit transfer being done badly (Pagiola et al 2004) and there remains a risk of it being used inappropriately.

There is a tension emerging between what might be termed the conventional approach to non-market valuation, of seeking some number to demonstrate that non-market values of sites at risk are not zero, and the more recent approach informed by the notion of ecosystem services that is much more focussed on the stream of benefits from a particular site. The latter approach is much more exacting in the use of benefit transfer values – choice modelling studies have shown significant differences in value between apparently similar situations, due to influences that have not been adequately recognised and controlled for (Kerr & Sharp 2004).

Such considerations also point to limitations in drawing on international studies for benefit transfer purposes, and limitations on the uses of valuation databases that have begun to emerge, such as the New Zealand Non-Market Valuation Database hosted at Lincoln University and the EVRI Database compiled by Environment Canada. Such databases may indicate the likely relative valuation of different types of natural asset, but are less reliable for determining the absolute value to use in benefit transfer because of a range of variables that may not be fully accounted for in the valuation process. There are significant challenges in ensuring that valuation work and the compilation of databases are relevant for practical policy and management purposes (Allen & Loomis 2008).

Publication pressure has resulted in an abundance of novel applications in non-market valuation which are increasingly theoretical, "quirky" or otherwise far removed from the day-to-day concerns of resource management, and such studies require substantial reworking to extract comparable results for meta-analysis. To be useful in influencing practical policy and management decisions non-market valuation and valuation databases need to overcome scepticism outside the fields of environmental economics by demonstrating their reliability relative to the transacted values used elsewhere in assessing economic outputs and performance.

For practical purposes, the usefulness of benefit transfer depends on the context of its proposed application. For matters of national importance, such as a site's contribution to reducing the probability of losing a component of biodiversity, it could be argued that the nation is indifferent as to where the conservation takes place. Simply put, the value of a unit of conservation gain (however defined) should be the same wherever it takes place.

Transfer of a value of conservation benefit derived through a reliable estimation process would give reasonable guidance on the value of conservation at each location. The critical factor is the soundness of biophysical science in determining how what happens at each site affects the probability of survival of biodiversity components.

For matters of more local or regional significance, (such as recreation where the demand will be influenced by such factors as the population age, affluence and tastes and the accessibility of substitute sites to any origin location) benefit transfer needs to use demand functions that apply to both the original and the transfer recipient sites.

Appendix C Valuation practice to date in New Zealand

New Zealand studies on the economic value of conservation fall under two broad headings: economic impact studies and economic welfare estimates. Economic impact studies focus on the current expenditures associated with conservation and protecting natural assets. Welfare analysis aims to measure economic surpluses derived from them and includes non-market values as well.

Examples include a series of regional impact studies around regions with national parks or walking tracks by the Department of Conservation (DoC 2006) and numerous reports prepared as evidence in support of applications for resource consent on major development projects involving natural areas.

Economic contribution and impact analysis

The economic impact of conservation is usually assessed by examining how much money conservation contributes to the local economy—through spending related to conservation activities, and through ancillary services such as transport and accommodation that support activities in the conservation areas. Gross expenditures do not represent net benefits to the economy, but they do encapsulate the importance of natural assets in stimulating local business, and they provide a basis for comparison with other economic sectors.

Welfare analysis

There is a wide range of non-market valuation studies recorded on the New Zealand Non-Market Valuation database, hosted at Lincoln University.

Lincoln and Massey Universities pioneered interest in non-market valuation in New Zealand. It has since spread to Auckland, Otago and Waikato universities. There has also been interest from private economic consultancies, including non-market valuations for biosecurity assessments (Bell et al 2008) and in transport applications (Guria & Miller 1989).

Yao and Kaval (2007) present a meta-analysis based on a database of 92 non-market valuation studies. They suggest that most of the studies conducted before the 1991 Resource Management Act were done for academic purposes. After the Act was passed an increasing proportion were commissioned by central or local government agencies. But they provide little detail of how they have adjusted the studies for differences in methods used, nor on how the studies have been used by their commissioning agencies.

Yao and Kaval (2008) applied contingent valuation to reveal preferences for increased planting of indigenous forest for biodiversity purposes. Marsh and MkWara (2008) carried out stated preference studies of water quality. Other significant recent studies include those of Kerr and Sharp (1995) on option and existence values of the

Waitaki River, and a collection with respect to valuing biodiversity for biosecurity assessment purposes (Nimmo-Bell 2011).

Most non-market valuation studies in New Zealand value particular components of biodiversity rather than biodiversity itself. Exceptions are a study that suggested that the **total annual value** provided by all New Zealand's indigenous biodiversity could be more than twice that of New Zealand's gross domestic product (Patterson & Cole 1999), following the methodology of Costanza et al (1997) who estimated global biodiversity had a value three times that of global GDP. But these are not meaningful economic valuations. Estimating a value based on trade-off capability greater than the income available to pay for it is not a meaningful economic valuation, and these estimates show the danger of over-reliance on benefit transfer from studies of variable quality and potential for double counting.

Most environmental valuation in New Zealand to date has used stated preference techniques, or else concentrated on economic impact and multiplier studies. An exception to this is a replacement cost-based valuation of water collection services provided by the Te Papanui Conservation Park (DoC 2006).

Despite their number, only a few non-market valuation studies have been decisive in policy decisions in New Zealand. Guria & Miller's 1989 contingent valuation led to the adoption of a new value of statistical lives saved in transport appraisals. Harris & Meister's 1983 study of the value of Lake Tutira for recreation appears to have reinforced a previous decision to clean up the lake. Nimmo-Bell (2011) claims one has been "accepted" in an Environment Court hearing on the Waitaki River, and another was used to gauge residents' willingness-to-pay a special levy to clean up Lake Rotorua.

But non-market valuation studies commonly result in high values for obscure species relative to what New Zealanders in general pay towards conservation. This suggests they may distort responses in other ways (Clough 2010).[5]

While impact studies provide some information on the contribution of conservation to the national economy, they have shortcomings:

- they do not cover the full effects of externalities
- they make it difficult to aggregate values across different park areas
- they don't help to answer questions such as what would happen to the net value from conservation in a region if some of the natural assets were to be modified or transformed by other uses.

The non-market valuation studies are dominated by stated preference studies.

It appears therefore that there are significant gaps in the availability of valuation estimates applicable to inform specific issues of relevance to management of natural assets in New Zealand. Some of this is due to limitations in knowledge of the biophysical characteristics and how change in the natural environment changes the flows of services flowing from it. But some of this may be due to mismatch between the focus of valuation practitioners and the requirements of policy.

[5] Such results may be due to the well-documented "part-whole bias" or "embedding problem", a recognised characteristic of stated preference valuation techniques whereby respondents state the same willingness-to-pay for a small or for a large amount of environmental improvement.