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REVEALING THE ECONOMIC VALUE OF BIODIVERSITY: A NEW INCENTIVE MEASURE TO CONSERVE AND PROTECT IT

Canadian Case Study on Biodiversity Incentive Measures

by F. Filion, J. Frehs, and D. Sprecher

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FOREWORD

This paper is one of a series of 22 case studies that describe practical experiences in OECD Member countries with the use of incentive measures for the conservation of biodiversity and the sustainable use of its components. These case studies were submitted by OECD Member countries to the OECD Working Group on Economic Aspects of Biodiversity as a contribution to the OECD study of the design and implementation of appropriate incentive measures for biodiversity conservation and sustainable use. In order to ensure maximum comparability between the case studies, all were developed under the common methodology described in "Incentive Measures to Promote the Conservation and the Sustainable Use of Biodiversity: Framework for Case Studies" [OECD/GD(97)125].

The practical experiences described in the 22 case studies were used as the basis for the policy advice developed in the Handbook of Incentive Measures for Biodiversity: Design and Implementation (OECD, 1999). This Handbook combines the lessons learned through the various experiences described in the case studies covering a wide range of ecosystems, economic pressures on biodiversity, and utilising various incentive measures with sound economic theory to develop a practical, step-by-step guide for policy-makers on the design and implementation of successful incentive measures for the conservation and sustainable use of biodiversity.

This paper was provided by the Canadian Government and was written F. Filion, J. Frehs, and D. Sprecher. It is released as an unclassified document under the responsibility of the Secretary-General of the OECD with the aim of bringing information on this subject to the attention of a wider audience.

This study, and the other 21 case studies submitted by Member countries, are available on the world wide web at http://www.oecd.org/env.

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by

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EXECUTIVE SUMMARY

Summary Canadian prairies to provide water for agricultural production, tourism and municipal needs in order to add to the original monetised private goods estimates the public goods benefits and costs of the effects on biodiversity. The Environmental Valuation Reference Inventory was used to find valuation studies conducted in similar situations from which estimates of the values of the effects in this project could be drawn (benefits transfer). In the original study, both the economic costs and benefits of the project were valued to be CAN$ 76.5 million. The original study also identified some non-quantifiable environmental benefits and costs from the project, which an assessment panel concluded would tend to result in an overall net benefit, thus improving the relative economic effects of the project. As a result, the reservoir was constructed. Once the benefits transfer exercise was conducted – and drawing on studies that utilised contingent valuation and travel cost methods for determining the environmental values – it was found that the revised BCA for the project would result in a net loss of approximately CAN$ 10 million.

Ecosystems studied: grasslands, rangelands, inland freshwater ecosystems, forests

Incentive measures used: economic valuation, information provision

Main lessons learned: Public economic values of biodiversity can be revealed through economic valuation using a benefits-transfer approach, thus mitigating information failures; this is a very cost-effective means of producing monetary values for biodiversity goods and services.

[1] The Authors wish to thank Paula Caldwell, Paul De Civita, Michael Jay and Doug Tilden for valuable input during the production of this paper. We also wish to acknowledge Kimberly Rollins and Michael Ivy for their valuable work in advancing or applying the EVRI.

1. GENERAL DESCRIPTION

1.1 Overview

A decade ago, the Bruntdland Commission (1987) observed that "species issues" lacked "political clout" because they were not perceived as "leading economic concerns". A few years later, the Global Biodiversity Strategy (1992) concluded that a fundamental cause of biodiversity loss was the fact that society did not recognise its economic value. The issue of adequate knowledge about the value of biodiversity is not new, yet it remains one of profound policy relevance for senior decision makers charged with the welfare of ecosystems on which the well-being of people depends. When such fundamental information failures exist about the importance of biodiversity, one would expect to find important policy failures regarding its conservation and protection. It is argued here that valuing biodiversity, in concrete economic terms, can help redress notable market and information failures, and provide a fresh incentive to policy makers to conserve it for future generations. In this context, valuation can help to level the playing field, which may at times be tilted in favour of unsustainable development.

This reality is illustrated in the following case study, which describes how a development project, involving several economic sectors on the Canadian Prairies, affected biodiversity in several ecosystems. The project involved the construction of a reservoir to provide water for agricultural (crop irrigation, and livestock production), tourism, and municipal needs. The development also impacted on biodiversity in fescue grasslands/rangelands, a wetland, riparian woodlands, and three endangered species (the baird sparrow, the ferruginous hawk, and the burrowing owl). In the process, relatively invisible public goods were at risk, including losses in passive (existence) use values for ecosystems, habitat and endangered species. This study focuses on the strategic importance of contrasting the monetized private goods estimated to occur from the development proposal with less obvious public goods from biodiversity (public goods which may be at risk when little or no factual evidence can easily be found on their actual economic value to society).

The project affected federal public lands, and the development proposal was reviewed by a panel falling under the authority of Canadian Environmental Assessment Act (1992). The assessment included a **benefit-cost analysis (BCA),** which focused on benefits and costs for which market values were available. The panel recognised that some public goods and services from biodiversity would be affected, but did not have ready access to concrete data on the magnitude of their actual economic value. In the absence of biodiversity values, the outcome of the BCA analysis (see Table 1, Column B), which was based on the best available economic information at hand at the time, allowed the development to proceed.

The case study revisits the above BCA. This time, a conservative estimate of the actual economic values for the public goods and services of biodiversity are quantified and factored in. To accomplish this, several earlier problems had to be overcome — not the least of which was the relative absence of readily available data on the non market value of biodiversity. The solution was to apply a **benefits transfer (BT)** approach, which has been advocated by the OECD (1994). To achieve the most defensible benefits transfer, a new tool was employed, the **Environmental Valuation Reference**

Inventory (EVRI), developed jointly by Environment Canada and the US Environmental Protection Agency. The EVRI allows valuation to take place quickly and inexpensively in situations where primary valuation is not feasible (a situation that occurs more often than not in many OECD countries). Using BT procedures from the EVRI, results from valuation studies conducted elsewhere were successfully matched with the prairie ecosystem policy site. By including non-market economic values obtained with the EVRI in the revised BCA, the results were shown to be significantly different from those in the earlier analysis (see Column C in Table 1). The new analysis revealed that the well-being of society at large was not well served by allowing the development proposal to proceed. In this event, a strategic incentive has been provided to decision makers to conserve biodiversity.

There are several lessons to be learned from the Canadian case study which are transferable to other OECD and non OECD countries. They are discussed under the Relevant Policy Conclusions, in section 6.0.

1.2 Background

This case study examines the construction of a reservoir on a Canadian grassland and rangeland and the economic and environmental impacts this project would create. The purpose of the reservoir is to contain water diverted from a stream; and to reduce seasonal fluctuations in water supplies for irrigation, livestock watering, and for municipal water systems. A wetland and riparian woodland are affected by the project. Economic activities such as recreation/tourism, agriculture and urban water supply are the main impacts resulting from the construction of the reservoir.

Under the Canadian Environmental Assessment Act, this project was reviewed by a panel to assess the impacts of the proposed project. As part of this impact assessment, the advocates of the project presented a benefit-cost analysis that relied solely on market valued costs and benefits of the project. According to this analysis, the *economic benefits* of the project totalled $76.5 million, including local spending directly associated with the proposed project's construction, the recurring costs to operate and maintain the reservoir and recreation areas, and the increased income for local farmers and suppliers of goods and services. These in turn would be compounded through subsequent spending and re-spending of the new income resulting from revenue gained by increased agricultural production in the region. The *economic costs* of the project included construction of the reservoir, overhead and maintenance on the reservoir and recreation infrastructure, capital costs for irrigation and additional costs to farm production. These costs were also estimated to be $76.5 million.

The environmental assessment also identified some additional non-market environmental impacts that would result from the construction of the reservoir, including: loss of habitat (fescue grassland and riparian woodland), constructed wetlands, creation of reservoir, fisheries and alteration of stream flows. The assessment panel concluded that these costs and benefits did not lend themselves easily to quantitative economic analysis, and were identified as non-quantifiable factors that are relevant to any consideration of the economic effects of the project. The panel concluded that these non-quantifiable impacts would tend to improve the relative economic effects of the project.

Using market values, the benefit-cost ratio used in the impact assessment was equal to 1, which implied that the project costs were equal to its benefits (see Table 1, column B). Since the non-quantifiable benefits were assumed to be positive, the benefit-cost ratio was assumed to exceed 1. This normally suggests that society as a whole would be better off by undertaking this project. As a result, the panel recommended that the project proceed.

The environmental assessment panel made the best possible decision based upon the information available. If the panel was correct in assuming that the non-quantifiable impacts were positive, then the benefits would have exceeded the costs, and society would have been better off if the project were to go ahead. However, if the non-quantifiable impacts were negative, then the costs would have exceeded the benefits, and either the project should not have gone ahead, or more extensive mitigation measures should have been required.

In keeping with the concepts advanced earlier by the OECD, we agree that: "(I)ncentives should work to make biodiversity an asset rather than a liability to concerned agents" (OECD:1996, 69). We see positive incentives as: "monetary or non-monetary inducements which encourage or motivate governments, organisations and individuals to safeguard biological diversity " (OECD: 1996,10). We also see incentives as measures that: 1) make use of market forces to achieve their objective, 2) reduce the gap between the value of biodiversity to individual business interest groups and to society as a whole, and 3) "work to level the playing field between the observable returns to destructive activities and the non-observable returns to conservation" (OECD: 1996, 8). When examining the market forces as they pertain to biodiversity, we will employ methods that go beyond actual market prices, and also include techniques based on surrogate market prices as well as simulated market prices (Filion and Adamowicz: 1994, 221-242). In order to achieve optimum impact, valuation should focus not only on the above mentioned direct uses of biodiversity, but also on the many non-market goods and services that the natural environment provides. These goods and services include an array of non extractive use, ecological functions, human health, as well as passive use and option values (OECD: 1996, 56-57).

The analysis conducted below was undertaken to illustrate how environmental values could have been incorporated into the panel's assessment, and how these values could have been used to by the panel to make a more informed decision. As we will see, there is a need to have non-quantifiable or non-market value information available in an environmental assessment decision.

1.3 Description of the Ecosystem

The reservoir is located near a park campground which has a mixed stand of poplar, spruce, and forest pine trees with a stream running through it. The stream empties into a series of lakes and a river. Due north of the park, the stream is flanked by a coulee and a ridge which harbours about 500 hectares of relatively rare native prairie fescue grassland. Prairie pot-hole wetlands are scattered throughout this landscape. An eleven hectare stand of poplars straddles the stream. Three towns are situated east of the reservoir and the stream. Cattle farms and rural dwellings are distributed relatively evenly throughout the agricultural areas surrounding the reservoir.

Several environmental attributes were permanently disturbed as a result of constructing a dam and reservoir in the stream basin. The reservoir was projected to occupy approximately 600 hectares, thus eradicating 11 hectares of poplar woodland and over 500 hectares of rare native prairie fescue grassland. A 20 hectare constructed wetland was proposed as an effort to mitigate possible soil erosion at the north end of the reservoir.

Trout fisheries that exist north and south of the reservoir may be disturbed as a result of changing instream and outstream flows through reservoir operations. During peak periods of high use (mid- to late summer), the reservoir would be drawn down to accommodate local water consumption and irrigation demands.

2. IDENTIFICATION OF CAUSES AND SOURCES OF PRESSURES

As indicated above, through the conversion of the wetland the creation of the reservoir affected the stream flows in the region. The immediate beneficiaries were the agricultural community and the three towns around the reservoir which can draw water from the reservoir. Cattle farming represents a significant amount of agricultural output in this region of Canada. The creation of the reservoir benefits the cattle farmers that use the water supply to increase their agricultural output. In essence, this project increases the agricultural economy at the expense of the public land and the biodiversity it represents.

People conducting tourism/recreation activities such as camping, swimming, boating and fishing were also affected by this project. In the original environmental assessment it was not determined whether the project would be beneficial to this group. The most immediate pressures occurred to the habitat for 3 endangered species: the baird sparrow, the ferruginous hawk and the burrowing owl.

For this case study, the area around the reservoir is public land and, as such, there is no information on the value this land provides to society. A BCA of the project was conducted which contained mostly financial information. The financial analysis of the project readily identified the benefits to the community which created a clear market signal that the project was beneficial to society. Because the BCA indicated the project was viable, the economic analysis was considered as a positive factor in the decision to proceed with the project. The panel therefore decided to construct the reservoir at the expense of the public land and its associated biodiversity components.

In 1992, the Global Biodiversity Strategy (WRI, IUCN, UNEP: 1992) observed that one of the fundamental causes underlying the loss of biodiversity throughout the planet resided in the fact that societies had failed to value the environment and its resources. This is largely due to the fact that the goods and services that the environment provides to people, and their economy, are not traded in the market place (OECD: 1996, 51). Except for a relatively narrow set of commercial and other direct uses, biodiversity does not benefit from market signals to reveal its true economic significance. The vital contributions that biodiversity makes to the well being of people is clouded by the fact that its true economic value goes largely unmeasured in every day life. Because biodiversity lacks economic visibility, its vital contribution to the wealth and sustainability of nations goes largely unrecognised in decision making.

This market failure inevitably leads to an important information failure (OECD: 1996,55). Information failure about the economic value of biodiversity may in turn lead to policy failures in areas which affect environmental conservation and protection. If the economic worth of biodiversity cannot be ascertained in concrete terms, then policies which favour economic development may be privileged at the expense of conservation and protection - activities which tend to be perceived as a cost from a developer's perspective. Under these circumstances, the sustainability of nations is likely to suffer, as the natural capital upon which their wealth depends is allowed to dwindle.

Where might one begin to address some of these important market, information, and policy failures? This paper shows that a strategic point of departure may be to develop instruments which can

reveal the actual economic value of biodiversity to senior policy and decision makers. It is argued in this context that when previously unknown values are revealed, they act as incentives to conserve and protect nature. Revealing these unknown values serves to address two fundamental causes of biodiversity decline: namely, market failure and information failure.

3. IMPACTS ON ECOSYSTEMS

Based on the environmental assessment of the project, six non-market environmental impacts were identified which would likely cause changes in non-market benefits that flow from the environment to people. The impacts of the proposed reservoir are the following:

- Loss of fescue grassland (over 500 hectares).
- Loss of riparian woodland (11 hectares), including habitat for three endangered species (baird sparrow, ferruginous hawk, and burrowing owl).
- Constructed wetlands (20 hectares).
- Creation of reservoir (600 hectares).
- Fisheries (trout and cold-water fisheries north and south of the reservoir), and
- Alteration of stream flows (up and downstream).

3.1 Loss of Fescue Grassland

Because it is relatively rare, the 500 hectares of native prairie vegetation taken for construction of the reservoir constitutes a loss. The passive use, or existence value of the fescue grassland that is lost to the reservoir must be taken into account as an additional non-market benefit foregone in the construction of the reservoir.

3.2 Loss of Riparian Woodland Habitat for Wildlife, Including Three Endangered Species

The 11 hectares of riparian woodland that would be lost to the reservoir is a habitat for three endangered birds: (1) the baird sparrow, (2) the burrowing owl, and (3) the ferruginous hawk. The environmental assessment predicted a loss of animals which are classified as endangered species during the construction of the reservoir and due to the loss of critical habitat. Thus, a non-market value of the area is the passive-use value of this habitat. It would be incorrect to assign the full value of the endangered species to the habitat, because loss of the habitat would not necessarily cause the extinction of these species. The cost would be the loss due to the local disappearance of animals, and the increased probability of the extinction of species due to habitat loss.

Moreover, the non-market value of the 11 hectares of riparian woodland would also need to be evaluated separately from the function of providing a habitat to endangered species. There is also an aesthetic loss that arises from the loss of the 11 hectares of poplar since there is so little riparian woodland left in the area.

3.3 Constructed Wetlands

The proponents of the reservoir project proposed mitigation efforts that would offset the loss of some non-market values of flooded lands. The construction of wetlands in the north end of the reservoir was suggested as a mitigation measure and to reduce erosion and sedimentation of the reservoir. Use and non-use values of wetland habitat would need to be included as non-market benefits. In order to calculate these non-market values, estimates are required of the amenity values of wetland habitat (wildlife, ecology, protection from surface water run-off, protection from soil erosion, and freshwater filtration). To calculate non-market net-benefits of the wetland, the costs of constructing the wetland would need to be net out, as well as net out the benefits of alternative values foregone for the land on which the wetland was created.

3.4 Creation of the Reservoir

The environmental assessment suggests that the existence of bodies of water breaking up the grasslands have aesthetic and recreational value. The value of the 600 hectare reservoir may create non-market value to residents of the area. Thus, a comparison is needed between the non-market value of aesthetic amenities before construction of the reservoir and the non-market value of aesthetic amenities after construction.

Several non-market benefits may flow from the creation of the reservoir. Benefits include recreational opportunities on the reservoir and averted costs of supplying municipal water. Local towns and communities surrounding the proposed site experience significant water shortages during the summer months of the year and during severe drought. In this instance, the non-market benefit is the security individuals receive from the knowledge of a having a year-round secure water supply. The economic value of a more secure source of municipal water was not included in the original market-based benefit-cost analysis. It is possible to quantify this security benefit as the reduction in cost of transportation and conveyance of water to each community from other sources.

3.5 Reservoir Fishery, Trout, and Coldwater Fisheries North/South of the Reservoir

The environmental assessment noted that the construction of a reservoir in the proposed site would impact fish habitat upstream and downstream due to the interruption and variation in flow caused by the reservoir. Variable flow of the river may change depth upstream and downstream causing temperatures to fluctuate in these areas. These fluctuations in temperature may adversely effect fish habitat upstream and downstream. Moreover, the environmental assessment noted that increased variable levels and flow rates downstream could increase soil erosion, thus affecting amenities, fisheries and river ecology downstream. Under these circumstances, a determination is needed of what and how much fish and wildlife habitat is lost to the reservoir, and what this loss constitutes in terms of non-market costs of the reservoir.

3.6 Alteration of Natural Stream Flows

The alteration of a natural stream flow may represent an existence value loss to people who prefer to allow unaltered portions of waterways to remain in a natural state. The loss of one more wild portion of waterway may represent a loss, especially in an agricultural landscape in which the majority of waterways have been altered.

4. IMPACTS ON ECONOMY AND WELFARE

When conducting a BCA, the impacts on the economy due to a project are usually thought of in terms such as job creation and impact on Gross Domestic Product. These numbers are relatively easy to generate. However, there are also broader impacts, such as changes to biodiversity, that also have economic effects, but which are harder to monetise. In this development project the welfare effects were considered but not quantified. Specialised valuation methodologies are required to capture these values.

One of the attractive features of incorporating the economic value of environmental assets in a BCA lies in the fact that information is provided in monetary units, a common basis which is preferred by senior policy makers. Even in situations when economic values may be difficult to ascertain for all components of biodiversity, the rigorous process that BCA provides constitutes an important aid in making decisions.

BCA involves the definition, and valuation to the extent possible, of all benefits and costs under study. The years of practice and development of standards for BCA provide a tool that can be used to examine resource use decisions. Moreover, BCA can be used to examine the distribution of benefits and costs among members of society. By utilising the EVRI, we have identified studies that can be used in a BT exercise to determine benefits and costs that were not included in the original analysis. The results are juxtaposed with the original BCA to illustrate how the valuation information could have been used to improve the final decision.

There are many reasons why a thorough economic valuation of biodiversity may not be conducted during a BCA. Valuation is a relatively new science. It is complex, and requires specialized skills that are not always readily available. As a result, much of the primary research that has been done is of a pioneering nature. Further, when empirical valuation information does exist it is not always easy to locate and obtain. Hence, there are two complementary approaches to valuing the benefits of biodiversity -- primary research and benefits transfer.

4.1 Primary Approaches for Valuing Impacts

Often the analyst can use market data to measure expected changes in economic values arising from a project. The benefits of enhanced irrigation from a proposed reservoir, for example, may be quantified by observing decreased costs in beef production or by the value of increased feed grain produced per hectare. These values are measurable by market prices, as long as the markets are functioning properly.

The irrigation project described above may cause changes in the quality and quantity of environmental services that do not have market prices through which value can be determined. The stream in the case study, for example, is home to: habitat of 3 endangered species, 11 hectares of poplar forest, and over 500 hectares of rare native prairie fescue grassland. These environmental attributes would be

necessarily lost if the project were to be approved. All of these amenities provide benefits to society, but the benefits are not easily quantified in a manner comparable to the benefits of the reservoir.

Economists have used various methods to estimate the value of non-market benefits. The benefits of a recreational fishery at the stream, for example, can be estimated using a travel cost model. Travel cost models are based on the idea that the distance people travel to get to the stream can be used to generate a benefit function for the value of fishing at the stream.

Another approach, known as contingent valuation, might involve asking fishers to divulge amounts they would be willing to pay to protect the fishery at the stream. Resource users would be presented with distinct scenarios about the environmental asset and then asked to state their preferences according to ranges of monetary values. A variety of applications of these and other valuation methods over the last 15 years have provided policy makers with additional information to make informed policy decisions. The value of this information is that measurements of non-market environmental values can be directly compared with economic costs and benefits that are priced in markets, because they are based on a common unit of measure - the dollar.

Not all environmental values have been, nor can be, quantified easily by non-market valuation methods. The extent that some values may be quantified, however, increases the information available to support policy decisions. Ideal benefit-cost analyses should fully recognise and incorporate all economic values, including non-market values, in the calculation of benefit-cost criteria. In practice, however, most applications of benefit-cost analyses omit non-market values and can, therefore, lead to misleading results. Imagine that non-market costs and benefits could be estimated in common units comparable to dollar values. Such values would include, for example, the costs of increased sedimentation imposed by the reservoir downstream and the recreational benefits provided by the reservoir. Depending on whether these net values were positive or negative, their inclusion in the BCA could alter the economic feasibility of the proposed irrigation project.

Primary valuation studies that attempt to estimate non-market values for each policy decision are ideal, but are not always feasible. Often government budgets do not allocate funds to conduct such studies. Primary valuation studies can be lengthy while time may be limited. Under these circumstances, an alternative process of taking into account non-market values may be considered. Conducting a primary study for each of the affected biodiversity components in our case study, was not practical or feasible.

4.2 Secondary Approaches for Valuing Impacts - Benefits Transfer

The concept of benefits-transfer is a strategy that attempts to assign values for physical attributes of a policy site when it is impossible to conduct a primary valuation study of the policy site. The notion is to transfer the values that were estimated using non-market economic valuation methods from other sites that share similar geographic, demographic, and environmental characteristics with the policy site. BT is based on the theory that we do not have original data for the policy site, but we have data from other studies that approximate the value of the characteristics we are interested in. Putting it another way, benefits-transfers may, in certain situations, constitute a next best alternative to primary research for valuing environmental impacts of proposed policy decisions.

Environment Canada developed the Environmental Valuation Reference Inventory to aid analysts in constructing and conducting BT. The EVRI is a computer-based facility designed for the World Wide Web with three basic components. First, it contains a database of extended summaries of existing non-market valuation studies that have estimated non-market benefits and costs of other policy sites. Second, the EVRI allows an Internet user to conduct a customised search of existing valuation studies. The search

is customised by a series of text strings and keywords within 5 broad categories. According to these categories, users may select studies that best approximate characteristics of the non-market values of a given policy site. Finally, the EVRI includes a protocol for continual entry of new studies into the database.

An attribute of the EVRI that facilitates the process of conducting a BT is the way in which the data is presented to the user. There are several techniques available on the EVRI website that allow users to construct and perform subject searches specifically related to their policy site. For example, the EVRI imposes a protocol on the user's search that effectively narrows the range of possible values that could be used in a BT according to site characteristics that match the policy site under investigation. Thus, the EVRI is designed to help users construct a data search with the idea of conducting a BT with the results. This paper will not go into details of how a search of the EVRI was constructed, the studies that were selected from the EVRI to conduct the transfer, or the process of the transfer itself.[2]

4.3 Comparing the Original Benefit-Cost Analysis with the Revised Results

The project proponent provided a BCA in which the total quantified cost of developing the reservoir project, was estimated to be $76.5 million. This included, construction costs, operation and maintenance costs, costs of flooded land, capital costs and production costs for irrigation and beef herd expansion, and recreation infrastructure. The benefits quantified included increased agricultural production and improved recreational activities, totalling $76.5 million. The final **benefit-cost ratio (BC ratio)**, using the 1992 dollar value as a base, at a 5.7 per cent discount rate over 54 years, was equal to one.

The proponent identified additional impacts that could not be quantified in the analysis such as recreation benefits. These non-quantified impacts were believe to be overall a net benefit. Once we include the non-market information that the BT process provided, we begin to see how valuation can be an important incentive measure. If the results indicate a net gain by including the non-market values, we can conclude society is better off from the project. However, as indicated in Table 1 the study's results estimate a net loss of non-market value indicating that project costs exceed benefits. We have augmented the BCA in our analysis with the six impacted ecosystems identified in Section 3 and the associated values of these impacts.

Viewing the BC ratio using either the upper or lower bound estimates, reveals that the ratio is now 0.88. This implies that excluding the non-market biodiversity values in the BCA, resulted in a decision that did not meet economic criteria. That is, the BC ratio is less than one (1) indicating that society is worse off if the project is undertaken. The implication from this study is that a BCA which includes the non-market values, indicates the project was not economically viable and would generate net economic losses to the public.

As the table indicates, the project costs increase from $76.5 million to $88.8 million, using the lower bound estimate, and increases to $91.2 million using the upper bound estimate. Taking the mid point estimate we see an increase in the costs of the project of $13.5 million. This increase is largely due to the benefits lost due to the conversion of the riparian habitat.

It is interesting to note that there is no estimate for the loss of fescue grassland. This is due to the fact that no studies could be identified to match the study site with the policy site. Had we been able to

[2] The reader is referred to Rollins and Ivy, "The Use of the Environmental Valuation Reference Inventory (EVRI) in the Environmental Assessment Process", Environment Canada, 1997.

conduct a transfer, the project cost would have increased and therefore the BC ratio would have decreased even more. The zero value reported for the non-reservoir fisheries results from the fact that we were unable to determine whether a loss in the cold water fishery would be offset by a gain in the warm water fishery.

Table 1 **Comparison of benefit-cost analysis including and excluding monetised biodiversity values**

(A) **Cost and Benefit Categories of the Project**	(B) **Original BCA (Excluding Biodiversity Values)**	(C) **Revised BCA (Including Biodiversity Values)**[(i)] **Lower Bound**	**Upper Bound**	(D) **Difference Between B and C Attributable to Biodiversity Values based on mid points for C**
Project Costs				
Operations & Management	$76 500 000	$76 500 000	$76 500 000	$0
Riparian Woodland Habitat Loss	$0	$11 159 000	$11 159 000	$11 159 000
Free Flow Loss in River	$0	$1 180 000	$3 540 000	$2 360 000
Fescue Grassland Loss	$0	NA	NA	NA
Non-reservoir Fisheries Loss	$0	$0	$0	$0
Total Cost	$76 500 000	$88 839 000	$91 199 000	$13 519 000
Project Benefits				
Project Operation	$76 500 000	$76 500 000	$76 500 000	$0
Recreational Use of Reservoir	$0	$472 000	$2 364 000	$1 419 000
Increased Municipal Water Supply	$0	$868 000	$1 360 000	$1 114 000
Constructed Wetland	$0	$11 000	$11 000	$11 000
Total Benefits	$76 500 000	$77 851 000	$80 235 000	$2 544 000
Project Benefits less Project Costs	$0	-$10 988 000	-$10 964 000	-$10 975 000
Benefit / Cost Ratio	1.000	0.876	0.880	

For the project benefit side, the benefits of the project increase from $76.5 million to $77.8 million, for the lower-bound estimate, and to $80.2 million for the upper-bound estimate. Using the mid point, this represents an increase of $2.5 million above the projected benefits of the project. For the recreational benefits, it is interesting to note the range in the estimates. This due to the assumptions that are made regarding the projected use of the reservoir once the project has been completed.

(i) Values were obtained from a benefits transfer based on 25 studies selected from the Environmental Valuation Reference Inventory (EVRI).

5. IMPLEMENTATION OF INCENTIVE MEASURE AND CONTEXT

In order to illustrate how valuation can act as an incentive measure this study has utilized a BT approach in lieu of conducting a primary study. Institutionally, under the Canadian Environmental Assessment Act, any direct changes in socio-economic or human health conditions that are a direct result of a change in the environment must be considered in an EA. While there is no legislated requirement to include the value of these losses in an assessment, most projects that go to a panel review include a BCA of the project. These analyses often reference environmental effects in qualitative terms but make no attempt to provide a value for the losses. As we have identified in the course of the paper, these values are typically considered non-quantifiable.

This is not to say that the agencies that are involved in the process of steering a project through a review are not against this type of analysis. The Canadian Environmental Assessment Agency is in the process of drafting guidelines to aid project proponents in valuing the environment in a BCA analysis. In the past, the argument has been that this type of analysis was too difficult to conduct, the techniques were not well developed, or that the time and cost was too onerous. Institutionally, we are seeing a will to include non-market values to have a better informed BCA. By utilising BT techniques and the EVRI, the non-market values are more readily available.

5.1 Process of Implementation and Distributional Effects

By including valuation information, we have provided the non-market signals that would have better informed the panel on the losses that were occurring. In doing, so we have created the platform for an improved panel decision based on a more complete information package. Therefore, the outcome of the panel decision would likely have been altered. If this was the case, who would be the winners and losers from such a decision? As argued during the course of this paper, a BCA is conducted to deem whether society is better or worse off through the implementation of a policy, program, or in this case, a project. The purpose is not to determine the distributional impacts of such a measure. As with any project, at a local level there can be significant economic impacts in terms of employment and incomes. These can be experienced anywhere in a country, depending upon the location of the project.

This analysis in this particular instance has deemed that Canadian society is not as well off as originally expected by allowing the project to proceed. This conclusion has been based largely on the fact that the impacts on the ecosystem and its biodiversity component were compromised. As we have seen in Table 1, Column C, the losses in excess of $11 million from the riparian woodland habitat represent a significant proportion of the costs associated with the project. The value that Canadians place on this component of the environment and the benefits lost by proceeding with this project have meant a direct loss in welfare. While the panel made the best possible recommendation it could, given the information that was provided, valuation would have been a strong incentive measure for the panel to alter its recommendation.

5.2 The Role of Information and Uncertainty in the Implementation Process

It has been argued there is an important role for valuation as an incentive measure but it is with caution that any BT be conducted. The analyst must be able to identify and minimise measurement error in BT. Measurement error in a BT arises from the unavoidable fact that the situation of the policy site and the study sites are not identical. The complex interactions between environmental functions and flows of economic values are likely to be quite different at different sites. The hypothesised effects of differences in population sizes and characteristics of potentially affected individuals, the numbers and types of substitute environmental goods and services, the exact welfare measure (for example, willingness to pay for an environmental improvement versus willingness to accept compensation for an environmental decline) between a study site and the policy site must be evaluated. A number of subjective judgement calls will need to be made, in terms of which study sites are most appropriate, whether potential measurement biases are likely to produce over- or under-estimates of economic value, and whether study site values could be adjusted by various means consistent with economic theory to more closely reflect the situation of the policy site. The structure provided by the EVRI helps the user organise and cross-reference studies on the basis of characteristics in terms of how far they differ from the policy site; thereby streamlining the job of identifying potential sources of measurement error.

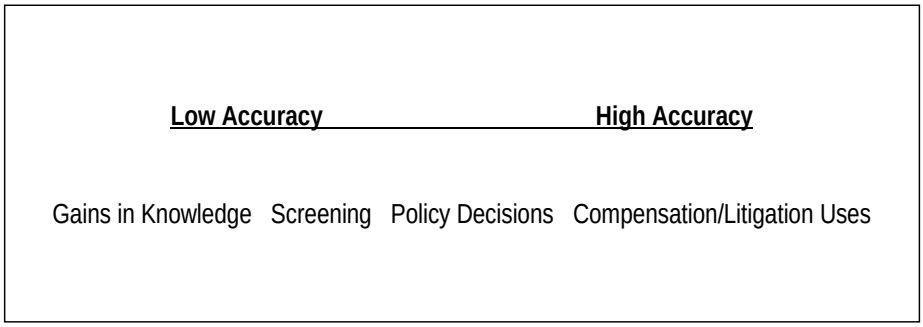
The US Department of Commerce's *Final Rule* allows for BT to be used in federal damage assessments provided three issues are addressed: "the comparability of the users and of the natural resource and/or service being valued in the initial studies and the transfer context; the comparability of the change in quality or quantity of natural resources and or services in the initial study and in the transfer context (where relevant); and the quality of the studies being transferred" (U.S. Federal Register, January 5, 1996, p 499).

The OECD identifies difficulties in implementing BT methods which are similar to the Department of Commerce's issues. The OECD suggests that a way to reduce the cost of locating and matching quality studies for a transfer would be to establish a non-market valuation library. "The long-run cost savings from such a library are likely to be large, particularly as serious environmental valuation efforts become part of standard project appraisal and policy analysis procedures in developing countries." (OECD, 1994, p178). A tool such as the EVRI is a step in this direction.

The characteristics and keywords that have been built in to the EVRI are consistent with the Department of Commerce's criteria. That is, the user who is operating within the bounds of these criteria will find that the EVRI has been developed such that the user can easily justify and verify a search based on these criteria. For example, the EVRI includes categories on *Environmental Issues* and *Human Populations* which contains several subcategories that allow the user to address the first of the Department of Commerce's issues -- comparability of users and of the natural resource being valued in the study and policy sites. The second issue above can be addressed using a variety of subcategories in the EVRI's *Environmental Issues* and *Welfare Measures* categories. The quality of studies used, the third of the Department of Commerce's issues, can be addressed, in part, by the trained analyst using information provided by the full records in the EVRI.

The degree of accuracy of the BT depends in part on how the results are to be used. Brookshire (1992) and Desvousges et.al. (1992) talked about a continuum of accuracy for BT based on the intended use of the BT. (see Figure 1). The minimum degree of accuracy necessary is related to the cost of making a wrong decision based on the results of the BT. Using BT in a BCA for an environmental assessment project would require a middle level of accuracy in order to influence a policy decision. For our case study, conducting a BT in order to demonstrate how valuation can be utilised in an environmental assessment, represents a gain in knowledge that costs society relatively little from any inaccuracies in the actual BT

Figure 1 **Continuum of Accuracy for Benefits Transfer Analysis**



However, if a BT is used as a basis for determining just compensation in the context of natural resource damage litigation, the costs of a wrong decision to individuals and society could be quite high. In this case, the accuracy of a BT should be very high. In the cases of decisions that would lead to potentially irreversible losses of extremely scarce environmental attributes, such as an endangered species, it may be that only a primary study would be acceptable. The cost of making the wrong decision may be so high as to justify expenditure on a primary study instead of performing a BT.

5.3 Framework and Context of Implementation

As mandated under Canadian Environmental Assessment Act, any project that falls within a federal jurisdiction, must identify the environmental effects caused by the project and any directly related socio-economic effects. When one includes the non-market valuation information the links between the environment and human become transparent. When public lands are involved, as in this case study, governments have a central role to play. As trustees of the environment it is in government interests to ensure that all information is present so the best possible decision can be made. As such, non-market valuation must be included as part of the process in an environmental assessment.

This statement has implications for all levels of government as well as private entrepreneurs and non-government organisations. In order for a comprehensive and holistic evaluation of the environmental impacts of a proposed project, valuation must form a central component of a project proposal and its review. Without this measure in place, the incentives will continue to be to develop land and not to conserve and protect biodiversity.

6. POLICY RELEVANT CONCLUSIONS

This case study revisited an actual development project on the Canadian Prairies which affected biodiversity in several ecosystems. The project was originally subjected to an environmental assessment, including a BCA, based on the best economic information available at the time. In this case, the project's benefits (not including the value of biodiversity impacts) had been estimated to be at least equal to its costs. As a result of the BCA, the assessment panel had concluded that the project should proceed.

The BCA for the above project was revised by including a conservative estimate of biodiversity values using a new tool for conducting BT (i.e. the Environmental Valuation Reference Inventory - EVRI). The project costs were shown to exceed the benefits by a notable margin (see Column C in Table 1). In this case, the logical conclusion would be that the project should not proceed, and the ecosystems and biodiversity would therefore not be affected. If biodiversity values had been included in the original environmental assessment, the assessment panel would have had an economic rationale for a different policy decision.

This study points out that by revealing public economic values that are not self-evident, one of the most fundamental causes of policy failure, namely the information failure, can be mitigated. Further, by addressing this failure, a strategic incentive is advanced to favour the conservation and protection of biodiversity.

6.1 Transferability of the Experience

Valuation can provide a strategic incentive to conserve and protect biodiversity in a number of situations that arise in many countries. For example, the above case study illustrates how the outcome of a BCA conducted in the context of an environmental assessment is dependent on the nature and availability of the information considered. More specifically, information on the value of biodiversity can play an influential role in tilting the balance away from development for private interests, in favour of conservation for the public good. In other words, revealing the actual economic values which are at risk provides a powerful inducement which favours biodiversity over development.

To the extent that BCA is conducted on development projects in other countries, economic valuation is without a doubt an important element in the conservation and protection of biodiversity. However, the strategic persuasion that valuation provides to conserve the natural environment extends well beyond the above assessment, and the BCA context presented here. Valuation serves fundamental needs associated with the development and calibration of a number of incentive measures, which are being showcased by other countries in their case studies. Valuation results are also important for determining compensation in cases of environmental damage, developing pricing schedules that take into account the environmental impact of economic production (i.e. full-cost pricing), and developing national resource accounts (OECD:1996, 80-82). Further, valuation is essential in developing indicators of a nation's sustainability. For example, recent work by the World Bank advances the notion that a nation's

sustainability is a function of its wealth, and that wealth is based on capital. It argues that an important part of the wealth of a nation is the worth of its natural capital (World Bank: 1995, 19).

These applications of valuation are not only relevant for policies in other OECD countries, but also in a number of non OECD countries.

6.2 Lessons Learned

This country study shows that valuation can play a critical role in preserving and protecting biodiversity. However, in practice it is not used as often as it might be in decision-making processes. Why is this?

There may be several reasons why valuation is not recognised and used as an incentive measure more often. Some of these reasons include the following:

The institutional framework must allow for the valuation of both market and non-market goods and services resulting from biodiversity to be considered. For example, if environmental assessment legislation does not require the inclusion of environmental values in BCA, then decisions will be made with incomplete information, thus placing biodiversity at a disadvantage in the decision making process.

Those conducting an environmental assessment or BCA must be made aware of the full spectrum of goods and services from biodiversity that may be at risk; that may range from familiar direct extractive and non-extractive uses, to less familiar uses such as ecological functions, health effects, as well as passive use and option values (OECD: 1996, 56-57). In many cases, assessment practitioners do not consider this broad range of environmental goods and services.

The valuation process must not be restricted to actual market prices, since much of the value stemming from biodiversity falls outside the market place. In other words, valuation methods must be extended beyond actual market prices to include surrogate market pricing techniques (i.e. replacement cost, travel cost techniques, etc…), and simulated market pricing techniques (i.e. contingent valuation methods, etc…) to reveal values which are not immediately apparent (OECD: 1996).

Because information on the value of biodiversity is often not readily available, primary economic valuation research must be encouraged at national and international levels.

In situations where time, money and expertise preclude primary valuation, BT should be considered more often as a potentially attractive alternative (OECD: 1994). When choosing to employ BT for valuation, it is important to bear in mind the relative level of precision needed for the decision at hand, as illustrated in Figure 1. The development of new tools for more comprehensive. BT should be encouraged.

6.3 Possible Policy Advice for Implementation

What can be done to overcome the above information failures and impediments to conducting biodiversity valuations? Given the constraints of time, money and expertise involved in conducting primary valuation research, a special effort must be made to budget for this. Failing that however, more attention should be deployed to alternate approaches. A promising approach is the methodical conduct of BT. While this alternative may not provide results which are as defensible as those from primary research (Perrings: 1995, 857), new developments in the field have contributed significantly towards advancing this state of the art technique. One of these promising advancements is a new tool called the Environmental

Valuation Reference Inventory, which has been developed by Environment Canada in close collaboration with the US Environmental Protection Agency.

The EVRI can assist in achieving more accurate BT on two important fronts: 1) facilitating eventual access to all available valuation studies in the world via the Internet, and 2) promoting more relevant matches between the policy site in question, and valuation results available elsewhere from other study sites. EVRI can help foster more comprehensive matching by providing easier access to detailed information on essential matching criteria such as human population characteristics, geographical attributes, the nature of the environmental goods and services, the valuation measure and market characteristics, as well as research methods employed in these other studies.

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OECD Case Studies on the Design and Implementation of Incentive Measures for the Conservation and Sustainable Use of Biodiversity

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Country	Case study title
Australia	A Revolving Fund for Biodiversity Conservation in Australia
Austria	Austrian Case Study on Economic Incentive Measures in the Creation of the National Park Neusiedler See - Seewinkel: Summary
Austria	The Austrian Programme on Environmentally Sound and Sustainable Agriculture: Experiences and Consequences of Sustainable Use of Biodiversity in Austrian Agriculture
Canada	Revealing the Economic Value of Biodiversity: A New Incentive Measure to Conserve and Protect It
Canada	Using the Income Tax Act of Canada to Promote Biodiversity and Sensitive Lands Conservation
Denmark	Economic Incentives for the Transformation of Privately Cultivated Forest Areas into Strict (Untouched) Forest Reserves
Finland	The Act of the Financing of Sustainable Forestry and the Development of Forest Certification
France	A Cost-Benefit Analysis of Biodiversity Conservation Programmes in the Garonne Valley
Germany	UNESCO Biosphere Reserves Schorfheide-Chorin and Rhön
Greece	Incentives for the Conservation of the Nesting Grounds of the Sea Turtle *Caretta caretta* in Laganas Bay, Zakynthos, Greece
Japan	The Case of Oze Area: Case Study on the Japanese Experience Concerning Economic Aspects of Conserving Biodiversity
Korea	Case Study on Korean Experiences Relating to the Conservation of Biodiversity in Mount Chiri, with Special Attention to the Poaching of Bears
Mexico	Incitations Economiques pour la Protection des Especes de la Vie Sauvage au Mexique: Le cas de l'Espece *Ovis canadensis*
Netherlands	Green Investment Funds: Organic Farming
Netherlands	Green Investment Funds: PIM Project
New Zealand	Conservation of the Pae O Te Rangi Area
Norway	Valuation of Benefits Connected to Conservation or Improvement of Environmental Quality in Local Watercourses in Norway
Poland	Case Study on the Polish Experiences Relating to the Implementation of Economic Incentive Measures to Promote the Conservation and Sustainable Use of Biodiversity in the Biebrza Valley, with Special Attention to the Biebrza National Park
Turkey	The Development of Appropriate Methods for Community Forestry in Turkey
UK	Heathland Management in the UK
US	US Experiences with Incentive Measures to Promote the Conservation of Wetlands
US	Individual Transferable Quotas as an Incentive Measure for the Conservation and the Sustainable Use of Marine Biodiversity