Literature Review and Framework Analysis of Non-Market Goods and Services Provided by British Columbia's Ocean and Marine Coastal Resources

Prepared for:
Canada/British Columbia Oceans Coordinating Committee

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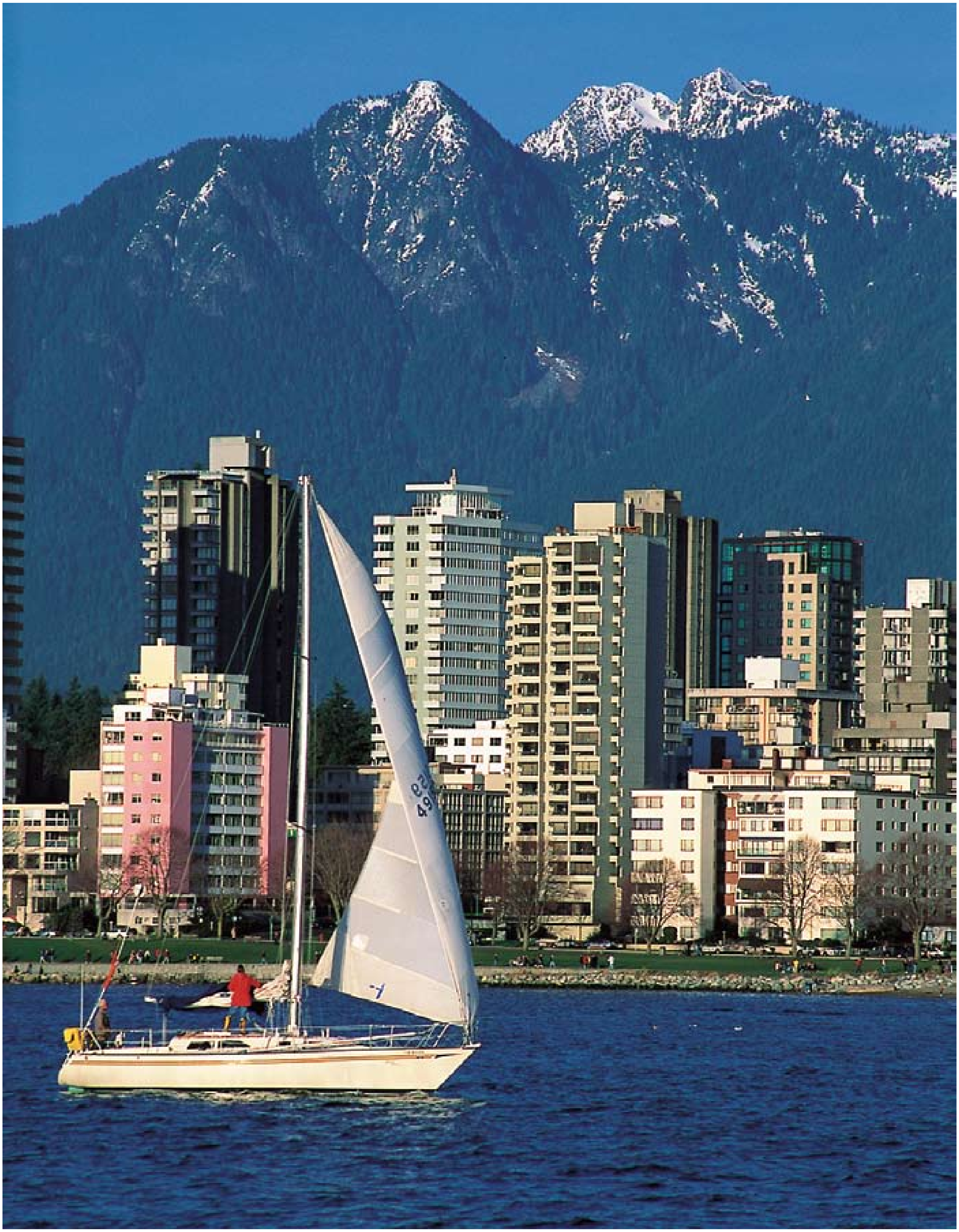


Executive Summary

Sections 1 - 4

The flow of goods and services from British Columbia's ocean and marine coastal resources is dependent on the integrity of the underlying ecosystems that support the generation of these goods and services. For example, the viability of the commercial salmon fishery is dependent on underlying ecosystems that support the recruitment of salmon, including freshwater habitat, coastal estuaries, and ocean systems. While it is relatively straightforward to value the contribution of harvested salmon to British Columbia's economy using the market price of salmon, it is less straight forward to value the contribution of the underlying ecosystem-based goods and services that support the generation of the end product (salmon, in this example). These goods and services are not traded in a market institution; hence, they are referred to as non-market goods or services. Many of these goods and services provide benefits across multiple scales: local, regional, national, and global. For example, the sequestration of carbon in the ocean provides benefits across multiple scales, but the value of this service is not easy to measure. The complex nature of underlying ecosystems, coupled with the absence of market institutions to measure the exchange and value of goods and services they generate, often leads to (1) underestimation of their magnitude and value; (2) limited recognition of their importance in policy and decision-making arenas; and (3) lack of ecosystem-oriented management frameworks to ensure the sustainable flow of market and non-market goods and services over time.

Sections 5 - 6

Incorporating non-market values into the policy or decision-making process requires the adoption of a suitable valuation framework that captures all values (market and non-market). The most common, and most appropriate framework for aggregating the value of ecosystem goods and services (including non-market goods and services) is total economic value (TEV). Within a TEV framework, the value of ecosystem-based goods and services is classified into two categories: use values and non-use values. Use values include direct use value (e.g. provisioning services such as food, water), indirect use value (e.g. regulating services such as climate control, waste assimilation, water quality), and option value (i.e. the value derived from the option to make use of a resource in the future). Non-use (also referred to as "passive use") values include existence value, bequest value, and altruism value. A number of methodological approaches exist to measure the value of non-market goods and services. These approaches are based on two principal concepts in welfare economics: consumer surplus and producer surplus. The methodologies are broadly classified into two categories: revealed preference methodologies (e.g. hedonic and travel cost methodologies), and stated preference methodologies (e.g. contingent valuation and contingent choice modelling methodologies). Valuations based on revealed preferences are derived from prices paid for goods or services. It may sound paradoxical that non-market goods and services are sometimes valued based on revealed preferences, but this approach is used to tease out non-market components that are contained in market priced goods or services. Valuations based on stated preferences reflect a willingness to pay for a good or service (or a willingness to accept to forego it) expressed in terms of a stated choice in hypothetical scenarios presented to respondents. Others methodologies that are not as well grounded in economic concepts of value include the benefit transfer methodology, and cost based methodologies (replacement cost, avoided cost, and opportunity cost).

Section 7

Despite the abundance of ocean and marine coastal resources in British Columbia, the number of non-market valuation studies is limited. Existing studies focus primarily on the role of ecosystems services in terms of their contribution to commercial and recreational fishery sectors. For example, Sumaila et al. (2000a) estimated the value of restoring ecosystem functions in the Strait of Georgia at $261,000/year/km2 (measuring only market-based economic benefits), or $3,796,000/year/km2 (measuring market and non-market ecological-social-economic benefits). Knowler et al. (2003) estimated the value of freshwater coho salmon habitat (in terms of economic rents accruing to the commercial fishery) at $1,322 – $7,010/km stream length. This study values the role of terrestrial ecosystems in the production of marine goods, which is indicative of the complex interaction of marine and terrestrial ecosystems. Cameron and James (1987) estimated the value of recreational fishing on the south coast at $49/day/angler. Numerous non-market valuation studies have been completed in the United States and in other countries, although the focus is often on commercial and recreational values.

Section 8

There are five recommendations in this report. Each recommendation is discussed in more detail in Section 8:

- understand the limits of economic valuation in the context of single value proxies for entire ecosystems, and issues of double counting when valuing more than one good or service;
- adopt a "total value" framing approach to the valuation of ecosystem-derived goods and services, which requires the identification and valuation of all non-market ecosystem goods and services;
- ensure valuation is part of an integrated, interdisciplinary framework;
- expand research of non-market valuation in British Columbia in order to integrate non-market values into policy, decision-making, and management frameworks in British Columbia;
- value non-market ocean and marine coastal resources in British Columbia, in accordance with the following five steps:
    - - identify all non-market goods and services derived from each of the ecosystem functions;
    - - assess the relevant scale (local, regional, national, global), and magnitude of all goods and services derived from each ecosystem function;
    - - prioritize the valuation of non-market goods and services identified in step 1;
    - - execute valuation studies in accordance with step 3, which will require careful assessment of each valuation approach based on suitability/applicability, cost, access to data, availability of requisite skills, and institutional capacity;
    - - integrate non-market values into policy, decision-making, and management frameworks at local, regional, national, and international levels.

Contents

Glossary

TEV	Total economic value
GDP	Gross domestic product
DCE	Discrete choice experiment
WTP	Willingness to pay
WTA	Willingness to accept
CS	Compensating surplus
EV	Equivalent surplus
CVM	Contingent valuation method
CBA	Cost-benefit analysis
CV	Compensating variation
EV	Equivalent variation
CRD	Capital Regional District
GVRD	Greater Vancouver Regional District
TC	Travel cost
CV	Contingent valuation

1. Introduction

In British Columbia, coastal communities harvest, extract, and consume many marine coastal and ocean resources: fisheries and timber resources, oil and gas, strategic and non-strategic minerals, and other non-living natural resources. Ocean areas are also used for the provision of other goods and services such as transportation. These activities all take place within a market environment, and they are thus defined as market goods or services. Their contribution to British Columbia's economic prosperity is accounted for at provincial and national levels within a gross domestic product (GDP) accounting framework, and policy decisions about the management or regulation of these goods and services are often made using cost-benefit analysis (CBA). However, marine coastal and ocean ecosystems provide many other goods and services that benefit humans locally, regionally, nationally, and globally. In British Columbia, these goods and services range from simple pleasures such as wildlife viewing and other recreational activities, through to complex biophysical systems that support life on Earth. Many of these goods and services are not traded in a market environment, and are defined as non-market goods and services. They are not easily accounted for in economic terms, and are generally not accounted for in a GDP accounting framework[1]. Furthermore, many of the benefits are not directly captured by individuals, corporations, or governments in the form of income, profits or taxation, which makes the task of valuing them in economic or monetary terms a challenging one.

The absence of an easily understandable framework to measure the value of non-market goods and services can lead to limited recognition of the value of these goods and services. When no markets exist, the "price" of environmental goods and services is often considered to be zero. This lack of "market influence" may lead to policy decisions that ignore the impact of environmental changes, especially in the context of CBA (Pearce, Atkinson, and Mourato 2006). Furthermore, the public good character of marine coastal and ocean resources, coupled with the presence of open-access conditions (in certain instances), and significant economic externalities, can further limit the recognition of the value of these resources. Undervaluation of non-market goods and services is a contributing factor in the depletion and degradation of marine coastal and ocean resources; however, much greater attention is now being paid to the restoration of coastal ecosystems (Ledoux and Turner 2002; Lotze et al. 2006). Recent natural disasters provide a stark reminder of the human, environmental and economic costs of environmental degradation of coastal resources on local and regional communities. Climate change presents much greater potential for catastrophic costs at a global scale, and the degradation of marine coastal and ocean ecosystems is an important component of this problem (Stern 2006). The valuation of non-market goods and services derived from environmental and ecosystem functioning has evolved significantly over the last 30 years or so. This evolution has been driven by an increasing awareness of the benefits accruing to humans from these goods and services, and by the subsequent need to make more informed policy decisions regarding their management.

1 Green GDP is meant to account for nature's value on an equal footing with the market economy; however, green GDP is in its infancy, and its application is currently limited (Boyd; Boyd and Banzhaf 2006).

2. Scope of Report

This literature review and framework analysis is part of a larger review of market[2] and non-market contributions of ocean and coastal resources in British Columbia, undertaken by the Canada/British Columbia Oceans Coordinating Committee. Valuation of non-market goods and services is important for three reasons: (1) ocean and marine coastal ecosystems are complex, and any policy or management decision process must incorporate as much information as is readily available; (2) the decision to choose a particular policy or project is often made based on a CBA, usually in the context of budget constraints. Given that trade-offs are central to CBA, it is crucial that non-market goods and services are valued in comparable terms to market goods and services. This approach does have some serious limitations, especially as it relates to the interaction of complex ecosystem components (e.g. the integrity of the whole system may be worth more than the sum of its parts, or impossible to disaggregate); and (3) there are many non-market externalities associated with the provision of all goods and services that should be incorporated into any CBA to accurately reflect "true" benefits and costs associated with any policy or project choice.

The focus on the valuation of ocean and marine coastal resources is a reflection of the limited scope of this report, and existing jurisdictional authority for ocean and marine coastal resources. A more integrated approach would include ocean and coastal zone resources, which would properly reflect the interaction of marine and terrestrial ecosystems. For example, Knowler et al. (2003) highlight the importance of this interaction in their valuation of freshwater habitat for salmon recruitment. Using a bio-economic model, the authors estimate the value of a change in the environmental quality of salmon spawning/rearing habitat (i.e. from a pristine level to a degraded level), based on the change in downstream net benefits that accrue to the commercial fishery. The construct of jurisdictional authority may limit the recognition of these valuable interactions between marine and terrestrial ecosystems; which, in turn, may lead to a less than optimal management approach to ecosystem integrity in the coastal zone.

2 GSGislason and Associates Ltd. Forthcoming, April 2007. Economic Contribution of the Oceans Sector in British Columbia: Report Prepared for the Canada/British Columbia Oceans Coordinating Committee.

3. Basic Concepts, Theory, and Assumptions of Economic Value

3.1 Concept of value

Ecologists and economists often represent two different paradigms in their respective definitions of value. Ecologists may refer to an ecosystem or environmental process as having intrinsic value. Intrinsic value or inherent value is based on the belief that something has value in "itself" or "for its own sake". Economists refer to instrumental value as the basis of economic evaluation. Instrumental value is the value something has in terms of its contribution to achieving some other end or purpose. For example, the value of a coastal estuary might be defined by ecologists as having intrinsic value or inherent value by virtue of its existence. Economists might value a coastal estuary for its contribution to the biomass of fish, or its ability to assimilate waste; both represent goods or services consumed or utilized by humans. Goods and services provided by ecosystems and environmental processes are instrumentally valuable in terms of their ability to improve human well-being (Freeman III 2003a).

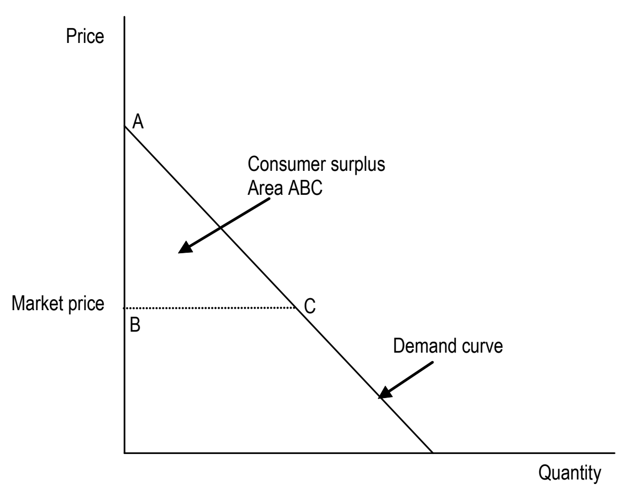
3.2 Economic theory of value

Three fundamental premises of welfare economics underpin the concept of instrumental value: (1) improving human well-being is the underlying goal of economic activity; (2) individuals are in the best position to determine how well off they are in any given set of circumstances[3]; and (3) social welfare is ultimately measured by aggregating individual welfares across society (Freeman III 2003a, 2003b; Pearce, Atkinson, and Mourato 2006; Pearce and Moran 1994; Pearce and Turner 1990). Well-being is defined by an individual's preferences, and his/her willingness to pay for gains or accept compensation for losses (Freeman III 2003a). Individual preference for one state over another is therefore the basis for valuation, and individuals order their preference for different states based on self-interest. People express their preferences through the choices and tradeoffs that they make, given certain constraints such as those on income or available time.

3.3 Measures of economic surplus: consumer surplus and producer surplus

Measures of value (or more correctly, "economic surplus") are derived from two principal concepts in welfare economics: consumer surplus and producer surplus. Consumer surplus is the difference between the price actually paid for a good, and the maximum amount that an individual is willing to pay for it (Figure 1). Compensating variation (CV) and equivalent variation (EV), and compensating surplus (CS) and equivalent surplus (ES) are more technically precise measures of economic surplus, which evolved from the concept of consumer surplus (Hicks 1943). Notions of "willingness to pay" (WTP) and "willingness to accept" (WTA) are directly linked to these measures of economic surplus (Pearce, Atkinson, and Mourato 2006).

Figure 1: Consumer surplus

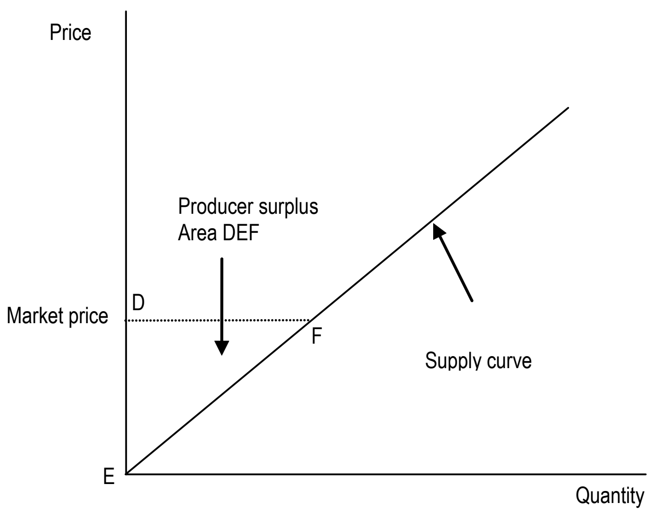


Producer surplus is the difference between the total amount earned from a good (price times quantity sold) and the production costs (Figure 2). If producers receive a higher price than the minimum price they are willing to accept, they receive a benefit from the sale (the producer surplus). Producer benefit is similar to consumer benefit, because it measures the gain

3 There is an assumption here that individuals act in a rational manner. A rational consumer will also choose the most preferred bundle of goods from a set of feasible choices (thereby maximizing his/her utility), and he/she is assumed to be able to prioritize or rank the different choices from any set of choices (Hanley and Spash 1993).

to the producer from receiving a price higher than the minimum price they would accept for the good. Intuitively, total economic surplus is simply the sum of consumer surplus and producer surplus.

Figure 2: Producer surplus



3.4 Willingness to pay (WTP) and willingness to accept (WTA)

WTP and WTA represent two alternative means to measure value. WTP is the amount (measured in goods, services, or dollars) that an individual is willing to give up for a particular good or service. WTA is the amount (measured in goods, services, or dollars) that a person is willing to accept to forego a particular good or service. In general, increases in value are often associated with WTP, and decreases in value are often associated with WTA. Historically, economists were largely indifferent between the use of WTP and WTA for valuation purposes, with most of the literature focusing on WTP. More recent research has identified divergences between valuations using WTP versus WTA, and the decision as to which measure to use may have important policy implications. In the context of non-market goods and services, both measures may be relevant depending on the property rights regime in place (Table 1).

Table 1: Property rights, WTP, and WTA

Property Rights	Decrease in value	Increase in value
Right to the status quo	WTA to tolerate loss of existing service or amenity	WTP to secure gain from to new service or amenity
Right to a new situation	WTP to avoid loss of planned/future service or amenity	WTA to forego gain from new service or amenity

By comparing the results of 45 studies that measure WTP and WTA, Horowitz and McConnell (2002) highlight the importance of choosing the most appropriate measure for valuation purposes. For example, in the case of preserving coastal land from development, the authors suggest (based on the results of their study) that the amount of land that would be preserved, if development deeds were in public hands (i.e. WTA compensation), would be approximately seven times higher than if the rights were in the hands of the landowner and had to be purchased by the public (Horowitz and McConnell 2002). The authors also show that the less a good behaves like a market good, the higher is the ratio of WTA/WTP (Table 2). Public and non-market goods have the highest ratio, meaning that the choice to use WTP versus WTA to value a non-market good or service can have a significant impact on the choice of policy alternatives for that good or service.

Table 2: Ratio of WTA/WTP for different goods

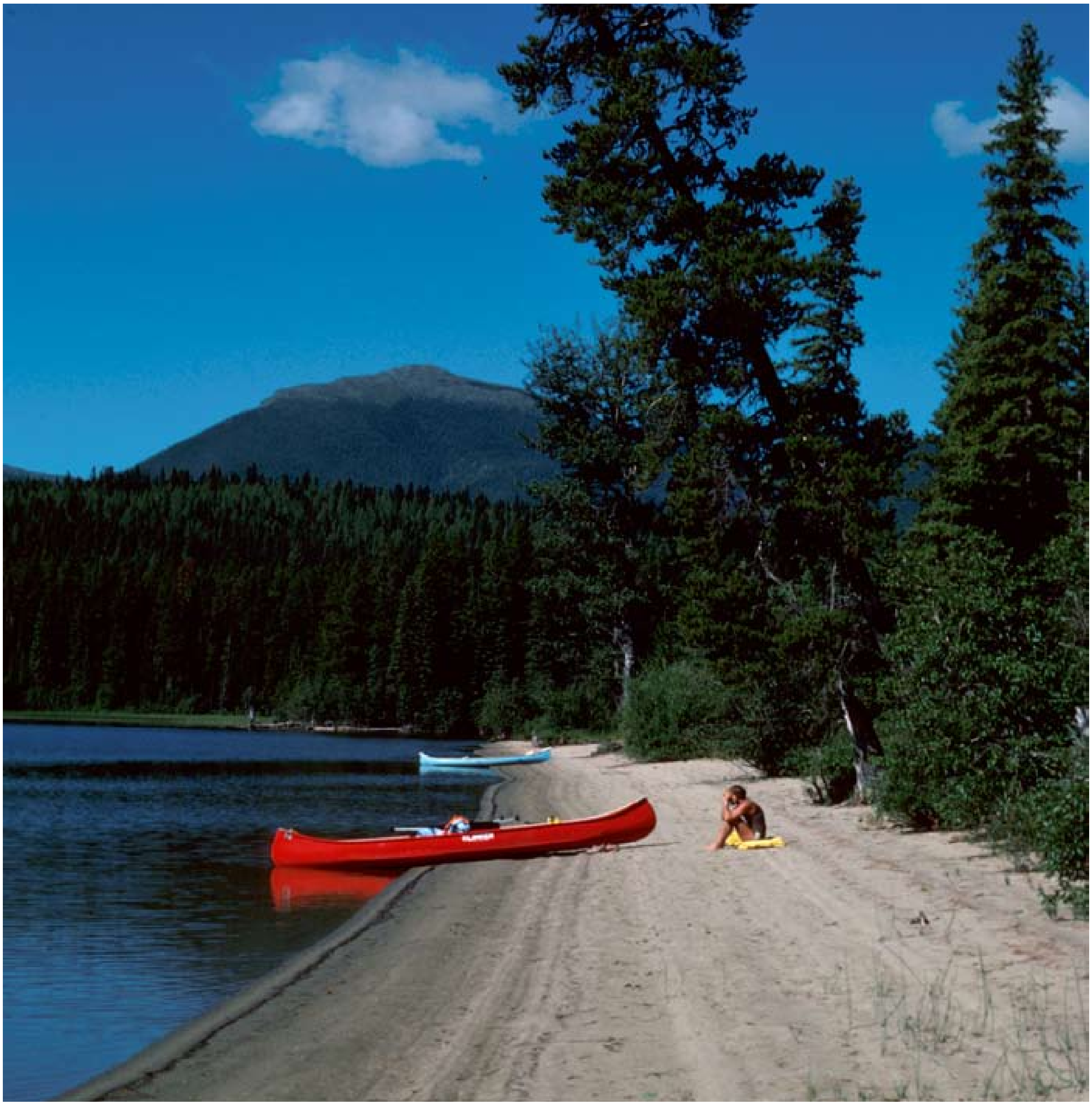
Type of Good	Ratio	Standard Error
Public or non-market	10.4	2.5
Health and safety	10.1	2.3
Private goods	2.9	0.3
Lotteries	2.1	0.2
Time at which good is supplied	1.9	0.2
All goods (mean value)	7.2	0.9

Source: Horowitz and McConnell (2002)

3.5 Marginal versus total value

Economists measure discrete, or marginal (i.e. very small) changes in the value of ecosystem goods and services, as opposed to the total value of the goods or services provided. It is important to bear this in mind when considering the value of ecosystem services, or the value of ocean and marine coastal resources in this report. An attempt by Costanza et al. (1997) to measure the total value of global ecosystems was met with some criticism for not adhering to fundamental economic tenets of marginal analysis (Bockstael et al. 2000; Pearce 1998).

It is also important not to confuse total value in this sense with total economic value (TEV). TEV is a framework for aggregating the marginal values of different components of an ecosystem, and is discussed in more detail in Section 5.



4. Context and Background

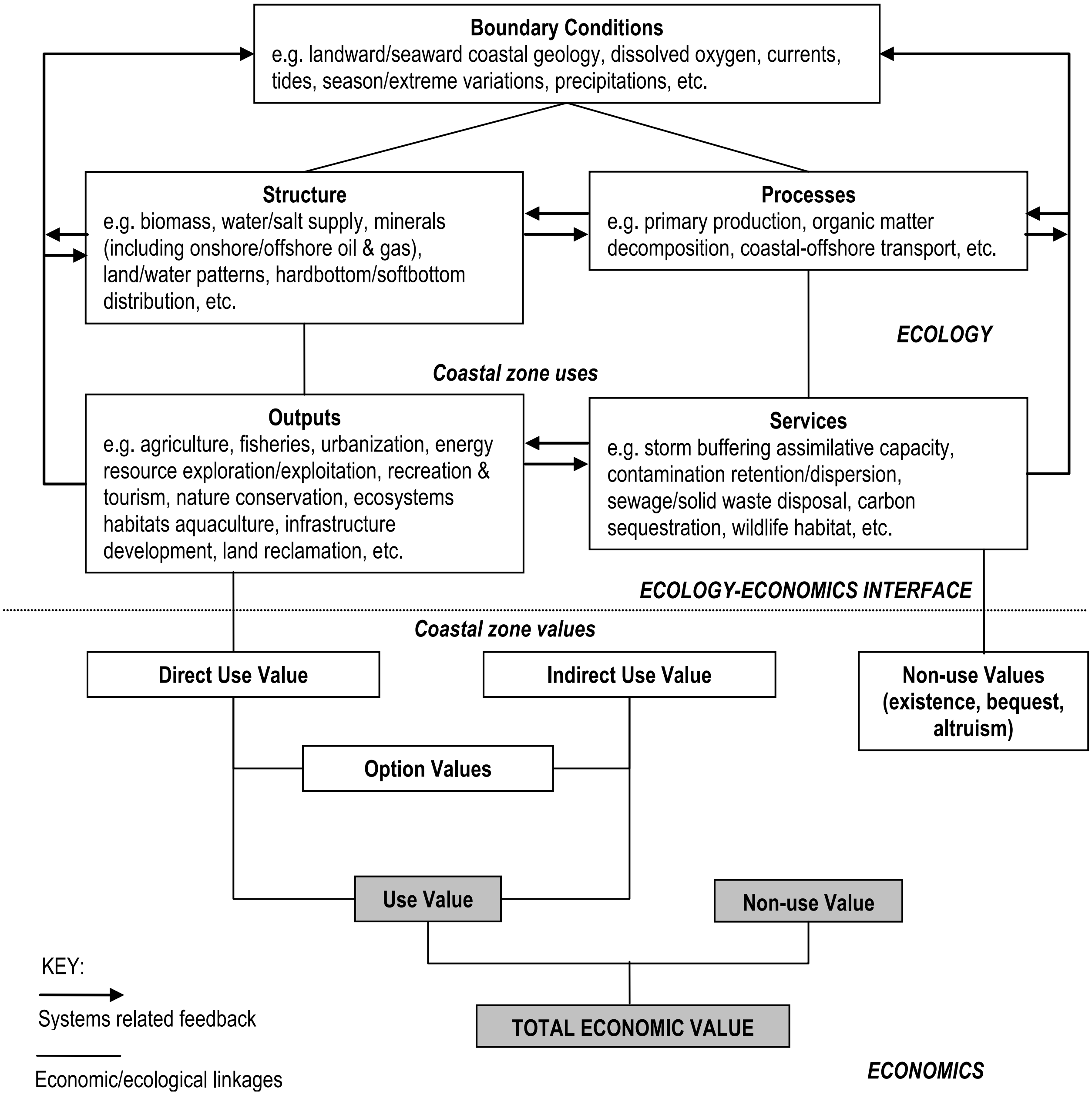
4.1 Ecosystem services, and the ecological-economic interface

The Millennium Ecosystem Assessment (MA) recognizes a range of benefits obtained by people from coastal and marine ecosystems (UNEP 2006). These ecosystem benefits include: provisioning services such as food, water, timber, and fibre; regulating services such as the regulation of climate, floods, disease, wastes, and water quality; cultural services such as recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling[4]. Approximately 70% of the Earth's surface is covered by oceans, and marine systems are highly interconnected by a network of surface and deep-water currents. Ocean and coastal ecosystems are among the most productive, and threatened, ecosystems in the world. They include terrestrial ecosystems, areas where freshwater and saltwater mix, near-shore coastal areas, and open ocean areas (UNEP 2006).

Coastal areas are the interface between continental land masses and a continuum of ocean aquatic systems, including rivers, estuaries, coastal fringes, and the continental shelf (Turner 2000). These systems are interdependent, and characterized by complex biogeochemical processes and functions: primary productivity generation (solar energy fixation), organic biomass decomposition, nutrient fixation, and carbon sinks. River networks and wetlands are important delivery and processing mechanisms. Rivers provide both downstream (e.g. nutrients and groundwater) and upstream (e.g. salmon spawning) delivery services, and wetlands filter many of these nutrients on their way to the ocean. These systems, processes, and functions both benefit (in the form of ecosystem derived goods and services), and are affected by, human activity. Socio-economic activities dominate coastal and related land areas, all of which reflect the final demand of a variety of goods and services within the area. These socio-economic demands increase environmental pressures, which can lead to changes in environmental systems states. Natural ecosystem variability can also augment these environmental pressures. The link between ecosystem processes, composition and functions, and the output of goods and services and related socio-economic impacts is graphically represented below (Figure 3), and the valuation of use and non-use values is discussed in Sections 5 and 6.

4 Hein et al. (2006) distinguish between three categories of ecosystem services: production services, regulation services, and cultural services. Supporting services are not included since they are integral to the underlying functions of an ecosystem; hence, their inclusion might lead to double counting (Hein et al. 2006: 211). De Groot, Wilson, and Boumans (2002) classify ecosystems functions into four categories: regulation, habitat, production, and information. Ecosystem functions are defined as "the capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly" (de Groot, Wilson, and Boumans 2002: 394; de Groot 1992) It is from these functions that all ecosystem goods and services flow.

Figure 3: Coastal zone functions, uses, values, and valuation methodologies



Based on Turner (2000)

4.2 The coastal zone: British Columbia

British Columbia's coastline stretches 27,000 km, and the value of output from the ocean sector was $6.0 billion in 2000[5], measured in terms of its direct contribution to Gross Domestic Product (GDP) (Lacroix 2006; Mitchell 2003). Approximately 70% of the province's population lives on or near the coast, as compared to 40% of the world's population that lives on or near the coast (Map 1).

5 An updated study will be available in April 2007 (GSGislason and Associates Ltd. Forthcoming, April 2007).

Map 1: British Columbia's coastal environment

Source: BC Stats (2004)

The bulk of the population on British Columbia's coast live in the Greater Vancouver Regional District (GVRD), and the Capital Regional District around Victoria (CRD). These Districts accounted for more than half of British Columbia's entire population in 2001 (Table 3).

Table 3: Population growth on British Columbia's coast (by coastal district)

Area	1996 Census	2001 Census	2005 Estimate	Growth (91 – 05)	2025 Projection
Greater Vancouver	1,906,500	2,073,662	2,155,880	13.08%	2,746,489
Capital	331,098	340,030	351,022	6.02%	408,158
Nanaimo	126,265	132,555	141,080	11.73%	192,391
Comox-Strathcona	101,367	100,325	105,327	3.91%	135,341
Cowichan Valley	73,530	75,139	78,802	7.17%	98,569
Kitimat-Stikine	45,397	42,662	42,919	-5.46%	48,072
Alberni-Clayoquot	32,840	31,664	32,692	-0.45%	30,944
Squamish-Lillooet	32,059	34,533	37,193	16.01%	61,904
Skeena-Queen Charlotte	25,787	22,639	22,464	-12.89%	25,309
Sunshine Coast	25,781	26,713	28,557	10.77%	39,419
Powell River	20,621	20,627	21,114	2.39%	20,734
Mount Waddington	15,144	13,683	13,684	-9.64%	13,606
Central Coast	3,900	3,943	3,905	0.13%	3,991
Stikine	1,455	1,374	1,377	-5.36%	1,663
Total (14 coastal districts)	**2,741,744**	**2,919,549**	**3,036,016**	**10.73%**	**3,826,590**
Province of British Columbia	3,874,276	4,078,447	4,254,522	9.81%	5,350,793

Source: BC Stats (2005; 2006)

Despite increasing pressure on coastal resources, economic activity and human wellbeing are higher in coastal zones than inland. This situation is due, in large part, to the highly productive capacity of coastal ecosystems that support complex marine and terrestrial food webs, and provide important goods and services for human benefit. Coastal First Nations communities were, and still are, heavily dependent on ocean and marine coastal resources for food, fuel, building supplies, medicinal, transport, trade, ceremonial, spiritual, and other needs (BC Ministry of Environment 2006). Historically, many of these communities recognized the complex interactions between economic, social, and environmental aspects of coastal resources and ecosystem services. In many instances, non-market values were, and still are, at the heart of conservation and management strategies practised by coastal First Nations.

5. Framework for Non-market Valuation

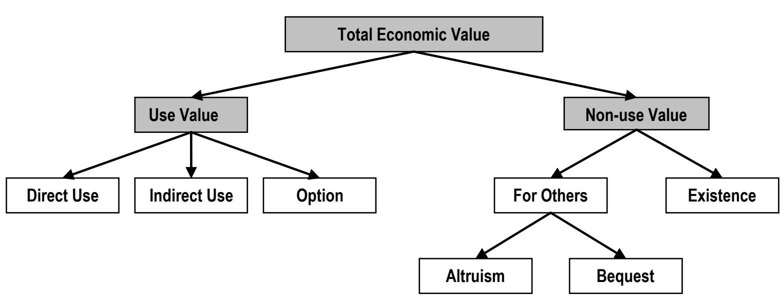
5.1 Introduction

Increasing population density in coastal zones is evidence of the value of marine coastal and ocean resources; however this has also increased pressure on the availability of these resources. The relative scarcity of any resource increases the value of the resource, unless substitutes[6] or alternatives are available. In economic terms, scarcity is reflected through price signals in the market for goods and services: the scarcer the good or service, the higher the price. Price signals also regulate demand and consumption, and provide feedback to policymakers regarding future action. But what about the case of non-market goods and services? How do we value these goods and services, or measure the direct and indirect contributions they make to our lives? How do we incorporate non-market values into a decision making framework, such as CBA? For example, how do we determine subsistence values for goods and services consumed by First Nations, or determine compensation values for damage to cultural or spiritual services provided by coastal ecosystems (McDaniels and Trousdale 2005; Wolfe 2004)? How do we value the contribution of functioning ecosystems and species richness to the production of biomass; an extremely important issue when considering the current state of global fisheries (Knowler 2002; Worm et al. 2006)? In another context, anecdotal evidence suggests that ocean views are highly valued, but how do we isolate the value of an ocean view when the empirical evidence (house prices) are confounded by many other factors other than the view (Benson et al. 1998; Wardley 1993)?

5.2 Total Economic Value

The most common and most appropriate framework for aggregating the value of ecosystem goods and services (including non-market goods and services) is total economic value (TEV). This approach does not necessarily assess the total value of an ecosystem, but rather allows changes to be calculated for all values (use and non-use values) associated with one or several ecosystem functions (Figure 4). TEV can be assessed as willingness to pay (WTP) or willingness to accept (WTA) payment. WTP is the more common method, as more tools for estimating economic value are relevant to this approach. WTP can also be considered a conservative estimate in cases where WTA would be preferred, although this approach may underestimate values if WTA is the more appropriate method (Horowitz and McConnell 2002). The net sum of WTP and WTA across use and non-use values defines the TEV.

Figure 4: Total economic value (TEV)



Based on Pearce, Atkinson, and Mourato (2006)

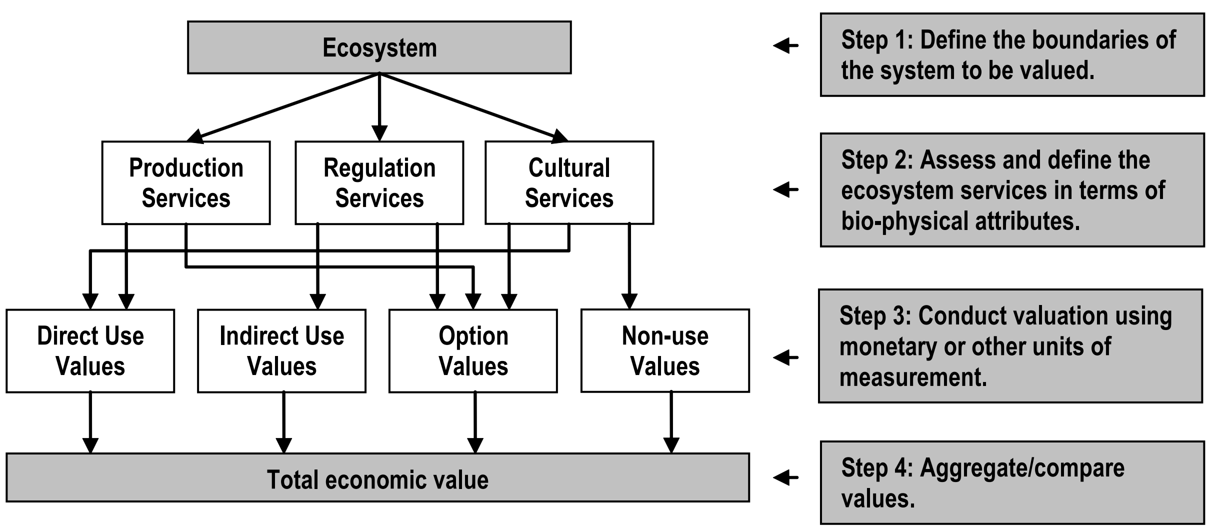
6 Most goods and services have substitutes (e.g. margarine can be substituted for butter), and once they become too costly, the cost drives innovation to find cheaper substitutes. However, some goods and services are unique, and have no economic substitutes (e.g. water, air). Many of these nonsubstitutable goods and services are derived from ecosystem functioning, and are vital to sustaining life on Earth (McMichael, Butler, and Folke 2006).

Direct use value refers to the value derived from the direct use or interaction with ecosystem-based provisioning services (e.g. food, water), and some cultural services (e.g. recreation). Indirect use value refer to the value derived from regulating services (e.g. climate control, waste assimilation, water quality) and supporting services (e.g. nutrient cycling). Option value refers to the value derived from the option to make use of a resource in the future. Non-use (also referred to as "passive use") values are derived from benefits associated with a resource or ecosystem-based service. These values include existence value (sometimes referred to as intrinsic value), which is the value derived from knowing something exists; bequest value, which is the value derived from being able to pass something on to another generation; and altruism value, which is derived from giving something to somebody else. There is a great deal of debate regarding the validity and accuracy of non-use values, but few economists would deny their existence (Cummings and Harrison 1995; Johansson 1992; Loomis et al. 2000).

5.3 TEV: an applied framework for valuing ecosystem goods and services

Hein et. al (2006) outline a series of steps to value ecosystem services, with specific reference to spatial scales (Figure 5). Since any calculation of TEV will depend heavily on the spatial and temporal scales being assessed, economists must be clear about the intended scope of their study (Bateman et al. 2006; Bateman et al. 2002; Pate and Loomis 1997). Temporal scales present economists with many valuation challenges, especially regarding the issue of intergenerational equity, and the application of discount rates for CBA purposes (Hanley 1999; Sumaila 2004; Sumaila and Walters 2005).

Figure 5: Applied framework for ecosystem valuation

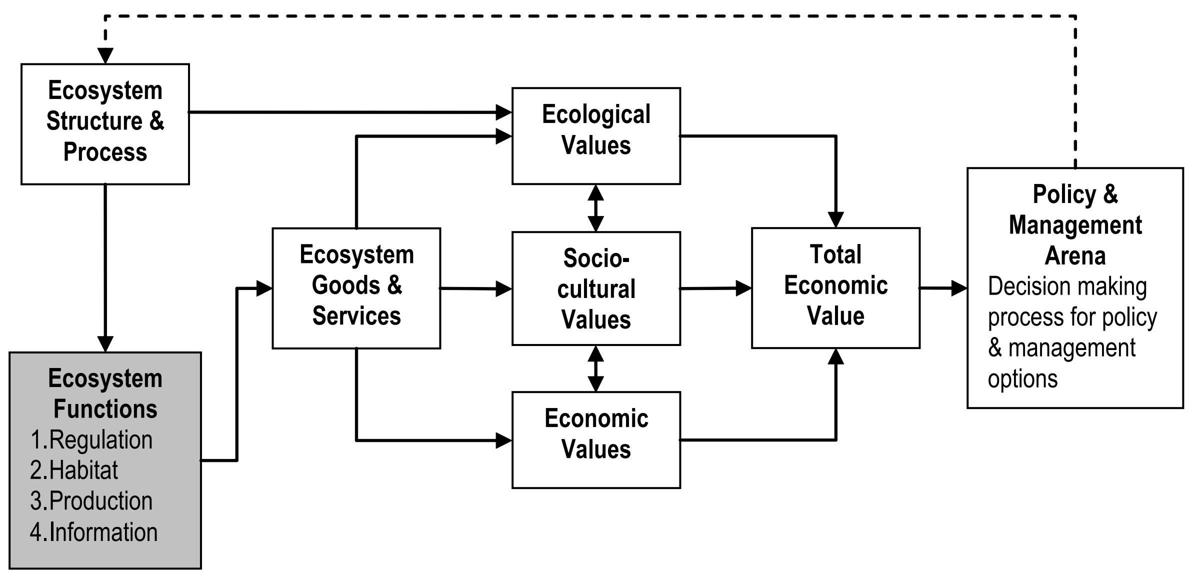


Based on Hein et al. (2006)

5.4 Non-market goods and services: British Columbia

As with many ocean and coastal locations, British Columbia is dependent on complex and productive ecosystems that generate many different goods and services. These systems include the ocean, coastal deltas and shelves, estuaries, wetlands, beaches, etc. The distinction between "goods" and "services" is important, especially as it relates to the underlying processes and outputs described earlier in this section (Figures 3 and 5). Ecosystem services contain all "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life" (Daily 1997: 3). Ecosystem goods are tangible, and represent the material products that are derived from ecosystem functioning for human use (de Groot, Wilson, and Boumans 2002). Ecosystem goods and services are present at multiple scales, "from climate regulation and carbon sequestration at the global scale, to flood protection, water supply, soil formation, nutrient cycling, waste treatment and pollination at the local and regional scales" (Wilson et al. 2005: 3) The degree to which these goods and services affect human welfare vary from relatively indirect impacts (e.g. climate regulation and carbon sequestration services of the ocean), through to direct impacts (production of food, raw materials, genetic resources, recreational opportunities, and aesthetic and cultural values in coastal areas) (Wilson et al. 2005). This section uses a typology developed by de Groot, Wilson, and Boumans (2002) to categorise ecosystem functions that capture a wide range of ecosystem goods and services. These functions are regulation, habitat, production, and information (Figure 6). Regulation functions relate to the regulating role of ecosystems for life support systems; habitat functions of ecosystems provide refuge and reproduction habitat for flora and fauna; production functions flow from the primary production process; and information functions are derived from the role of natural ecosystems as a "reference function" (de Groot, Wilson, and Boumans 2002: 395).

Figure 6: Ecosystems functions within integrated valuation framework



Based on de Groot, Wilson, and Boumans (2002)

Table 4 is an overview of non-market related goods and services provided by the four ecosystem functions in British Columbia. The first column is a list of 22 specific functions, the second column describes the underlying ecosystem processes involved, and the third column is a list of related goods and services. These goods and services are ecologically sustainable since they are generated by ecosystem functions, unlike the extraction of oil and gas, and other non-renewable resources (all of which are market related goods).

Table 4: Functions, goods and services of ocean and marine coastal resources in British Columbia

Function	Ecosystem Processes & Components	Goods & Services (examples)
Regulation Functions	**Maintenance of essential ecological processes & life support systems**	
1. Gas regulation	Role of ocean ecosystem in bio-geochemical cycles (e.g. CO2/O2 balance, ozone layer, etc.)	1.1. UVb protection by O3 1.2. Maintenance of air quality 1.3. Influence on climate 1.4. Maintaining a balanced chemical composition in the atmosphere
2. Climate regulation	Influence of ocean area & coastal interface, & biological processes (e.g. DMS production) on climate	2.1. Maintenance of favourable climate (e.g. temp., precipitation, gas regulation) for human habitation, health, cultivation, etc.
3. Disturbance prevention	Influence of ecosystem structure on limiting environmental disturbances	3.1. Storm protection (e.g. reefs, coastal veg.) 3.2. Flood protection (e.g. wetlands, coastal forests)
4. Water regulation	Role of coastal wetlands, estuaries, deltas in regulating runoff & river discharge	4.1. Regulation of global, regional & local scale hydrology through currents & tides 4.2. Medium for transport
5. Water supply	Filtering, retention & storage of fresh water (e.g. storage of water returned to land as precipitation)	5.1. Provision of water for consumption
6. Stabilization of bottom sediment (soil retention)	Role of reefs, seagrass & other vegetation in stabilizing in-shore coastal areas	6.1. Increase water clarity 6.2. Prevents coastal erosion (especially under stormy conditions)
7. Erosion & sediment transport/deposition (soil formation)	Moving sediments from source areas & replenishing depositional areas	7.1. Contributes to coastal accretion
8. Nutrient cycling/ regulation	Role of flora & fauna in the storage, internal cycling, processing & acquisition of nutrients, nitrogen fixation, phosphorus cycles	8.1. Maintenance of healthy ecosystems
9. Waste treatment	The breakdown of excess xenic & toxic compounds	9.1. Pollution control 9.2. Detoxification of waste
10. Biological control	Population control through trophic-dynamic relations	10.1. Control of pests & disease 10.2. Maintenance of biodiversity
Habitat Functions	**Providing habitat (suitable living space) for wild flora & fauna**	
11. Refugium function	Suitable living space for wild fauna & flora	11.1. Maintenance of biological & genetic diversity (thus the basis for many other functions)
12. Nursery function	Suitable reproduction & feeding habitat for resident & transient populations	12.1. Feeding & nursery habitats for resident & transient populations of harvested species 12.2. Maintenance of commercially harvested species

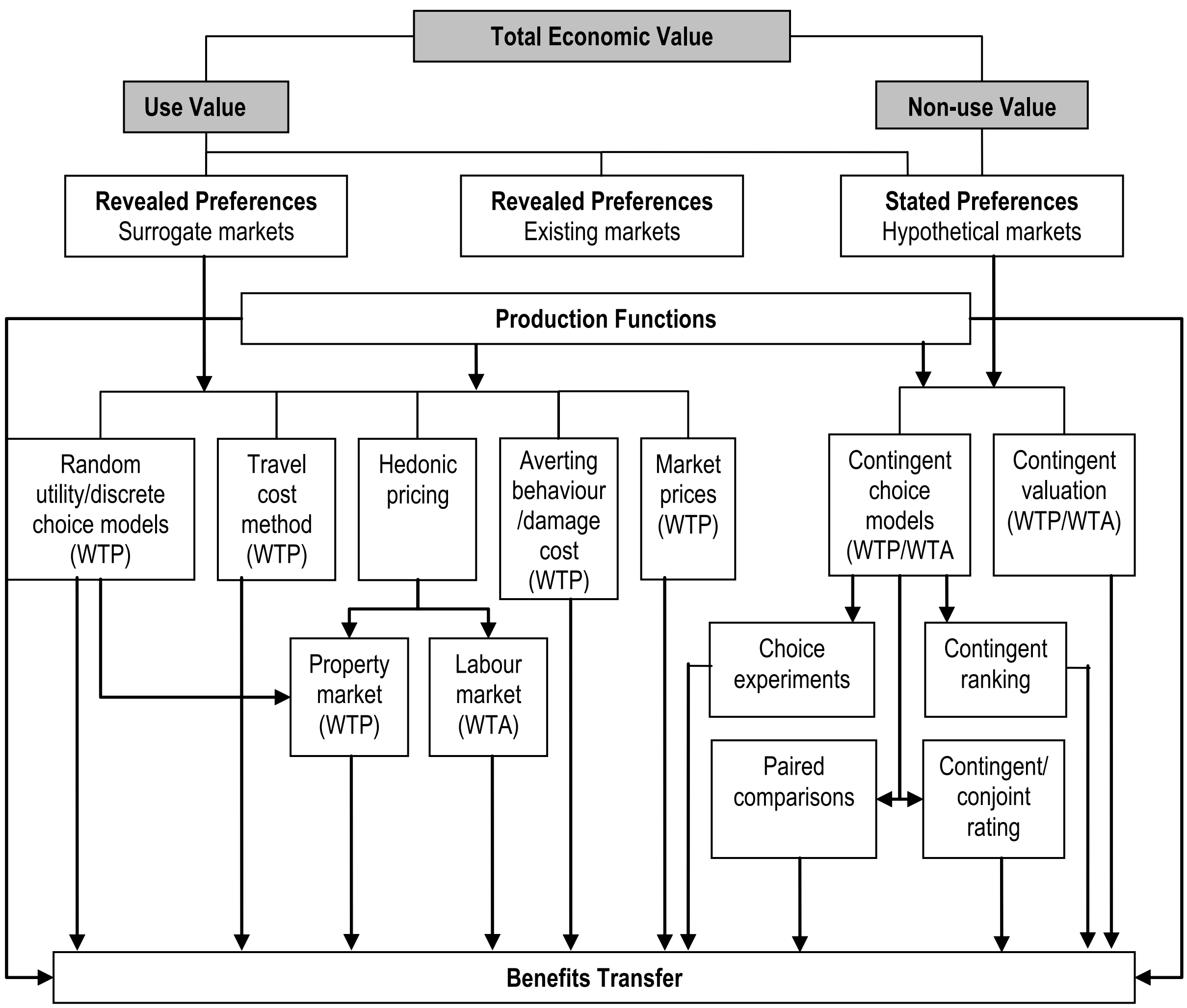
Function	Ecosystem Processes & Components	Goods & Services (examples)
Production Functions	**Provision of natural resources**	
13. Food	The portion of gross primary production which is extracted as food for humans	13.1. Subsistence harvest of pelagic & non-pelagic species 13.2. Small-scale, subsistence aquaculture
14. Raw materials	The portion of gross primary production which is extracted as fuel or building material	14.1. Building & manufacturing for subsistence purposes 14.2. Renewable energy (e.g. tidal, wave, wind, thermal, solar & microbial fuel cells) 14.3. Fertilizer & other organic matter
15. Genetic resources	Genetic material & evolution in wild flora & fauna	15.1. Health care & other applications
16. Medicinal resources	Variety in (bio)chemical substances in, & other medicinal uses of, wild flora & fauna	16.1. Drugs & pharmaceuticals 16.2. Chemical models & tools 16.3. Test- & essay organisms
17. Ornamental resources	Variety of flora & fauna in natural ecosystems with (potential) ornamental use	17.1. Resources for ceremonial, spiritual, fashion, handicraft, decoration, & souvenirs
Information Functions	**Providing opportunities for cognitive development**	
18. Aesthetic information	Attractive seascape features	18.1. Enjoyment of scenery (ocean views, beaches, cliffs, etc.)
19. Recreation	Variety in seascape with (potential) recreational use	19.1. Travel to natural ecosystems for eco-tourism, outdoor activities, etc. (boating, kayaking, sport fishing, whale, bird & general wildlife viewing, beach & water related activities, scuba diving, sailing & powerboat activities, etc.)
20. Cultural & artistic information	Variety in natural features with cultural & artistic value	20.1. Use of ocean & coastal features as symbols & sources of inspiration
21. Spiritual & historic information	Variety in natural features with spiritual & historic value	21.1. Use of nature for spiritual or historic purposes (e.g. heritage value of natural ecosystems & features)
22. Science & education	Variety in natural features with scientific & educational value	22.1. Use of natural systems for school excursions, etc. 22.2. Use of nature for scientific research

Based on de Groot, Wilson, and Boumans (2002)

6. Methodological Approaches for Non-market Valuation

The potential for multiple use and non-use values derived from ocean and marine coastal ecosystem functioning clearly demonstrates why TEV provides a useful framework to aggregate or compare these values across a single site or system. Within this framework, a number of methodological approaches exist to value non-market goods and services (Figure 7).

Figure 7: Valuation methodologies within TEV framework



Based on Pearce, Atkinson, and Mourato (2006)

Each method is often best suited for a particular valuation task. For example, in an ocean and coastal context, the travel cost method is often used to measure recreational values, the hedonic pricing method for valuing coastal views, production function methods for valuing ecosystem services as factors of production, and contingent valuation methods for non-use values (Wilson et al. 2005).

The methodological approaches are broadly categorized into two groups: revealed preference methodologies and stated preference methodologies. Valuations based on revealed preferences are derived from prices paid for goods or services (i.e. real monetary exchanges in a market place that reveal the preferences of buyers); hence, they only measure use values (Figure 7) (Boyle 2003a). It may sound paradoxical that non-market goods and services are sometimes valued based on revealed preferences, but this approach is used to tease out non-market components that are contained in market-priced goods or services. The price of a house with an ocean view may be higher than the price of the same house without a view, so the difference in price may be function of the view (the purchaser does not pay separately for the view). The same site that generates a view for a home owner may also provide beach park facilities for recreational users, or assimilative waste treatment services for a local municipality. The value of the recreational benefits of the beach park can be derived using the travel cost method, another revealed preference approach that uses the cost of travel to the site (and the time it takes) to derive a value for the site. Valuations based on stated preferences reflect a WTP for a good or service (or a WTA to forego it) expressed in terms of a stated choice in hypothetical scenarios presented to respondents (Brown 2003). Using the above case of beach park amenities, it is possible to value, for example, the benefits associated with additional facilities, an improvement in water quality, or simply the value derived from walking on the beach, or knowing the beach exists. Alternatively, the value of the habitat function for fish species, or the capacity of the coastal structure to protect local residents and their property could be derived based on respondents' WTP to preserve the area from encroachment or development.

A number of other valuation methods exist, even if they are not as commonly used, or as precise a measure of economic value (Table 5). Many of these methods are based on cost-derived measures of value. These methods do not provide strict measures of economic value (i.e. WTP or WTA); instead, they assume that the cost of avoiding damages, or of replacing ecosystem services provides a useful estimate of the value of these ecosystem services. This approach is based on the assumption that the services are worth at least what people paid to replace them. The value of assimilative services provided to local municipalities for waste water treatment can be measured using a replacement cost method, although this approach may misstate the value if incorrectly applied (Freeman III 2003b; Gosselink, Odum, and Pope 1974). The discharge of untreated effluent into the Georgia Strait is a case in point. The Capital Regional District, on Vancouver Island, has relied on the assimilative capacity of the ocean to treat its solid waste. The capital cost estimates for building primary and secondary treatment facilities (excluding land costs and annual maintenance costs, etc.) at Clover Point and Macaulay Point, for the CRD, are $237 million and $447 million respectively (Stubblefield et al. 2006). However, replacement cost is only a valid measure of economic value if three conditions are met: (1) the human-engineered system must provide comparable quality and scale of function; (2) the human-engineered system must be the least costly alternative; and (3) individuals, in aggregate, must be willing to incur these costs if the natural system were not available (Freeman III 2003b: 460)[7].

7 On point (3), there is some debate regarding the willingness of individuals, in aggregate, to incur the cost of building treatment facilities (Stubblefield et al. 2006: 97-99).

Table 5: Other valuation methods

Valuation Method	Short description	Welfare measure
Avoided cost	Ecosystem services allows society to avoid costs that would have been incurred if the services were not available. (e.g. off-shore islands provide flood control, thus avoiding property damage along the mainland coast).	Estimates a value for ecosystem services based on avoiding damages due to lost services.
Replacement cost	Cost of replacing ecosystem service with an alternative technology	Estimates a value of ecosystem services based on the cost of replacing a service.
Opportunity cost	Value of next best alternative use of resources (e.g. agricultural use of water and land)	Consumer surplus, producer surplus, or total revenue associated with next best alternative
Production function	Estimates value of ecosystem functions as an input in production. This method is based on the assumption a non-marketed good or service is an input into the production of a marketed good or service.	Producer surplus
Net factor income	Ecosystem services enhance incomes, and value is assigned as a function of associated product(s), net of costs of other inputs (e.g. water quality improvements increase fish biomass, leading to an increase in incomes accruing to fishers).	Producer surplus

A final approach to non-market valuation is the benefit transfer method. Benefit transfer is a cost-effective method of assigning existing values or functions that were developed for a particular context, to another context that exhibits similar characteristics. For example, in 1993 an oil spill in Tampa Bay Florida caused significant damage to a 13 mile section of the coast. A damage assessment determined that significant non-market costs were incurred by local recreational users when the beach was closed. In one instance, assessors determined that compensation be paid in the amount of $2.5 million, based on a travel cost valuation method (i.e. for the extra cost of having to travel to beaches elsewhere). In another instance, assessors determine that compensation be paid in the amount of $11.25 million for a related spill of similar magnitude, based on a benefit transfer analysis (NOAA 2002). Benefit transfer is a controversial method, especially regarding its use to value ecosystem services that differ in magnitude and scope. Its use should be restricted to cases where the following conditions apply: (1) the good or service being valued is very similar to the good or service at the original site; (2) the affected populations exhibit similar characteristics; and (3) the original value is meaningful (Pagiola, von Ritter, and Bishop 2004).

6.1 Revealed preference methods

6.1.1 Hedonic pricing method

The hedonic pricing method is used to estimate economic values for ecosystem or environmental services that directly affect market prices. It is most often applied to variations in housing prices that reflect the value of local environmental attributes (Taylor 2003). It can be used to estimate economic benefits or costs associated with environmental quality (air pollution, water pollution, noise), or environmental amenities (aesthetic views, proximity to recreational sites). The basis of the hedonic pricing method is that the price of a marketed good is a function of its characteristics. To apply the hedonic pricing method, the following information must be collected: a measure or index of the environmental amenity of interest; and data on property values and household characteristics for a well-defined market area (e.g. distance to an environmental amenity, such as a view of the ocean).

Regression analysis is used to analyze the data, which relates the price of the property to its characteristics and the environmental characteristic of interest. The regression results indicate how much property values will change for a small change in each characteristic, holding all other characteristics constant. This process can be complicated by a number of factors: a non-linear relationship between price and the characteristic of interest; correlation between variables, which can lead to understating the significance of some variables in the analysis. Different functional forms and model specifications can be used to overcome these complications.

The hedonic pricing method has a number of advantages and disadvantages:

Advantages	Disadvantages
▪ it can be used to estimate values based on revealed preferences; ▪ property markets can be good indications of value since they respond reasonably efficiently to information; ▪ property records are reliable, and data on property sales and characteristics are easily available; ▪ the method is versatile, and can be adapted to consider several possible interactions between market goods and environmental quality.	▪ the scope of environmental benefits that can be valued is limited to attributes related to housing prices; ▪ the method only captures people's WTP for perceived differences in environmental attributes, and their direct consequences (i.e. if they are not aware of the link between the environmental characteristic and the benefits accruing to them, the value will not be reflected in the price of the home); ▪ the method assumes that people have the opportunity to select the combination of features they prefer, given their income; ▪ the method is relatively complex to implement and interpret, requiring a high degree of statistical expertise, it requires large amount of data, and the results depend on model specification.

6.1.2 Travel cost method

The travel cost method is used to estimate the value of recreational benefits derived from ecosystems (Parsons 2003). It assumes the value of the site, or its recreational services, is a function of peoples' WTP to get to the site. It uses actual behaviour (revealed choices) to infer values. The travel cost method can be used to estimate economic benefits or costs generated by changes in access costs for recreational sites, elimination of existing recreational sites, addition of new recreational sites, or changes in environmental quality at recreational sites.

The basis of the travel cost method is that time and travel expenses incurred by visitors is the "price" of accessing the site. Their willingness to pay to visit the site can be estimated using the number of trips made at different travel costs (analogous to estimating their WTP for marketed goods based on the quantity demanded at different prices). The travel cost method uses established economic modelling techniques to measure value, the data is derived from actual choices, it is based on an uncontroversial assumption that travel costs reflect recreational value, and it is relatively inexpensive to apply.

To apply the travel cost method, the following information must be collected: number of visits from each origin area; demographic data about residents from each area; round-trip distance from each area; travel costs per kilometre; the value of travel time (or the opportunity cost). Using various survey methods, additional information can be collected in terms of other sites visited or substitute sites; other possible reasons for making a trip to the site; characteristics of the site, and quality of experience at the site. The most challenging elements of applying the travel cost method relate to the treatment of multi-purpose trips, classification of travel time as a cost (as opposed to being part of the recreational experience), and how to determine the opportunity cost of travel time.

The travel cost method has a number of advantages and disadvantages:

Advantages	Disadvantages
▪ the travel cost method replicates empirical methods applied by economists to estimate economic values based on market prices; ▪ the method is based on actual behaviour, as opposed to hypothetical behaviour; ▪ the method is relatively inexpensive to apply; ▪ people are usually willing to participate in on-site surveys; hence sample sizes are large and representative; ▪ results are relatively easy to analyze and describe.	▪ the travel cost method assumes people respond to changes in travel costs the same way they respond to changes in admission price; ▪ simple applications of the method assume individuals take a trip for one purpose only, to visit a recreation site (if there is more than one purpose, the value may be overestimated); ▪ the definition and measurement of the opportunity cost of time is problematic (travel time must be accounted for, otherwise the value may be underestimated); ▪ substitute sites affect value (i.e. a person who has access to substitute sites, but who still visits the site of interest may value it more that a person who has no access to substitutes sites, given both travel the same distance); ▪ respondents who value particular sites may choose to live nearby (i.e. they will have low travel costs, and therefore their high preference for the site is not captured); ▪ interviewing visitors on site can introduce sampling biases to the analysis; ▪ distances travelled need to vary enough in order to estimate the demand function, which is often not the case for sites near metropolitan areas where the origin areas are quite close to each other; ▪ user participation is required, which limits the scope of its analysis (i.e. the value of the site may be underestimated because the method cannot be used to assign values to on-site ecosystem goods and services that are not valued by users, nor can it be used to estimate non-use values or off-site goods and services supported by the site); ▪ as in all cases of statistical analysis, the results can be affected by the choice of functional form, model estimation techniques, and variable selection.

6.2 Stated preference methods

6.2.1 Contingent valuation method

The contingent valuation method (CVM) is used to estimate use and non-use economic values for a wide range of non-market ecosystem and environmental goods and services (Boyle 2003b). It is also a controversial valuation method (Arrow and Solow 1993; Carson, Flores, and Meade 2001; Carson 2000). The contingent valuation method is based on asking respondents how much they would be willing to pay (or accept, if a loss) for a specific ecosystem or environmental good or service. The method is conducted using a survey, and the term "contingent" is based on a respondent's WTP (or WTA) for a good or service, contingent on a hypothetical scenario. It is a stated preference method because it relies on each respondent's statement of value in a surrogate market environment. Since it does not rely on revealed preferences expressed via the market, it is very flexible, but also subject to criticism. Contingent valuation is one of the few methods used to assign dollar values to non-market, non-use values of the environment including life support functions generated by ecosystems, recreational benefits such as wildlife viewing or scenery, and the option of enjoying these activities in the future (or bequeathing them to future generations), or simply knowing they exists.

Applying the contingent valuation method requires a series of complicated steps: survey design, pre-testing, and implementation. An ill-conceived design may produce misleading results, especially if the hypothetical scenario is unclear. Survey questions must focus on specific goods or services, in a clearly defined context. For example, building a boardwalk in a coastal marsh area may provide a number of benefits, but it is crucial that the survey question define exactly what good or service is being valued as a result of the improved access to the area (such as bird watching). Respondents must be reminded not to confound their willingness to pay for a specific good or service with other possible benefits that may arise from the improvement to the ecosystem or the environment. Survey questions can be framed as open-ended (i.e. what is the maximum amount a respondent is willing to pay for specific good or service) or closed-ended (i.e. the respondent is asked whether they would be willing to pay a specified amount for a specific good or service). The closed-ended (also know as discrete choice) format is generally the preferred method. The results of a contingent valuation survey must be properly analysed to ensure accurate values are assigned.

The contingent valuation method has a number of advantages and disadvantages:

Advantages	Disadvantages
▪ contingent valuation is flexible, and can be used to value almost any ecosystem or environmental good or service; ▪ it is the most prevalent method for estimating TEV (use and non-use values); ▪ the results of a contingent valuation survey are relatively easy to analyse and describe (dollar values can be presented as a mean/median value per capita/household, or as an aggregated value for the affected population); ▪ it is widely applied, and ongoing research continues to offer new applications and improvements to the method.	▪ as a stated preference method, contingent valuation is controversial, especially regarding its ability to accurately measure respondents' WTP. There may be a fundamental difference between the way hypothetical decisions are made versus actual decisions; ▪ it assumes respondents understand what is being valued, and that they make the same rational decisions about their choices in the hypothetical scenario as they would make in a market environment; ▪ bias is possible since a respondent may be answering a different question to what the surveyor intended (i.e. instead of focusing on the value of the item the respondent may focus on other elements of the scenario); ▪ respondents may also react to the scenario itself, including the method of payment (e.g. taxes), description of the environmental good or service, etc.; ▪ respondents may make associations among environmental goods or services that the researcher did not intend. For example, a survey that asks a respondent for their WTP for improved swimming conditions at a beach (i.e. cleaner water) may be affected by the respondent's association of value stemming from cleaner water that improves fish habitat; ▪ the difference between WTP and WTA for ecosystem or environmental goods and services can be significant (Horowitz and McConnell 2002), which further questions the validity of hypothetical scenarios versus real choices; ▪ survey design issues and respondent perceptions are often interactive, which can affect values: "ordering problem", where people are influenced by the order in which goods or services are valued; "embedding", where the value of a single part of an ecosystem good or service is perceived to be the same as the entire system; choice of payment vehicle (e.g. a tax or a contribution), which can influence a respondent's response; ▪ strategic bias, where a respondent tries to influence the outcome for his/her personal reasons; information bias, where respondents have limited knowledge of the good or service in question; non-response bias, where non-respondents have different values than respondents; ▪ it is difficult to validate estimates of non-use values; ▪ contingent valuation studies can be expensive and time-consuming, and the method is still not always accepted by policymakers, the legal system, and other decision makers.

6.2.2 Contingent choice method

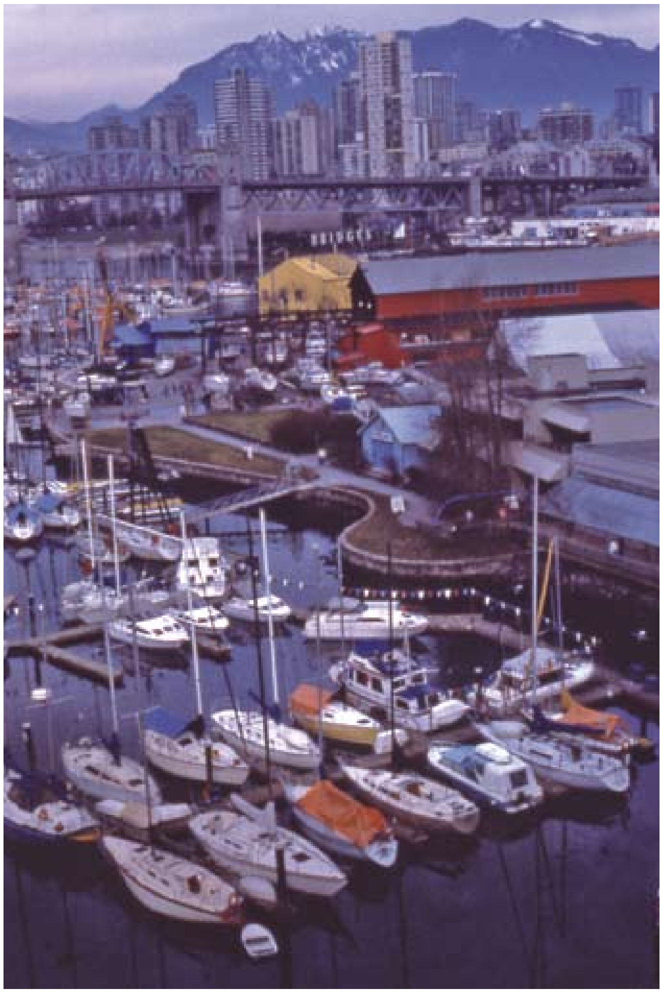
Like the contingent valuation method, the contingent choice method[8] is used to estimate use and non-use economic values for a wide range of non-market ecosystem and environmental goods and services (Holmes and Adamowicz 2003). It also asks people to make choices based on hypothetical scenarios; however, it differs

8 The contingent choice method is closely related to contingent valuation. However, contingent valuation is widely recognized as a stand alone method for estimating value that directly asks respondents to state their WTP. Contingent choice methods are not as well established, and are differentiated from contingent valuation by the indirect reference to WTP in hypothetical choice scenarios that contain more than one attribute. Contingent choice methods are also referred to as conjoint analysis or attribute-based methods (Holmes and Adamowicz 2003).

from contingent valuation in that it does not directly ask people to state their WTP for a particular good or service. Instead, their WTP is inferred from the choices they make, with respect to the scenarios presented to them. The first study to use the contingent choice method to value non-market environmental goods and services was done by Adamowicz et al. (1994). Since then, it has become an increasing well recognized method for the valuation of non-market goods and services (Christie et al. 2006; Boxall et al. 1996; Adamowicz et al. 1998; Hanley, Wright, and Adamowicz 1998). Although it is not applied as extensively as the contingent valuation method, it does offer certain advantages: reduction of some the potential biases associated with contingent valuation; generation of additional information from each respondent; and the possibility of testing for internal consistency (Alpizar, Carlsson, and Martinsson 2001).

The contingent choice method asks the respondent to state a preference between one group of environmental services or attributes, at a given price to the individual, and another group of environmental attributes at a different price. Since it focuses on tradeoffs among scenarios with different attributes, contingent choice is especially suited to policy decisions where a set of possible actions might result in different impacts on natural resources or environmental services. Thus, it is particularly useful in valuation of improvements to ecosystems, given that several service flows are often simultaneously affected. Improved water quality in the beach example may improve the quality of several services, including swimming, fishing, and biodiversity.

A number of variations of the contingent choice method can be applied: contingent ranking; discrete choice experiments; and paired rating. Contingent ranking surveys ask individuals to compare and rank alternate program outcomes with various attributes, including costs. In a discrete choice experiment, respondents are simultaneously shown two or more alternatives with the same attributes, but each attribute may differ in terms of its specified level. Respondents are then asked to identify the most preferred alternative in the choice set. Paired rating is a variation of the discrete choice experiment, where respondents are asked to compare two alternate situations and are asked to rate them in terms of strength of preference relative to the other alternative. In each of the three variations, statistical analysis is central to the interpretation of the data to determine WTP for valuation purposes. As with contingent valuation, in order to collect useful data and provide meaningful results, the contingent choice survey must be properly designed, pre-tested, and implemented. With the focus on tradeoffs rather than direct expressions of dollar values, the contingent choice method minimizes some of the problems associated with contingent valuation. In addition, respondents are usually more comfortable expressing relative values in contingent choice studies versus absolute values in contingent valuation studies.



The contingent choice method has a number of advantages and disadvantages:

Advantages	Disadvantages
▪ the contingent choice method can be used to value single attributes, or impact of large-scale changes; ▪ respondents are encouraged to think in terms of trade-offs, which is easier than directly expressing dollar values. The trade-off process makes it easier to check for consistency of responses, and the scenarios are more "life-like"; ▪ the direct trade-off between environmental attributes and money, prevalent in contingent valuation studies, is deemphasised in favour of qualitative rankings or ratings of attribute bundles that include prices; ▪ survey methods may be better at estimating relative values than absolute values, and even if results are not 100% accurate they are still useful for policy decisions; ▪ the method minimizes many of the biases that can arise in open-ended contingent valuation studies where respondents are required to "price" non-market amenities; ▪ the method has the potential to reduce other problems associated with contingent valuation (e.g. expressions of symbolic values, protest bids).	▪ respondents may find it difficult to evaluate certain trade-offs if they are unfamiliar with the process, and they may resort to simplified decision rules if the task is too complicated (which may bias the results); ▪ if the number of attributes or the levels of each attribute are increased, the sample size (or number of comparisons each respondent makes) must be increased; ▪ if a respondent is faced with too many comparisons or choice sets, he/she may lose interest in the exercise; ▪ contingent choice may extract preferences in the form of attitudes as opposed to behaviour intentions, and by limiting the number of options respondents may be forced into making choices they otherwise would not make; ▪ contingent ranking requires more sophisticated statistical techniques to estimate WTP. ▪ translating the answers into dollar values, may lead to greater uncertainty in the actual value that is placed on the good or service of interest. ▪ although contingent choice has been widely used in the field of market research, its validity and reliability for valuing non-market goods and services is relatively untested.

6.3 Benefit transfer method

The benefit transfer method is used to estimate economic values for ecosystem goods and services by transferring existing information from completed studies in one location and/or set of characteristics to another location and/or set of characteristics (Rosenberger and Loomis 2003). The concept of benefit transfer is based on the assumption that the situations are similar enough to warrant such a transfer of results, and that the results of the original study are accurate. It can be a useful method, especially when costs and scale are too high, or time is too limited to administer original valuation studies. Prior to a series of papers in Water Resources Research in 1992, the benefit transfer method transferred point estimates or measures of central tendency for one study to another (Rosenberger and Loomis 2003). Loomis (1992) advocated a more complex approach that involved the transfer of entire WTP or demand functions, while other authors conducted meta-regression analyses to generate a more robust alternative to single point estimates (Walsh, Johnson, and McKean 1992).

Appling a benefit transfer requires a number of steps: identification of relevant studies; review of the studies for transfer applicability in terms of site and demographic characteristics, and validity of results; and adjustment of existing values to better reflect the values for the site under consideration.

The benefit transfer method has a number of advantages and disadvantages:

Advantages	Disadvantages
▪ benefit transfer is generally a cheaper method than an original valuation study; ▪ valuation of economic benefits can be estimated more quickly than an original study; ▪ it can be used as a preliminary tool to determine whether an original valuation study is needed; ▪ it is quick and easy to conduct a benefit transfer for gross values associated with recreational values, as long as the sites and recreational experiences are similar; ▪ a wide range of relevant literature is sometimes available.	▪ benefit transfer may have limited validity, unless the sites share all of the site, location, and demographic characteristics; ▪ the number of ideally suited studies may be limited, unavailable, or difficult to find if unpublished; ▪ relevant studies may not disclose sufficient information to make important adjustments to the point estimate or function; ▪ existing studies may not be accurate or valid, and benefit transfers can only be as accurate as the initial value estimate. ▪ point estimates can quickly become dated.

7. Review of Valuation Studies

Costanza et al. (1997) generated a great deal of debate about the value of global ecosystem services[9], including services provided by ocean and marine coastal resources. To derive estimates of the economic value of ecosystem services, the authors used existing estimates of productivity per hectare of each ecosystem type and service, and a WTP estimate for the service. By estimating a per hectare value of the ecosystem service for each ecosystem type, and by aggregating the results across all services, they established a value per hectare for each ecosystem type. This per-hectare value was then multiplied by the number of hectares of each ecosystem type, and summed across ecosystem types to derive the total value of ecosystem services. They estimated that the annual value of ecosystem services for the earth ranged from $16 trillion to $54 trillion, with a mean estimate of $33 trillion. This value was significantly higher than the value of global GDP at that time ($18 trillion). While they were criticized for their methodological approach and results (e.g. potential for double counting, and the high value of ecosystem services compared to global GDP), their study did focus attention on the role of ecosystem services in general, and more specifically on ocean and coastal ecosystem services.

Using the typology generated by de Groot, Wilson, and Boumans (2002), Wilson et al. (2005) cross-referenced ecosystem goods and services against coastal landscape features and habitats to identify, and differentiate between, values associated with landscape features, habitats, or both (Tables 6 & 7). This approach is important because "an accurate land-cover classification needs to be able to delineate whether or not ecosystem services are derived from landscape features or habitat to prevent the danger of double counting" (Wilson et al. 2005: 6). The information in Table 6 demonstrates that ecosystem good and service values can be linked to landscape features, habitats, or both. Open squares indicate potential ecosystem goods and services generated by landscape features and habitats, and ticked squares represent empirically derived values for ecosystem goods and services (Wilson et al. 2005).

9 Costanza et al. (1997) valued 17 ecosystem services in their study: nutrient cycling (accounting for over 50 percent of the total value), cultural values, waste treatment, water supply, disturbance regulation, food production, gas regulation, water regulation, recreation, raw materials, climate regulation, erosion control, biological control, habitat and refugia, pollination, genetic resources, and soil formation.

Table 6: Ocean and coastal zone goods and services

	Ecosystem Services																		Goods				
	Gas regulation	Climate regulation	Disturbance prevention	Water regulation	Water supply	Soil retention	Soil formation	Nutrient regulation	Water treatment	Biological control	Habitat functions	Refugium function	Nursery function	Aesthetic info	Recreation	Cultural & artistic info	Spiritual & historic info	Science & education	Food	Raw materials	Genetic resources	Medical resources	Ornamental resources
Landscape Feature																							
Cliffs			☐								☐	☐	☐	☐	☐	☐	☐	☐		☐			☐
Fjords			☐								☐	☐	☐	☐	☐					☐			☐
Estuaries	☐		☐	☑	☑			☑	☑		☐	☐	☐	☐	☑				☑	☑			☐
Tidal plains			☐	☐				☐	☐		☐	☐	☐	☐	☐	☐	☐		☐				
Barrier coast			☑								☐	☐	☐	☐	☐				☐				☐
Lagoons	☐	☐	☐	☐				☐			☐	☐	☐	☐	☐	☐	☐		☐				☐
Deltas	☐	☐	☐	☐	☐		☐	☐	☐		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐			
Beaches			☑			☐					☐	☐		☑	☑	☐	☐		☐				
Habitat - Intertidal																							
Cliffs			☐									☐	☐	☐	☐			☐					
Shingle			☐									☐	☐	☐	☐				☐				
Kelp	☐		☐			☐		☐		☐		☐	☐					☐	☐	☐			☐
Seagrass	☐		☐			☐		☐				☐	☐	☐				☐	☐				
Estuary	☐	☐	☑					☑	☑	☐		☐	☑	☑	☑			☐	☑				
Wetland	☐	☐	☑	☑	☑		☐	☑	☐	☐		☐	☐	☐	☑			☐	☑				
Salt marsh	☐	☐	☐			☐	☐	☑				☐	☐					☐	☑				
Mud flat			☑					☐				☐	☐					☐	☐				
Lagoons	☐	☐	☐					☐				☐	☐	☐	☐			☐	☐				
Sandbank								☐				☐			☐			☐	☐	☐			
Coral/reef								☐		☐		☐	☐	☐	☑	☐	☐	☐	☑	☑	☐	☐	☐
Ocean	☐	☐						☐		☐		☐		☐	☑	☐	☐	☐	☑		☐		

☑ = *Economic values available in peer-reviewed literature* ☐ = *No economic values available in peer reviewed literature, but values probable*

Based on Wilson et al. (2005)

Table 7: Summary of non-market ecosystem service values – Wilson et al. (2005)

Function	Author(s)	Location	Valuation Study	Method	Value	Note
Recreation & nutrient regulation	Bockstael, McConnell, & Strand (1989)	Chesapeake Bay, USA	Monetary value of water quality associated with 20% reduction in N2 & P introduced into the estuary.	Contingent valuation (CV) & Travel Cost (TC)	$10 - $100 million (aggregate WTP, 1984 $)	Assumption that improvement in water quality will improve the wellbeing of recreational users (beach use, boating, swimming, fishing) in the Chesapeake Bay.
	Kawabe & Oka (1996)	Tokyo Bay, Japan	Monetary value of water quality associated with reduction in N2 in the bay.	CV & TC	TC: ¥458.3 billion CVM: ¥1285 billion (both methods measure change in consumers' surplus, 1993 ¥)	Assumption that improvement in water quality will improve the wellbeing of recreational users (recreation types 1, 2, & 3) in Tokyo Bay.
	King (1995)	Eastbourne, England	Access to beach & seafront facilities on Eastbourne coast.	CV	£4.5 million (aggregate WTP, 1993 £)	Valuation of beach landscape feature for recreational visitors (based on WTP an entrance fee to visit).
	Johnston et al. (2002)	Peconic Estuary System, Long Island, USA	Value of recreational activities.	CV	Swimming: $12.11 million Boating: $18.03 million Fishing: $23.69 million Bird/wildlife viewing: $27.27 million (aggregate annual consumer surplus, 1995 $)	Total annual benefits (access values) for each of the four recreational activities studied. The total benefits are estimated by multiplying average consumer surplus for an activity by the estimated total number of trips to engage in that activity during the year (1995).
Aesthetic information	Leggett & Bockstael (2000)	Anne Arundel County, Chesapeake Bay, USA	Value of water quality improvement associated with decrease in observed fecal coliform count.	Hedonic	$230,000 (41 parcels) $12.12 million (494 parcels) Data collected between 1993 & 1997	Effect of hypothetical improvement in water quality on waterfront house prices (41 parcels & 494 parcels respectively).
Disturbance prevention	Farber (1987)	Louisiana, USA	Value of one mile strip of wetland on Louisiana gulf coast	Avoided cost	$1.1 & $3.7 million (discounted at 8% & 3% respectively, 1980 $)	Value of wetlands for their role in reducing wind damage to property because of diminished storm intensity.
	Parsons & Powell (2001)	Delaware, USA	Cost of beach retreat over 50 years	Hedonic	$291 million (2000 $)	Measures the cost of beach retreat in terms of land & capital losses.
Habitat & nursery functions	Johnston et al. (2002)	Peconic Estuary System, Long Island, USA	Value of wetlands in terms of food web productivity & habitat (eelgrass, salt marsh, intertidal mud flat).	Production function & ecological modelling	Eelgrass: $12,412 Salt marsh: $4,291 Intertidal mud flat: $786 (marginal asset value per acre, based on 25 year period & discount rate of 7%, 1995 $)	Productivity study yields estimates of the value of wetland ecosystems in the production of fish, shell fish, & birds. Results indicate substantial variance in ecological productivity values based on ecosystem type.
Existence value	Johnston et al. (2002)	Peconic Estuary System, Long Island, USA	Resource value of wetlands, shellfish areas, & eelgrass.	Contingent choice	Wetlands: $56,671 Shellfish areas: $31,744 Eelgrass: $69,956 (marginal asset value per acre, based on 25 year period & discount rate of 7%, 1995 $)	The contingent choice survey estimates relative preferences that residents & second homeowners have for preserving & restoring key PES natural & environmental resources.

Many non-market valuation studies on ocean and marine coastal resources in British Columbia, and further afield, focus on ecosystem services that directly or indirectly affect commercial and recreational fisheries (Mandale 1998; Sumaila et al. 2000b; Sumaila and Charles 2002; Worm et al. 2006; Massey, Newbold, and Gentner 2006; Sumaila 2004; Knowler 2002; Knowler et al. 2003; Alder et al. 2002; Reeves 2000; Cameron and James 1987; Duffus and Dearden 1993). This focus is a natural extension of the importance of the fishing sector to British Columbians, although the recognition of the environment as an important "factor of production" is more recent. Overall, the number of non-market valuation studies of ocean and marine coastal resources in British Columbia is quite limited, and more (and ongoing) research needs to be undertaken to provide policymakers with valid and meaningful information (see Section 8. for specific recommendations). Table 8 is a summary of British Columbia related valuation studies. These studies explore a range of non-market values for ecosystem services, including sport and commercial fishing, ocean views, marine protected areas, habitat, and ecosystem functioning. Duffus and Dearden (1993) focused on the recreational value of whale-watching in their policy and management oriented paper. Valuation of wildlife is important in terms of its existence, option, and recreational values, especially in the case of endangered species (Loomis and White 1996).

Table 9 is a cross-section of non-market valuation studies that are of relevance to British Columbia. While certainly not exhaustive, these summaries are examples of studies completed in the United States, and elsewhere. Many non-market valuation studies, in the United States, focus on recreational benefits associated with fishing, beaches, boating, water quality, and wildlife viewing; habitat (wetland, salt-marshes, deltas, estuaries, eelgrass, mud-flats, etc.) and ecosystem services that benefit commercial fisheries; and non-use benefits associated with existence, option, and bequest values. The study of non-market values associated with ocean and coastal resources has received significant recognition, especially after the Exxon-Valdez oil spill in Alaska, and the subsequent use of contingent valuation to evaluate non-market damages (Arrow and Solow 1993; Carson et al. 2003). The National Ocean Economic Program has a dedicated database of non-market valuation studies that contains a substantive list of references (National Oceans Economic Program (NOEP) 2006). Environment Canada hosts an "Environmental Valuation Reference Inventory" with a similar, although less comprehensive, list of ocean and marine coastal resource studies (Environment Canada 2006).

Table 8: Summary of non-market valuations in British Columbia

Author(s)	Location	Type	Valuation Study	Method	Value	Note
Cameron & James (1987)	South coast	Recreation	WTP for recreational fishing days in British Columbia.	Contingent valuation (CV)	Mean WTP for a recreational fishing day = C$49 per angler Average marginal value of extra fish caught (Chinook salmon) = C$14 per angler (1984 C$)	The CV survey established the habits of the fishermen, including where & when they fished, & their expenditures for fishing. For the WTP question, the respondent was asked whether he would still have gone fishing that day if the cost of the day's trip had been $(X) higher.
Knowler et al. (2003)	South Thompson drainage area	Habitat	Valuing freshwater salmon habitat.	Production function (bio-economic model)	C$1,322 - C$7,010 per km of coho salmon stream length (in perpetuity period & discount rate of 5%, 1994 C$)	Changes in land use can potentially reduce the quality of fish habitat & affect the economic value of commercial & sport fisheries that rely on the affected stocks. Parks & protected areas that restrict land-use activities provide benefits, such as ecosystem services, in addition to recreation & preservation of wildlife.
Sumaila et al. (2000a)	Strait of Georgia	Ecosystem functioning	Value of restoring Strait of Georgia ecosystem (restoration versus status quo).		Economic: C$261 Ecological-economic: C$2,469 Ecological-economic-social: C$ 3,796 (annual profit in '000 C$ per km2 of the ecosystem; 20-yr horizon & discount rate of 4.23%; 0.1 degradation/yr in status quo)	This analysis shows that restoring the Strait of Georgia ecosystem is a sound economic policy. It will help improve the potential market & non-market benefits from the ecosystem. As expected the gains are much higher when we incorporate non-market values, namely, the ecological & social values of the ecosystem.
Sumaila et al. (2000b) Alder et al. (2002) Sumaila & Charles (2002)	Marine protected areas	Habitat & biodiversity	Economic concepts related to marine protected areas.			These papers provide an overview of marine protected areas (MPAs), a concept that is attracting widespread attention worldwide, & the role of economic analysis & modeling in designing, implementing & evaluating MPAs.
Wardley (1993)	Oak Bay, Victoria	Aesthetic	Value of ocean views.	Hedonic & CV	Not available for review	M.A. thesis, University of Victoria

Table 9: Summary of relevant non-market valuation studies for British Columbia

Author(s)	Location	Type	Valuation Study	Method	Value	Note
Anderson (1989)	Virginia, USA	Habitat	Value of restoring seagrass habitat.	Production function & simulation modelling	$1.8 million/year benefit to blue crab fishermen. Additional $2.4 million benefit to consumers blue crab consumers	Seagrass beds appear to serve as preferred habitat for the blue crab (Callinectes sapidus) during early stages of its life history, & there is a statistically significant relationship between the abundance of submerged aquatic vegetation & catch per unit of effort in the Virginia hard-shell blue crab fishery.
Bell & Leeworthy (1990)	Florida, USA	Recreation	Value of beach visits by non-resident visitors.	Travel cost (TC)	$23.74 billion (asset valued based on 70 million tourist beach days in Florida & a discount rate of 10%, 1984 $)	This analysis deals with tourists that come from significant distances to use principally beach resources.
Bell (1997)	Florida, USA	Recreation	Value of salt marsh wetland for recreational fishery.	Production function	Consumer surplus of $6,471 & $981 per incremental acre of wetland on east & west coast of Florida respectively (1984 $).	This paper is concerned with placing an economic value on the contribution of wetlands in supporting recreational fishing in the south-eastern United States.
Bergstrom, Dorfman, & Loomis (2004)	Lower Atchafalaya River Basin estuary, Louisiana, USA	Recreation	Benefit of ecosystem functions for recreational fishing.	TC	Mean annual WTP = $493.44 - $948.20 per person	A combined actual & intended travel behaviour model is described that can be applied to estimate the recreational fishing benefits of estuary restoration & protection.
Brown et al. (2001)	Tobago	Recreation	WTP to prevent further deterioration in the quality of a coral reef	Contingent valuation (CV)	$3.70 - $9.30 per household	The CV survey revealed how much respondents were willing to pay to prevent further deterioration in the quality of Buccoo Reef (i.e. to prevent a loss).
Carson et al. (1997)	Prince William Sound, Alaska, USA	Existence value – water quality	WTP for a program to protect the sound from future oil spills.	CV	1991 study: WTP $52.80 1993 study: WTP $52.81 (per household, per year)	The same CV survey was administered in 1991 (22 months after the Exxon Valdez oil spill), & in 1993 (four years after the spill) to test for temporal reliability of the CV method.
Curtis (2002)	Northern Ireland	Recreation	Consumer surplus for salmon angling by European nationality.	TC	Mean: IR£138.6 German: IR£161.5 Other European: IR£151.7 Rep. of Ireland: IR£145.9 North. Ireland: IR£115.6 (consumer surplus/fishing day/angler)	Angling quality, age and nationality were found to affect angling demand and economic value of salmon angling in Co. Donegal, Ireland.
Loomis (1989)	Siuslaw National Forest (SNF), & Porcupine-Hyalite Wilderness (PHW), USA	Recreation, commercial fishery	Change in value due to disturbance caused by timber harvesting.	Production function (bioeconomic model) TC	SNF: loss to recreational & commercial anglers of $2 million (30 year period) PHW: loss to recreational & commercial anglers of $3.5 million (50 year period)	The change in value of recreational & commercial fisheries caused by timber harvesting & road building on two national forests was measured using an improved bioeconomic approach.
Loomis & Larson (1994)	California, USA	Habitat	Value of increase in number of grey whales for two groups (whale-watchers & non-users (California households).	CV	WTP $29.73 per visitor/year	

Author(s)	Location	Type	Valuation Study	Method	Value	Note
Loomis (2006)	California, USA	Existence & option value, & recreation	Value of expanding California's sea otter population.	Benefit transfer	$16.1 million per annum (based on Hageman (1985) study) $66.8 million per annum (based on Loomis & White (1996) study) (WTP based on an increase of 196 sea otters & 11.5 million households in California)	Valuations are based on two previous studies regarding the value of sea otters, & endangered species in California.
O'Neill & Davis (1991)	Ireland	Recreation	The effects of three alternative definitions of demand on estimated parameters are explored in a TC study of aggregate demand for recreational angling.	TC	Estimated user benefits: 1. £9.1 million 2. £22.21 million 3. £10.66 million	
Söderqvist et al. (2005)	Sweden	Water quality	Mean WTP/respondent for an improvement in water quality.	Contingent choice	SEK 1200 (cod stocks); SEK 600 (bathing quality); SEK 600 (biodiversity)	Water quality is represented by level of fish stocks (cod); bathing quality; biodiversity levels.

8. Recommendations

The recommendations in this report are intended to provide (1) general guidance regarding the incorporation of non-market valuation of ocean and marine coastal resources into policy and decision-making processes in British Columbia (Recommendations 1 – 4); and (2) specific steps to value non-market goods and services derived from ocean and marine coastal resources (Recommendation 5). Further study is required to identify specific needs flowing from each recommendation, and it is important to acknowledge that the process may not be as linear as envisaged in this report.

Recommendation 1:
Understand the limits of economic valuation

TEV is comprised of a number of market and non-market values associated with different ocean and marine coastal resources (Figure 7, page 18). As such, no single method is able to capture the economic value of the multiple goods and services provided by ocean and marine coastal resources (Johnston et al. 2002). Since many valuation studies target specific goods or services, policymakers can be left with the impression that the "true value" of an ecosystem is represented in a single value, thereby ignoring the fact that different methodologies may estimate different aspects of value. However, it is also fundamental to address the possibility of double-counting when estimating the value of more than one ecosystem good or service, or when more than one valuation method is applied (Johnston et al. 2002). In this context, it is important that policymakers and managers understand the economic methods (and their limitations) used to value ocean and marine coastal resources. Finally, the traditional economic approach to valuation (i.e. valuing marginal or incremental changes) assumes stability of ecosystems near a local equilibrium, which "seldom take into account the inherent complexities and resulting uncertainties associated with management of complex adaptive ecosystems" (Folke 2006: 687).

Recommendation 2:
Adopt "total value" framing approach to the valuation of ecosystem services

The valuation of non-market goods and services has increased our level of understanding of the benefits associated with ecosystem and environmental functions. However, valuation studies do not operate in a vacuum; they are generally part of larger policy or management processes. As such, the valuation of non-market goods and services is potentially subject to manipulation. To mitigate this potential outcome, policymakers need to clearly frame the research objectives, and researchers need to accurately define their research questions. Both parties play and important role in ensuring valid and meaningful results, and there are four approaches to frame an ecosystem-based valuation study (Table 10).

Table 10: Approaches to valuation

Approach	Why to do it?	Characteristics	How to do it?
1. Determine the total value of the current flow of benefits from an ecosystem.	Leads to better understanding of the contribution to society made by ecosystems.	This approach typically arises in the context of national accounting: how much does an ecosystem contribute to economic activity? It can be asked at global, regional or national level.	Identify all mutually-compatible services; estimate the quantity of each service, and multiple by the value of each service.
2. Determine the net benefits of an intervention that changes an ecosystem.	To assess whether the intervention is economically feasible.	This approach typically arises in the context of policy or project objectives: is the policy or project economically feasible (i.e. CBA). This approach deals with changes in flow as opposed to total value of flows.	Measure how the quantity of each service would change as a result of the intervention, as compared to the quantity without the intervention; multiply by the marginal value of each service.
3. Examine how the costs and benefits of an ecosystem (or an intervention) are distributed.	To identify winners and losers (issues of equity and policy implications)	Different stakeholder groups often view the value of an ecosystem quite differently: winners and losers may react very differently to an intervention, and marginalized groups may need to have specific equity issues addressed.	Identify affected stakeholder groups; determine which specific services each group uses, and the value of each service to the group.
4. Identify potential financing sources for conservation.	Help make conservation financially sustainable.	Knowing an ecosystem has value is insufficient to protect it; who are they interested parties, and what are they willing to contribute to protect it?	Identify groups that receive large benefit flows; approach these groups to support conservation initiatives.

Based on Pagiola, Von Ritter, and Bishop (2004)

The framing approach outlined in Approach 1. (Table 10) is recommended in this report, given the importance of ocean and marine coastal resources in British Columbia, and the limited body of knowledge that currently exists regarding non-market values associated with these resources. This approach should be reviewed upon completion, or upon substantial performance of Recommendation 5. Approaches 2. and 3. (Table 10) have particular relevance to the management of ocean and coastal resources in British Columbia, but their application should be predicated by a thorough determination of the flow of benefits from ocean and coastal resources.

Recommendation 3:
Ensure valuation is part of an integrated, interdisciplinary framework

As Figure 3 (page 9) demonstrates, the output of goods and services associated with ocean and coastal resources is intricately linked to ecosystem processes, composition, and functions. This level of complexity requires an integrated approach to properly manage coastal resources, and valuation is just one component of the decision making process. Many jurisdictions use an integrated ecosystem-based approach to manage ocean and marine coastal resources, which requires the development of an interdisciplinary management framework (Turner 2000; Johnston et al. 2002). In addition, new approaches are needed to evaluate consumptive and non-consumptive use of resources, and to characterize the value society places on competing uses. To ensure sustainability of ecosystem goods and services, those approaches must consider the rights of future generations and include discounting procedures for adjusting CBAs over time. Thus, an effective and adaptive ecosystem-based management approach for the marine environment will require the integration of socioeconomic science with more traditional ocean science (NSTC Joint Subcommittee on Ocean Science and Technology 2007).

Recommendation 4:
Expand research of non-market valuation in British Columbia

It is important to focus on a number of key research gaps in order to integrate non-market values into policy, decision-making, and management frameworks in British Columbia (Water Science and Technology Board 2004):

- improve the documentation of ocean and marine coastal resources, and the potential goods and service they provide;
- focus on the effects of human change on ecosystem structure and function;
- increase collaboration and interdisciplinary training between natural and social scientists;
- develop more detailed mapping between ecosystem services (as conceived by ecologists), and the goods and services valued by people (as conceived by economists);
- recognize the ecological and economic links between marine and terrestrial ecosystems, and develop a suitable research framework to integrate these two study areas;
- expand the range of goods and services under study, and develop case studies and templates suitable for more general use;
- develop more integrated valuation techniques (e.g. dynamic production function approaches, and general equilibrium modelling of ecological-economic systems);
- improve understanding of spatial and temporal thresholds for ecosystems, and develop methods to assess and incorporate uncertainties associated with complex ecosystem characteristics into valuation methods.

Recommendation 5:
Value non-market ocean and coastal resources in British Columbia

The following steps are required to value non-market goods and services derived from ocean and coastal resources in British Columbia:

1. Identify all non-market goods and services derived from each of the ecosystem functions: regulation, habitat, production, information (Table 4 provides examples, not a complete inventory). This process will require, if possible, the collaboration of First Nations, and other coastal communities. The identification of these goods and services should also be incorporated into existing geospatial databases for ease of access and analysis (Bateman et al. 2002).
2. Assess the relevant scale (local, regional, national, global), and magnitude of all goods and services derived from each ecosystem function.
3. Prioritize the valuation of non-market goods and services identified in step 1. A suitable approach could be based on a matrix of scale and magnitude parameters; however, this approach is entirely anthropogenic, and needs further research to incorporate ecosystem vulnerabilities (see Recommendation 3).
4. Execute valuation studies in accordance with priorities identified in step 3. The execution of these studies will require careful assessment of each valuation approach based on suitability/applicability, cost, access to data, availability of requisite skills, and institutional capacity.
5. Integrate non-market values into policy, decision-making, and management frameworks at local, regional, national, and international levels.

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Resource management and ecosystem goods and services

Alder, J., D. Zeller, et al. (2002). "A method for evaluating marine protected area management." Coastal Management 30(2): 121.

An assumption underlying the growing support for marine protected areas (MPAs) is that they meet conservation goals and provide economic benefits to fisheries and ecotourism. However, support for MPAs will be at risk if managers cannot assess whether various MPA objectives are being fulfilled. Current approaches to MPA management emphasize the need to evaluate performance criteria; however, there is little consensus on criteria and their evaluation. We propose a marine protected area evaluation model (MPAEM), based on and modified from a multidisciplinary approach used to assess the sustainability of fisheries, called rapid appraisal of fisheries (Rapfish). The application of the MPAEM was explored in a pilot study of 20 MPAs located in different regions of the world. Results indicate that the MPAEM can be used to evaluate MPA management effectiveness. However, the manner in which the evaluation attributes are scored and ways of engaging user groups should be explored before MPAEM can become part of the day-to-day management of MPAs.

Bateman, I. J., A. P. Jones, et al. (2002). "Applying Geographical Information Systems (GIS) to environmental and resource economics." Environmental and Resource Economics V22(1): 219.

Many of the analyses undertaken by environmental and resource economics are intimately concerned with spatial variations. This article examines the contribution which Geographical Information Systems (GIS) may provide in incorporating the complexities of the spatial dimension within such analyses. The paper introduces the reader to the types of data handled by a GIS and overviews the practical functionality offered by such systems. A brief literature review is supplemented by a number of more detailed applications illustrating various GIS techniques which may be of use to the applied environmental or resource economist.

Brown, K., W. N. Adger, et al. (2001). "Trade-off analysis for marine protected area management." Ecological Economics 37(3): 417.

This paper outlines an approach to natural resource management that incorporates multiple objectives for protected area management within a decision-making framework. Both regulators and other major stakeholders are directly incorporated into the approach to enhance decision-making processes. We call this approach trade-off analysis. The approach uses a framework based on multi-criteria analysis (MCA) but involves stakeholders at all stages. This holistic approach is appropriate for multiple use, complex systems such as marine protected areas (MPAs), where many different users are apparently in conflict and where linkages and feedbacks between different aspects of the ecosystem and economy exist. The paper applies trade-off analysis to the case of Buccoo Reef Marine Park (BRMP) in Tobago. Stakeholder analysis is undertaken, and social, economic and ecological criteria identified. The impacts of four different development scenarios are evaluated for these criteria. Stakeholders are asked to weight different criteria and then the outcomes of different stakeholder weightings in the MCA are used to explore different management options. For BRMP, the MCA suggests consensus around development options characterised as limited tourism development for the area surrounding the park in association with the implementation of complementary environmental management. The approach has been used to enhance stakeholder involvement in decision-making and develop consensus-based approaches to management of the MPA.

Colman, R. (2001). The GPI Atlantic Natural Resource and Environmental Accounts: Experience and Lessons Learned in Nova Scotia. Ottawa, National Round Table on the Environment and the Economy.

Costanza, R., F. Andrade, et al. (1998). "Principles for sustainable governance of the oceans." Science 281(5374): 198.

Pressures being exerted on the ocean ecosystems through overfishing, pollution, and environmental and climate change are increasing. Six core principles are proposed to guide governance and use of ocean resources and to promote sustainability. Examples of governance structures that embody these principles are given.

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de Groot, R. S. (1992). Functions of Nature: Evaluation of Nature in Environmental Planning, Management and Decision Making, Wolters-Noordhoff.

Duffus, D. A. and P. Dearden (1993). "Recreational use, valuation, and management, of killer whales (Orcinus orca) on Canada's Pacific coast." Environmental Conservation 20(2): 149.

In this paper the non-consumptive recreational use of Killer Whales (Orcinus orca) on Canada's Pacific Ocean coast is used as an example of management difficulties that are associated with oceanic species. Problems associated with jurisdiction and institutional arrangements are coupled to significant levels of biological uncertainty and restricted management options, as well as to management concerns associated with the human domain. The case is conceptualized as an interaction between the human and more general ecological spheres, mediated by the history of the relationship between humans and the species in question. Two routes to regulation are presented, dealing respectively with the human and ecological aspects. Of particular significance is the idea that both types of information are necessary to maximize utility to both the human user and the Whales. The unfortunate logic that results from this study is that if Killer Whales (a high-profile species) in Canada (a well-endowed nation) have not warranted more substantial protection, then the outlook for less well-known marine species in areas of the world where resource management priorities involve more direct survival concerns, is not optimistic.

Ferguson, A., G. Holman, et al. (1989). Wetlands are Not Wastelands Application of Wetland Evaluation Methods to the Cowichan Estuary, British Columbia, Canadian Wildlife Service; Wildlife Habitat Canada.

Fisk, G. W., R. W. Knecht, et al. (1998). Integrated Coastal & Ocean Management: Concepts and Practices, Island Press.

Gosselink, J. G., E. P. Odum, et al. (1974). The Value of the Tidal Marsh. Baton Rouge: Louisiana State University, Center for Wetland Resources.

Tidal marshlands depend in great part for their biological richness in fresh water nutrients. The value of the tidal marsh is dependent on the normal quality and quantity of nutrient feeding systems from inland or upland sources. For this reason land use planning and development for both agricultural and urban purposes must consider the stability and growth of the tidal marsh areas. Because of the tidal activity which faces these marshes daily it has been estimated that over 50% of the organic matter and nutrients which feed and support surrounding estuarine environments are produced in the tidal marsh. These nutrients support wildlife, plants and trees, fish and shellfish, all of which could not survive in the nursery stage without the life-substances derived from the tidal marshes. Land developers and population increases are exerting strong pressures to fill marshlands for commercial, industrial and residential use. Among the uses which most threaten the tidal marsh are careless planning; industrial, agricultural and urban sewage disposal; and chemical pollution.

Gottfried, R. R. (1992). "The value of a watershed as a series of linked multiproduct assets." Ecological Economics 5(2): 145.

This paper views ecosystem as long-lived multiproduct factories. Increased use of one ecosystem good or service (function) often affects the supplies of other ecosystem functions. The relationships between these functions can be modeled in terms of key variables related to ecosystem management. Thus, the analyst can determine the different mixes of functions an ecosystem can perform. Watersheds can be viewed as a series of ecosystems linked spatially and temporally by the downward flow of water. Changes in the mix of upstream ecosystem functions change the mix of downstream ecosystem functions. The paper presents an approach to valuing one ecosystem as a multiproduct factory using consumer surplus. The author then proceeds to apply the same methodology to a watershed viewed as a series of linked multiproduct assets. Because the flow of water closely links upstream and downstream ecosystems, a watershed can be treated as one unit and valued accordingly. However, this approach obscures a question of particular interest. If erosion in an upstream ecosystem causes it to lose value, but in turn causes the wetland downstream to gain value. does the value of the watershed rise or not? The paper examines this issue in terms of boundaries, redundancy and defensive expenditures, sustainability, and other factors which must be considered in the economic valuation of the watershed.

Grigalunas, T. A., J. J. Opaluch, et al. (1988). "A natural resource damage assessment model for coastal and marine environments." GeoJournal V16(3): 315.

Hageman, R. K. and S. F. Center (1985). Valuing Marine Mammal Populations: Benefit Valuations in a Multi-species Ecosystem, National Marine Fisheries Service, Southwest Fisheries Center.

Lacroix, P. (2006). The emerging opportunity for the British Columbia maritime economy as a driver for innovation and economic diversification (Phase 1 - Draft), COIN Pacific.

Lotze, H. K., H. S. Lenihan, et al. (2006). "Depletion, degradation, and recovery potential of estuaries and coastal seas." Science 312(5781): 1806.

Estuarine and coastal transformation is as old as civilization yet has dramatically accelerated over the past 150 to 300 years. Reconstructed time lines, causes, and consequences of change in 12 once diverse and productive estuaries and coastal seas worldwide show similar patterns: Human impacts have depleted >90% of formerly important species, destroyed >65% of seagrass and wetland habitat, degraded water quality, and accelerated species invasions. Twentieth-century conservation efforts achieved partial recovery of upper trophic levels but have so far failed to restore former ecosystem structure and function. Our results provide detailed historical baselines and quantitative targets for ecosystem-based management and marine conservation.

MacDonald, K., D. Boyce, et al. (2002). Application of Environmental Damage Assessment and Resource Valuation Processes in Atlantic Canada. Study prepared for the OECD (2002) Handbook of Biodiversity Valuation. Paris, OECD.

Environmental damage assessment (EDA) is a management tool under development in Canada that works to identify, quantify and value environmental injuries. The goal of EDA is to support restoration of the affected ecosystem or natural resource to its "pre-incident" condition. A step-wise process is employed for completing an environmental damage assessment, beginning with identification and determination of the source and extent of the injury, followed by restoration planning, then implementation of the restoration plan. While EDA is still in its infancy in Canada, and there is a pressing need to establish protocols for data collection and analysis, this approach has shown considerable promise as an ecosystem restoration tool. So far, Environment Canada has used EDA in cases involving the release of hazardous substances into freshwater and coastal ecosystems.

Mandale, M. (1998). "Estimating the economic value of coastal and ocean resources: the case of Nova Scotia." Prepared for the Oceans Institute of Canada and the Atlantic Coastal Zone Information Steering Committee. Halifax, NS.

McGowan, J. A., D. R. Cayan, et al. (1998). "Climate-ocean variability and ecosystem response in the northeast Pacific." Science 281(5374): 210.

The role of climatic variation in regulating marine populations and communities is not well understood. To improve our knowledge, the sign, amplitude, and frequency of climatic and biotic variations should be compared as a necessary first step. It is shown that there have been large interannual and interdecadal sea-surface temperature changes off the West Coast of North America during the past 80 years. Interannual anomalies appear and disappear rather suddenly and synchronously along the entire coastline. The frequency of warm events has increased since 1977. Although extensive, serial, biological observations are often incomplete, it is clear that climate-ocean variations have disturbed and changed our coastal ecosystems.

Mitchell, C. (2003). Canada's Ocean Industries: Contribution to the Economy 1988 - 2000, Ocean Policy Division, Department of Fisheries and Oceans.

The objective of this report has been to estimate the direct impact of each industry segment of the ocean sector on the national, Atlantic, Pacific, and Arctic regional gross domestic product (GDP). Two earlier reports, one published by DFO in 1998, provided ocean industry data for the period between 1988 and 1998. The present report extends this period to the year 2000, the last year for which reliable data are available for all segments of the oceans sector. This report excludes the Arctic region because it was found that the oil and gas data included in the earlier reports were mainly for land, not sea, production. Without marine oil and gas, the contribution of the ocean sector to the Arctic regional economy is small and is negligible in a national context. Hence the contribution of the ocean sector to the national economy given here is based on the ocean sector in the Atlantic and Pacific regions. In accordance with national accounting methodology, this contribution is measured by value-added.

Moberg, F. and C. Folke (1999). "Ecological goods and services of coral reef ecosystems." Ecological Economics 29(2): 215.

This article identifies ecological goods and services of coral reef ecosystems, with special emphasis on how they are generated. Goods are divided into renewable resources and reef mining. Ecological services are classified into physical structure services, biotic services, biogeochemical services, information services, and social/cultural services. A review of economic valuation studies reveals that only a few of the goods and services of reefs have been captured. We synthesize current understanding of the relationships between ecological services and functional groups of species and biological communities of coral reefs in different regions of the world. The consequences of human impacts on coral reefs are also discussed, including loss of resilience, or buffer capacity. Such loss may impair the capacity for recovery of coral reefs and as a consequence the quality and quantity of their delivery of ecological goods and services. Conserving the capacity of reefs to generate essential services requires that they are managed as components of a larger seascape-landscape of which human activities are seen as integrated parts.

Reeves, R. R. (2000). The Value of Sanctuaries, Parks and Reserves (Protected Areas) as Tools for Conserving Marine Mammals. Final report to the Marine Mammal Commission. Bethesda, Maryland, USA, Marine Mammal Commission.

The number of marine sanctuaries, parks, and reserves throughout the world grew from only a few to more than 1,200 in less than 25 years (apparently starting in about 1970). This number included primarily areas of the subtidal marine environment and therefore failed to reflect the many protected areas that incorporated intertidal, estuarine, or wetland areas but did not have a "marine" component. There clearly has been an enormous proliferation of marine protected areas around the world during the last quarter of the twentieth century. As one might expect, more than half of the marine protected areas included in the global inventory by Kelleher et al. (1995) were in the North Atlantic and North Pacific and their adjacent seas and about a fifth were in Oceania (New Zealand and Australia). One is also struck, however, by the fact that this proliferation has been a truly global phenomenon, encompassing all climatic zones and including countries large and small, rich and poor. The concept of protected areas is now understood to apply as much to the sea as to the land.

Stern, N. (2006). The Economics of Climate Change, Cambridge University Press.

Stubblefield, W. A., R. M. Gersberg, et al. (2006). Scientific and Technical Review: Capital Regional District Core Area Liquid Waste Management Plan. Victoria, British Columbia, Report submitted to the Capital Regional District.

In accordance with its terms of reference, the final report includes the following:

- assessment of the current environmental and human health impacts of the Clover and Macaulay points wastewater discharges;
- from a scientific perspective, a review of the need for treatment of leachate from Hartland landfill;
- evaluation of future risks of the CRD's wastewater management practices, including the risks associated with emerging contaminants;
- evaluation of the effectiveness of the CRD's liquid waste management programs including the source control program, the stormwater quality management program and the seafloor trigger;
- assessment of the applicability to the CRD of alternative and new liquid waste management systems, including the merits of smaller local sewage treatment systems;
- review of the overall effectiveness of the CRD's approach to liquid waste management compared to other coastal communities;
- evaluation of the benefits, risks and relative costs of implementing various levels of sewage treatment, from a technical and scientific perspective.

Sumaila, U. R. and A. T. Charles (2002). "Economic models of marine protected areas: an introduction." Natural Resource Modeling 15(3): 261.

This paper aims to achieve two goals. First, it provides an overview of marine protected areas (MPAs) a concept that is attracting widespread attention worldwide and the role of economic analysis and modeling in designing, implementing and evaluating such marine protected areas. Several major considerations to be taken into account in economic modeling of MPAs are also discussed. Second, the paper serves as an introduction to a pair of special issues of the journal, Natural Resource

Modeling, Vol. 15, Nos. 3 and 4, 2002, containing a selection of papers presented at the International Conference on the Economics of Marine Protected Areas held July 6-7, 2000, in Vancouver, Canada. The conference provided a first opportunity for academic, government and private sector actors to share ideas, information and models relating to the economic analysis of Marine Protected Areas, as tools in fishery management and marine ecosystem conservation. These special issues follow along similar lines, providing, apparently for the first time within an international journal setting, a comprehensive focus on the economics of MPAs.

Sumaila, U. R., S. Guenette, et al. (2000a). "Addressing ecosystem effects of fishing using marine protected areas." ICES Journal of Marine Science 57(3): 752.

This article is a synthesis of the current literature on the potential of marine protected areas (MPAs) a useful management tool for limiting the ecosystem effects of fishing, including biological and socio-economic aspects. There is sufficient evidence that fishing may negatively affect ecosystems. Modelling and case studies show that the establishment of MPAs, especially for overexploited populations, can mitigate ecosystem effects of fishing. Although quantitative ecosystem modelling techniques incorporating MPAs are in their infancy, their role in exploring scenarios is considered crucial. Success in implementing MPAs will depend on how well the biological concerns and the socio-economic needs of the fishing community can be reconciled.

Turner, R. K. (2000). "Integrating natural and socio-economic science in coastal management." Journal of Marine Systems 25(3): 460.

More sustainable management of coastal resources is an important policy goal for all governments of countries with coastlines. Coastal areas are under intense environmental change pressure with extensive feedback effects between the natural systems and the human systems. It could be argued that there is just one jointly determined and coevolving system that needs to be studied and managed. Understanding the interactions between the coastal zone and environmental change cannot be achieved by observational studies alone. Modelling of key environmental and socio-economic processes is a vital tool, required to buttress coastal management institutions and practice. Three overlapping procedural stages can be identified in the coastal resource assessment process. The scoping and auditing stage, implemented via a 'pressure-state-impact-response' framework, details, among other thing, problems, system boundaries and value conflicts. The framework is itself based on a conceptual model which lays stress on functional value diversity and the links between ecosystem processes, functions and outputs of goods and services which are deemed 'valuable' by society. The two subsequent stages are integrated modelling, combining natural and social science methodologies, and evaluation of management options and related gains and losses. An overview of a research project which utilised the P-S-I-R framework and supporting concepts and methods is presented in the last section of the paper, together with some generic 'lessons' for interdisciplinary research.

Turner, R. K., S. Subak, et al. (1996). "Pressures, trends, and impacts in coastal zones: interactions between socioeconomic and natural systems." Environmental Management 20(2): 159.

This paper assesses the status of coastal zones in the context of expected climate change and its related impacts, as well as current and future socioeconomic pressures and impacts. It is argued that external stresses and shocks relating to sea-level rise and other changes will tend to exacerbate existing environmental pressures and damage in coastal zones. Coastal zones are under increasing stress because of an interrelated set of planning failures including information, economic market, and policy intervention failures. Moves towards integrated coastal zone management are urgently required to guide the coevolution of natural and human systems. Overtly technocentric claims that assessments of vulnerability undertaken to date are overestimates of likely future damages from global warming are premature. While it is the case that forecasts of sea-level rise have been scaled down, much uncertainty remains over, for example, combined storm, sea surge, and other events. In any case, within the socioeconomic analyses of the problem, resource valuations have been at best only partial and have failed to incorporate sensitivity analysis in terms of the discount rates utilized. This would indicate an underestimation of potential damage costs. Overall, a precautionary approach is justified based on the need to act ahead of adequate information acquisition, economically efficient resource pricing and proactive coastal planning.

UNEP (2006). Marine and Coastal Ecosystems and Human Wellbeing: A Synthesis Report Based on the Findings of the Millennium Ecosystem Assessment, UNEP.

The Millennium Ecosystem Assessment (MA) was carried out between 2002 and 2005 to assess the consequence of ecosystem change for human well-being and to analyse the options available to enhance the conservation and sustainable use of ecosystems. The main findings of the MA were released on March 30, 2005. The human species, while buffered against environmental changes by culture and technology, is ultimately fully dependent on the flow of ecosystem services. The MA analyses ecosystem services at global and sub-global (local or regional) scales in terms of current conditions and trends, plausible future scenarios, and possible responses for sustainable resource use.

Water Science and Technology Board (2004). Valuing Ecosystem Services Services: Towards Better Environmental Decision-Making. Washington, DC, The National Academic Press.

Wolfe, R. J. (2004). Local Traditions and Subsistence: A Synopsis from Twenty-five Years of Research by the State of Alaska, Alaska Dept. of Fish and Game, Division of Subsistence.

This report provides a synopsis of findings on subsistence systems in Alaska, drawing on a quarter century of research by the Alaska Department of Fish and Game, Division of Subsistence. The synopsis examines the localized nature of subsistence systems. Subsistence is shown to comprise a diverse set of localized systems of food production and distribution, representing relatively unique combinations of ecological, cultural, and economic factors. The report concludes that there is not one subsistence tradition in Alaska, but a multitude of subsistence traditions linked to particular localities. The creators and principal users of these localized subsistence traditions are the long-term residents in the communities and areas where they occur. For resource managers to achieve fish and game management goals, locality is at times an essential regulatory tool. To illustrate this, the report presents three case examples of local subsistence traditions associated with difficult resource management issues arising from competition between urban-based harvesters and rural subsistence users: brown bear hunting in western Alaska, salmon dip net fishing in the Copper River, and Nelchina caribou hunting. The three cases illustrate ways that resource management systems have used locality within regulations to resolve resource issues.

Worm, B., E. B. Barbier, et al. (2006). "Impacts of biodiversity loss on ocean ecosystem services." Science 314(5800): 787.

Human-dominated marine ecosystems are experiencing accelerating loss of populations and species, with largely unknown consequences. We analyzed local experiments, long-term regional time series, and global fisheries data to test how biodiversity loss affects marine ecosystem services across temporal and spatial scales. Overall, rates of resource collapse increased and recovery potential, stability, and water quality decreased exponentially with declining diversity. Restoration of biodiversity, in contrast, increased productivity fourfold and decreased variability by 21%, on average. We conclude that marine biodiversity loss is increasingly impairing the ocean's capacity to provide food, maintain water quality, and recover from perturbations. Yet available data suggest that at this point, these trends are still reversible.

Concepts and theory of valuation, and total economic value (TEV)

Adger, N., K. Brown, et al. (1994). Towards estimating total economic value of forests in Mexico, CSERGE Working Paper GEC 94-21: Centre for Social and Economic Research on the Global Environment.

Failure to account for the numerous functions and economic uses of forests have led to patterns of global forest use with many detrimental environmental consequences. This study demonstrates the economic techniques for estimating the Total Economic Value (TEV) of forests. For the Mexican forest estate, the results show an annual lower bound value of the services of the total forest area to be in the order of $4 billion. This aggregate value stems from the non-marketed services provided by non-consumptive use; from future potential uses of the genetic resources and from pure existence values; and the largest proportion of economic value coming from the functional values of hydrological and carbon cycling. However, only a proportion of this value can feasibly be 'captured' within Mexico: much of the benefit of Mexico's forests falls outside the country's borders, and is therefore not considered by forest users or national policy makers.

Azqueta, D. and G. Delacamara (2006). "Ethics, economics and environmental management." Ecological Economics 56(4): 524.

Individuals derive utility from their access to resources provided by the biosphere, through the satisfaction of a number of needs and necessities. These needs, however, cannot often be met simultaneously since they compete with each other.

This conflict is not just relevant at an individual or even intragenerational level. Indeed, it implies a number of uncertainties and irreversibilities into the future, which should not be left to oblivion. From an extended anthropocentric ethical position, in which only human beings have immanent value and are, therefore, subjects of moral consideration, the identification of economic values can be of great use to allocate resources and make decisions on the environment. Economic analysis provides a number of decision tools than can be used to optimise efficiency and equity. The purpose of this paper is to reflect on some of the ethical constraints to the ability of conventional economic valuation techniques to inform decision-making processes affecting the environment. It will be argued that, depending on the stage of development, some environmental and natural assets might well be seen as a common heritage, either from a natural or a cultural viewpoint, rather than just a pool of economic resources that could be used to satisfy basic needs, and depleted or transformed accordingly, whether directly or indirectly. Furthermore, this boundary is not static: the same environmental asset will be demanded as a resource at lower stages of development (both individual and socially), and as a part of the common heritage, at a later stage (again, individual and socially). In the former, the use of conventional methods to value environmental goods and services will be warranted, whereas this would not be the case in the latter. We will also stress upon the fact that this is something quite different from the approach taken in Social Project Appraisal, where the introduction of efficiency prices and distributive factors also provides a move from individual to social welfare maximization, but without breaking away from the market logic.

Bateman, I. J., B. H. Day, et al. (2006). "The aggregation of environmental benefit values: welfare measures, distance decay and total WTP." Ecological Economics 60(2): 450.

We review the literature regarding the aggregation of benefit value estimates for non-market goods. Two case studies are presented through which we develop an approach to aggregation which applies the spatial analytic capabilities of a geographical information system to combine geo-referenced physical, census and survey data to estimate a spatially sensitive valuation function. These case studies show that the common reliance upon political rather than economic jurisdictions and the use of sample mean values within the aggregation process are liable to lead to significant errors in resultant values. We also highlight the fact that for resources with use values then we should expect overall values to reduce with increasing distance from such sites, but that changes in the choice of welfare measure will determine whether such 'distance decay' is to be expected within values stated by those who are presently non-users. The paper concludes by providing recommendations for future improvements to the methodology.

Bockstael, N. E., A. M. Freeman, et al. (2000). "On measuring economic values for nature." Environmental Science & Technology 34(8): 1384.

This paper describes how economists ascribe values to the things people can choose. The economic value of an ecosystem function or service relates to the contribution it makes to human welfare, where human welfare is measured in terms of each individual's own assessment of well-being. After developing how this definition is used, the paper describes problems and opportunities for advancing the state-of-the-art in measuring economic values for nature. These arguments are developed using recent studies that attempted to estimate economic values for ecosystems on a global scale. One implication of this evaluation is that there is a need for greater communication between ecologists and economists. Economic analyses must reflect the intricate web of physical interrelationships linking activities that have harmful effects in one part of an ecosystem to the potential effects on other parts. At the same time, economic values for ecosystems accept consumer sovereignty and should be interpreted as descriptions of the tradeoffs involved in evaluating well-defined changes to specific ecosystems.

Boyd, J. "Nonmarket benefits of nature: what should be counted in green GDP?" Ecological Economics In Press, Corrected Proof.

Green gross domestic product (green GDP) is meant to account for nature's value on an equal footing with the market economy. Several problems bedevil green GDP, however. One is that nature does not come prepackaged in units like cars, houses, and bread. Even worse, green GDP requires measurement of the benefits arising from public goods provided by nature for which there are no market indicators of value. So what should green GDP count? That is the subject of this paper. Ecological and economic theories are used to describe what should be counted—and what should not—if green GDP is to account for the nonmarket benefits of nature.

Boyd, J. and S. Banzhaf (2006). What are Ecosystem Services? The Need for Standardized Environmental Accounting Units, Resources for the Future.

This paper advocates consistently defined units of account to measure the contributions of nature to human welfare. We argue that such units have to date not been defined by environmental accounting advocates and that the term "ecosystem services" is too ad hoc to be of practical use in welfare accounting. We propose a definition, rooted in economic principles, of ecosystem service units. A goal of these units is comparability with the definition of conventional goods and services found in GDP and the other national accounts. We illustrate our definition of ecological units of account with concrete examples. We also argue that these same units of account provide an architecture for environmental performance measurement by governments, conservancies, and environmental markets.

Costanza, R., R. d'Arge, et al. (1997). "The value of the world's ecosystem services and natural capital." Nature 387(6630): 253.

The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. We have estimated the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is outside the market) is estimated to be in the range of US$16-54 trillion (1012) per year, with an average of US$33 trillion per year. Because of the nature of the uncertainties, this must be considered a minimum estimate. Global gross national product total is around US$18 trillion per year.

Cummings, R. G. and G. W. Harrison (1995). "The measurement and decomposition of nonuse values: a critical review." Environmental and Resource Economics V5(3): 225.

We critically review the literature that claims that existence values, or nonuse values in general, are a large and measurable component of total value for certain environmental resources. Our concern is not with the question "do nonuse values exist?" For some individuals they surely do. Rather, our concern is with two interrelated questions: are there operationally meaningful theorems which might lead to the specific measurement of nonuse values, and do we in fact have a body of credible evidence which shows that nonuse values, particularly components of any nonuse value, are large"? We find nothing in the way of operationally meaningful hypotheses which would permit the estimation of values attributable to specific motives of individuals. We find no credible basis for claims related to either the measurement of existence and other motive-related values or claims for the "large" relative size of such values. In short, we question the conventional wisdom that such values are measurable and that they are significant as a component of total value.

Curran, D. (2001). Economic Benefits of Natural Green Space Protection, The POLIS Project on Ecological Governance; Smart Growth British Columbia.

The purpose of this study is to review the literature documenting the effect of natural open space preservation on property values, and to briefly discuss the economic benefits such an approach has for land developers and municipalities. Generally, research indicates that natural open space has a positive effect on real estate values. Quantified benefits to communities include higher residential property values in areas proximate to, and/or with views of, natural open space. Homebuyers are willing to pay a premium for properties near natural open space, and residents will pay to permanently protect a natural open space in their neighbourhood. The presence of natural open space also has property tax implications for local governments and communities. Several studies have shown that agricultural and open space land pays significantly more in taxes than it requires in servicing from local governments. Likewise, the positive effect of natural open space on property values can result in higher assessments and thus property tax revenues for local governments. Finally, many developers and municipalities are saving money and increasing the marketability of projects by integrating ecological considerations into the development.

Farber, S. C., R. Costanza, et al. (2002). "Economic and ecological concepts for valuing ecosystem services." Ecological Economics 41(3): 375.

The purpose of this special issue is to elucidate concepts of value and methods of valuation that will assist in guiding human decisions vis-à-vis ecosystems. The concept of ecosystem service value can be a useful guide when distinguishing and measuring where trade-offs between society and the rest of nature are possible and where they can be made to enhance human welfare in a sustainable manner. While win-win opportunities for human activities within the environment may exist, they also appear to be increasingly scarce in a 'full' global ecological–economic system. This makes valuation all the more essential for guiding future human activity. This paper provides some history, background, and context for many of the issues addressed by the remaining papers in this special issue. Its purpose is to place both economic and ecological meanings of value, and their respective valuation methods, in a comparative context, highlighting strengths, weakness and addressing questions that arise from their integration.

Freeman III, A. M. (1995). "The benefits of water quality improvements for marine recreation: a review of the empirical evidence." Marine Resource Economics 10(4): 385.

This paper reviews the empirical literature on the economic value of marine recreation fishing, beach visits, and boating. Questions addressed include: What values do people place on changes in the attributes of recreation sites and activities? What do we know about how water pollution control policy affects these attributes? And, is it feasible to use the value information obtained for specific sites and/or activities to estimate the benefits of improving marine water quality? The literature establishes that some measures of pollution reduce the values of trips to beaches and that improved fishing success is valued by recreational anglers. However, there is substantial variation in value measures across studies. Welfare estimates can be sensitive to model specification and estimation. In the case of marine recreational fishing, the links between pollution control policy and the attributes of the activity that people value (catch rate) have not been established.

Freeman III, A. M. (2003a). Economic valuation. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht, Kluwer Academic Publishers: 1-27.

Freeman III, A. M. (2003b). The Measurement of Environmental and Resource Values: Theory and Methods. Washington, DC, Resources for the Future.

Hanley, N. (1999). Cost–benefit analysis of environmental policy and management. Handbook of Environmental Resource Economics. J. C. J. M. van de Bergh. Cheltenham, UK, Edward Elgar: 824-836.

Hanley, N. and C. L. Spash (1993). Cost-benefit Analysis and the Environment. Aldershot, Hants, England Brookfield, Vt., E. Elgar.

Hein, L., K. van Koppen, et al. (2006). "Spatial scales, stakeholders and the valuation of ecosystem services." Ecological Economics 57(2): 209.

Since the late 1960s, the valuation of ecosystem services has received ample attention in scientific literature. However, to date, there has been relatively little elaboration of the various spatial and temporal scales at which ecosystem services are supplied. This paper analyzes the spatial scales of ecosystem services, and it examines how stakeholders at different spatial scales attach different values to ecosystem services. The paper first establishes an enhanced framework for the valuation of ecosystem services, with specific attention for stakeholders. The framework includes a procedure to assess the value of regulation services that avoids double counting of these services. Subsequently, the paper analyses the spatial scales of ecosystem services: the ecological scales at which ecosystem services are generated, and the institutional scales at which stakeholders benefit from ecosystem services. On the basis of the proposed valuation framework, we value four selected ecosystem services supplied by the De Wieden wetlands in The Netherlands, and we analyze how these services accrue to stakeholders at different institutional scales. These services are the provision of reed for cutting, the provision of fish, recreation, and nature conservation. In the De Wieden wetland, reed cutting and fisheries are only important at the municipal scale, recreation is most relevant at the municipal and provincial scale, and nature conservation is important in particular at the national and international level. Our analysis shows that stakeholders at different spatial scales can have very different interests in ecosystem services, and we argue that it is highly important to consider the scales of ecosystem services when valuation of services is applied to support the formulation or implementation of ecosystem management plans.

Hicks, J. (1943). "The four consumer surpluses." Review of Economic Studies 11(1): 31.

Hoehn, J. P. (2006). "Methods to address selection effects in the meta regression and transfer of ecosystem values." Ecological Economics 60(2): 389.

The analysis develops an approach for dealing with selection effects in the meta regression of ecological values. The approach is based on Heckman's [Heckman, James. 1979. Sample Selection Bias as a Specification Error. Econometrica 47 (1):153–161.] two stage procedure and is adaptable to cross section and unbalanced panel data. The approach identifies both a method of testing for selection effects and for consistent estimation if selection effects are shown to be statistically significant. The approach is illustrated with a meta regression of wetland ecosystem values. The application shows that selection is statistically and economically significant. Selection effects lead to baseline wetland values that are almost 4 times larger than values computed using the selection corrected parameters. Value adjustment factors for wetland services and methodological variables appear less prone to selection effects. The uncorrected value adjustment factors for wetland services and research methods are, on average, within 15% of the selection corrected value adjustment factors.

Horowitz, J. K. and K. E. McConnell (2002). "A review of WTA/WTP studies." Journal of Environmental Economics and Management 44(3): 426.

Willingness to accept (WTA) is usually substantially higher than willingness to pay (WTP). These constructs have been studied for roughly 30 years and with a wide variety of goods. This paper reviews those studies. We find that the less the good is like an "ordinary market good," the higher is the ratio. The ratio is highest for non-market goods, next highest for ordinary private goods, and lowest for experiments involving forms of money. A generalization of this pattern holds even when we account for differences in survey design: ordinary goods have lower ratios than non-ordinary ones. We also find that ratios in real experiments are not significantly different from hypothetical experiments and that incentive-compatible elicitation yields higher ratios.

Howarth, R. B. and S. Farber (2002). "Accounting for the value of ecosystem services." Ecological Economics 41(3): 421.

A 'value of ecosystem services' (VES) may be calculated by multiplying a set of ecosystem services by a set of corresponding shadow prices. This paper examines the role of the VES concept in measuring trends in human well-being. Under conventional arguments from applied welfare economics, standard measures of market consumption may be extended to include the value of direct environmental services, which affect welfare in ways that are not mediated by the consumption of purchased goods. The VES concept does not capture values such as ecological sustainability and distributional fairness that are not reducible to individual welfare. And its operationalization is constrained by the well-known limitations of nonmarket valuation methods. Nonetheless, attempts to calculate the value of environmental services can provide insights into the tradeoffs between market activity and environmental quality that are implicit in the process of economic growth. Such efforts can promote informed debate concerning the achievement of sustainable development.

Hueting, R., L. Reijnders, et al. (1998). "The concept of environmental function and its valuation." Ecological Economics 25(1): 31.

Johansson, P.-O. (1992). "Altruism in cost-benefit analysis." Environmental and Resource Economics V2(6): 605.

It has recently been argued that altruistic motives for paying for a public sector project should be ignored in a cost-benefit analysis. The reason is that including altruism would mean a kind of double counting of the project's benefits. This paper takes a look at these arguments, and derives cost-benefit rules which cover different kinds of altruism. The paper also provides some recommendations for the treatment of altruism in studies using the contingent valuation method.

Ledoux, L. and R. K. Turner (2002). "Valuing ocean and coastal resources: a review of practical examples and issues for further action." Ocean & Coastal Management 45(9-10): 583.

This review article examines the importance of valuing environmental resources in the context of sustainable development. The different values stemming from ocean and coastal resources, relevant methodologies and issues raised by valuation approaches are reviewed. The authors then present practical policy-relevant valuation examples, and conclude by outlining progress since 1992 and remaining challenges. It is argued that while the Rio summit has shifted somewhat the emphasis from classical cost–benefit analysis to safe minimum standards through the adoption of the precautionary principle, economic valuation still provides useful information to decision-makers and should be part of a holistic decision-making process. It should be recognised, however, that although valuation techniques have been refined and linked to reliability protocols, they remain imperfect and for some commentators controversial. Further progress is needed on assigning monetary values but also on decision-making systems that better integrate monetary, social, and natural science criteria.

McComb, G., V. Lantz, et al. (2006). "International valuation databases: overview, methods and operational issues." Ecological Economics 60(2): 461.

Over the past decade, numerous online databases have been established to provide information and data contained in thousands of primary environmental valuation studies conducted since the early 1980s. Although these Internet resources have many similarities, most exist for specific analytic or policy purposes, and so vary considerably in their content, appearance and functionality. In this article we review a number of such databases and compare their various features, with special attention paid to the facilitation of benefits transfers. We also provide a demonstration of how to perform searches and benefits transfers on three of the more popular databases — including the Environmental Valuation Reference Inventory, Envalue, and the Ecosystem Services Database. Next, we discuss day-to-day operational issues surrounding two databases, followed by a discussion of their policy relevance. We conclude with some suggestions for future directions for valuation databases.

NOAA. (2002). "What is the "value" of the beach?" Retrieved 20 December, 2006, from http://www.magazine.noaa.gov/stories/mag61.htm.

Oliver, F. (2000). "Ecological structure and functions of biodiversity as elements of its total economic value." Environmental and Resource Economics V16(3): 303.

Rational economic decisions regarding the conservation of biodiversity require the consideration of all the benefits generated by this natural resource. Recently a number of categories of values (inherent value, contributory value, indirect value, infrastructure value, primary value) have been developed, especially in the literature of Ecological Economics, which, besides the individual and productive benefits of biodiversity, also include the utilitarian relevance of the ecological structure and functions of biodiversity in the, so-called, total economic value. For the question of including the ecological structure and functions of biodiversity in the total economic value it is of crucial importance to note, that these categories of values are not only terminologically different, but also relate to different ecological levels of biodiversity and – most importantly – to specific complementary relationships– between species, between elements of ecological structures and between ecological functions and their contribution to human well-being. This paper analyses these complementary relationships, discusses their implications for the total economic value of biodiversity and draws conclusions for decision making in environmental policy.

Pagiola, S., K. von Ritter, et al. (2004). Assessing the Economic Value of Ecosystem Conservation, World Bank, Environment Department.

Pearce, D. (1998). "Auditing the Earth." Environment 40(2): 23.

Reviews the report `The Value of the World's Ecosystem and Natural Capital,' by Robert Costanza, Ralph d'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V. O'Neill, Jose Paruelo, Robert G. Raskin, Paul Sutton and Marjan van den Belt. INSET: Costanza and his coauthors reply.

Pearce, D. W., G. Atkinson, et al. (2006). Cost-Benefit Analysis and the Environment: Recent Developments. Paris, Organisation for Economic Co-operation and Development.

Pearce, D. W. and D. Moran (1994). Economic Value of Biodiversity. London, Earthscan Publications.

Pearce, D. W. and R. K. Turner (1990). Economics of Natural Resources and the Environment. New York, Harvester Wheatsheaf.

Sumaila, U. R. (2004). "Intergenerational cost-benefit analysis and marine ecosystem restoration." Fish and Fisheries 5(4): 329.

Conventional cost-benefit analysis (CBA) tends to show that most ecosystem restoration programmes are not worthwhile in economic terms. This is because discounting puts more weight on current net benefits than future ones. I suggest that this is partly because conventional CBA is based on the current generation's time perspective (termed here the 'discounting clock'). That is, net benefits are discounted starting when the analysis is carried out (the present). To tackle this problem, I propose the use of an intergenerational CBA, which takes into account the fact that current restoration efforts may produce benefits, in particular, fish protein, to future generations, and that these benefits need to be valued using the respective discounting clocks of the generation receiving them. This approach appears to meet the requirements imposed by most management jurisdictions, where there is an explicit or implied requirement to account for benefits to future generations in decision-making concerning the use and management of marine resources.

Sumaila, U. R. and C. Walters (2005). "Intergenerational discounting: a new intuitive approach." Ecological Economics 52(2): 135.

This paper proposes a new intergenerational discounting approach for computing net benefits from the use of environmental resources. The approach explicitly incorporates the perspectives of both the current and future generations, as argued for by Pigou [Pigou, A.C., 1920. The Economics of Welfare 1952 (4th edition), London: Macmillan] and Ramsey [Ramsey, F.P., 1928. A mathematical theory of saving, Econ. J., 38 543–559], and required by most national and international laws related to the use of these resources. An equation for use in the calculation of net discounted benefits is developed, which provides a 'middle' position whereby both the 'reality' of 'personal' discounting and that of 'social' discounting are included in a social welfare function.

Turner, R. K., W. N. Adger, et al. (2001). Economics of Coastal and Water Resources: Valuing Environmental Functions, Kluwer Academic Publishers.

Turner, R. K., J. Paavola, et al. (2003). "Valuing nature: lessons learned and future research directions." Ecological Economics 46(3): 493.

This paper critically reviews the literature on environmental valuation of ecosystem services across the range of global biomes. The main objective of this review is to assess the policy relevance of the information encompassed by the wide range of valuation studies that have been undertaken so far. Published and other studies now cover most ecosystems, with aquatic and marine contexts attracting the least attention. There is also a predominance of single function valuation studies. Studies valuing multiple functions and uses, and studies which seek to capture the 'before and after' states as environmental changes take place, are rare. By and large it is the latter types of analyses that are most important as aids to more rational decision taking in ecosystem conservation versus development situations involving different stakeholders (local, national and global). Aggregate (global scale) estimates of ecosystems value are problematic, given the fact that only 'marginal' values are consistent with conventional decision-aiding tools such as economic cost–benefit analysis. In general, valuation data provide prima facie support for the hypothesis that net ecosystem service value diminishes with biodiversity and ecosystem loss [[Balmford et al., 2002], Science 297, p. 950]. Future research effort should include complementary research on multiple ecosystem services that seeks to capture the temporal disturbance profile and its causal factors. The explicit recognition of multiple, interdependent ecosystem services and values, poses both conceptual and empirical research challenges. It would serve to transform the practice of research in this sub-field via the a priori assumption of multiple (and inter-dependent) use, instead of independent single use. This line of reasoning can then be extended to the institutional arrangements that determine which values are captured. New institutional processes and arrangements are probably required in order to best realise benefit streams from multiple ecosystem use and non-use provision, across a range of different stakeholders.

Turner, R. K., D. W. Pearce, et al. (1994). Environmental Economics: An Elementary Introduction. New York; London, Harvester Wheatsheaf.

Wilson, M. A., R. Costanza, et al. (2005). Integrated assessment and valuation of ecosystem goods and services provided by coastal systems. The Intertidal Ecosystem: The Value of Ireland's Shores. J. G. Wilson. Dublin, Royal Irish Academy: 1-24.

Winkler, R. (2006). "Valuation of ecosystem goods and services. Part 1: an integrated dynamic approach." Ecological Economics 59(1): 82.

This is the first part of a two-part paper which offers a new approach to the valuation of ecosystem goods and services. The existing literature on environmental valuation is based on two distinct foundations. The ecological valuation methods derive values by a cost-of-production approach. Their common characteristic is the neglect of consumer preferences. The economic valuation methods focus on the exchange value of ecosystem services. Their common characteristic is that they are finally based on consumer preferences, and do not adequately take account of the complex internal structure of ecosystems. As the existing methods for the valuation of ecosystem services emphasize either the economic system or the ecosystem, the main objective of part 1 is to provide the conceptual foundations for a new method of valuation of ecosystem services, which deals simultaneously with the ecosystem, the economic system and society in a balanced way. Within a simple pre-industrial model it is shown how the interdependencies between the three subsystems influence values, and how values change over time.

Winkler, R. (2006). "Valuation of ecosystem goods and services. Part 2: implications of unpredictable novel change." Ecological Economics 59(1): 94.

This is the second part of a two-part paper which offers a new approach to the valuation of ecosystem

goods and services. In the first part a simple pre-industrial model was introduced to show how the interdependencies between the three subsystems, society, economy and nature, influence values, and how values change over time. In this second part the assumption of perfect foresight is dropped. I argue that due to novelty and complexity ex ante unpredictable change occurs within the three subsystems society, economy and nature. Again the simple pre-industrial model, which was introduced in part 1, serves as a simple paradigm to show how unpredictable novel change limits the possibility to derive accurate estimates of values.

Revealed preference methodologies

Bell, F. W. and V. R. Leeworthy (1990). "Recreational demand by tourists for saltwater beach days." Journal of Environmental Economics and Management 18(3): 189.

This analysis deals with tourists that come from significant distances to use principally beach resources. As Smith and Kopp [Land Econom. 56, 64–72 (1980)] have argued, those that use the conventional travel cost method (TCM) do not recognize its potential spatial limitations. One day trips as used by the TCM are certainly inapplicable to those coming from significant distances, such as tourists to Florida. The empirical data are consistent with the thesis that annual consumer demand by individual tourists for Florida beach days is positively related to travel cost per trip and inversely related to on-site cost per day. There are compelling reasons for treating recreational decision making for what we call tourists differently than for residents or those traveling relatively short distances. Employing the on-site cost demand curve for tourists using Florida's beaches, we find the daily consumer surplus to be nearly $34.00

Benson, E. D., J. L. Hansen, et al. (1998). "Pricing residential amenities: the value of a view." The Journal of Real Estate Finance and Economics V16(1): 55.

This study provides estimates of the value of the view amenity in single-family residential real estate markets. A focus on Bellingham, Washington, a city with a variety of views, including ocean, lake, and mountain, allows for differentiation of the view amenity by both type and quality. Results from a hedonic model estimated for several recent years suggest that depending on the particular view, willingness to pay for this amenity is quite high. The highest-quality ocean views are found to increase the market price of an otherwise comparable home by almost 60%; the lowest-quality ocean views are found to add about 8%. For ocean views of all quality levels, the value of a view is found to vary inversely with distance from the water.

Bergstrom, J. C., J. H. Dorfman, et al. (2004). "Estuary management and recreational fishing benefits." Coastal Management 32(4): 417.

Recognition of the benefits to society supported by estuary ecosystem functions and services, and threats to these benefits posed by human activities, has led to various public programs to restore and protect estuaries at the federal, state, and local levels. As available budgets shrink, program administrators and public elected officials struggle to allocate limited restoration and protection funds to the highest priority areas. Economic benefit and cost information can provide useful inputs into this decision-making process by quantifying estuary restoration and protection benefits and costs in commensurate terms. In this paper, a combined actual and intended travel behaviour model is described that can be applied to estimate the recreational fishing benefits of estuary restoration and protection. The model was estimated for recreational fishing in the Lower Atchafalaya River Basin estuary along the Gulf of Mexico, Louisiana, USA coast. Changes in freshwater flows into this estuary may affect redfish and speckled trout game fish populations. The model indicates that changes in catch rates of these two species would have a relatively minor affect on annual fishing trips per angler. However, because total effects may be large when effects per angler are aggregated across total anglers, resource management agencies should consider these changes in recreation benefits when evaluating projects that influence the ecology of coastal estuaries, fish populations, and catch rates. Moreover, in other coastal areas or situations, the responsiveness of angling trips to changes in catch rates may vary because of differences in user populations, environmental conditions, fish populations, and fishing experiences.

Boyle, K. J. (2003a). Introduction to revealed preference methods. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht, Kluwer Academic Publishers: 259-268.

Curtis, J. A. (2002). "Estimating the demand for salmon angling in Ireland." The Economic and Social Review 33(3): 319.

This paper reports the results of a count data travel cost model for estimating the demand and

economic value of salmon angling in Co. Donegal, Ireland. Angling quality, age and nationality were found to affect angling demand, while estimated consumer surplus per angler per day was approximately IR£138 based on a truncated negative binomial model allowing for endogenous stratification.

Leggett, C. G. and N. E. Bockstael (2000). "Evidence of the effects of water quality on residential land prices." Journal of Environmental Economics and Management 39(2): 121.

We use hedonic techniques to show that water quality has a significant effect on property values along the Chesapeake Bay. We calculate the potential benefits from an illustrative (but limited) water quality improvement, and we calculate an upper bound to the benefits from a more widespread improvement. Many environmental hedonic studies have almost entirely ignored the potential for omitted variables bias - the possibility that pollution sources, in addition to emitting undesirable substances, are likely to be unpleasant neighbours. We discuss the implications of this oversight, and we provide an application that addresses this potential problem.

Parsons, G. R. (2003). The travel cost model. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht, Kluwer Academic Publishers: 269-330.

Parsons, G. R. and M. Powell (2001). "Measuring the cost of beach retreat." Coastal Management 29(2): 91.

We estimate the cost over the next 50 years of allowing Delaware's ocean beaches to retreat inland. Since most of the costs are expected to be land and capital loss, especially in housing, we focus our attention on measuring that value. We use a hedonic price regression to estimate the value of land and structures in the region using a data set on recent housing sales. Then, using historical rates of erosion along the coast and an inventory of all housing and commercial structures in the threatened coastal area, we predict the value of the land and capital loss assuming that beaches migrate inland at these historic rates. We purge the losses of any amenity values due to proximity to the coast, because these are merely transferred to properties further inland. If erosion rates remain at historic levels, our estimate of the cost of retreat over the next 50 years in present value terms is about $291 million (2000$). The number rises if we assume higher rates of erosion. We compare these estimates to the current costs of nourishing beaches and conclude that nourishment make economic sense, at least over this time period.

Shrestha, R. K., A. F. Seidl, et al. (2002). "Value of recreational fishing in the Brazilian Pantanal: a travel cost analysis using count data models." Ecological Economics 42(1-2): 289.

Recreational fishing value of the Brazilian Pantanal is measured using travel cost method (TCM). We compare non-linear, Poisson and negative binomial count data models to estimate recreational fishing trip demands. The count data and truncated models are used primarily to account for non-negative integer and truncation properties of recreational fishing trips as suggested by the recreation valuation literature. The results reveal that non-linear and truncated count data models perform relatively well in our study. The economic values of recreational fishing in terms of consumer surplus (CS) are derived using non-linear and truncated models. We estimate the CS values from $540.54 to $869.57 per trip resulting in the total social welfare estimate range from $35 to $56 million. The study demonstrates a relatively high value of recreational fishing in the Pantanal in comparison to similar studies conducted in other parts of the world. The findings of this study would be important for resource management decisions in the Pantanal and could serve as a reference in valuing similar resources in other ecosystems around the world.

Smith, V. K. and R. B. Palmquist (1994). "Temporal substitution and the recreational value of coastal amenities." The Review of Economics and Statistics 76(1): 119.

This paper proposes a method for measuring the effects of substitutions in the timing of recreational use on people's willingness to pay for nonmarketed resources. Using the three markets (peak, pre-peak, and post-peak) for weekly rentals of vacation properties along the Outer Banks of North Carolina, we are able to control for changes in the mix of site characteristics selected at different times and estimate the effects of temporal substitution on tradeoffs between other characteristics. Proximity to the ocean was found to be a significant determinant of temporal substitution between the peak and pre-peak seasons with ocean front properties having 1.9% to 4.7% smaller discounts for pre-season rentals relative to other properties.

Taylor, L. O. (2003). The hedonic method. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and

T. C. Brown. Dordrecht, Kluwer Academic Publishers: 331-394.

Wardley, I. D. (1993). The value of an ocean view in Oak Bay, British Columbia: A Comparison of the hedonic pricing and contingent valuation methods for estimating intangibles. Department of Economics. Victoria, British Columbia, University of Victoria.

Stated preference methodologies

Adamowicz, W., P. Boxall, et al. (1998). "Stated preference approaches for measuring passive use values: choice experiments and contingent valuation." American Journal of Agricultural Economics 80(1): 64.

The measurement of passive use values has become an important issue in environmental economics. In this paper we examine an extension or variant of contingent valuation, the choice experiment, which employs a series of questions with more than two alternatives that are designed to elicit responses that allow the estimation of preferences over attributes of an environmental state. We also combine the information from choice experiments and contingent valuation to test for differences in preferences and error variances arising from the two methods. Our results show that choice experiments have considerable merit in measuring passive use values.

Alpizar, F., F. Carlsson, et al. (2001). Using choice experiments for non-market valuation, Working Papers in Economics no. 52: Environmental Economics Unit, Göteborg University.

This paper provides the latest research developments in the method of choice experiments applied to valuation of non-market goods. Choice experiments, along with the, by now, well-known contingent valuation method, are very important tools for valuing non-market goods and the results are used in both cost-benefit analyses and litigations related to damage assessments. The paper should provide the reader with both the means to carry out a choice experiment and to conduct a detailed critical analysis of its performance in order to give informed advice about the results. A discussion of the underlying economic model of choice experiments is incorporated, as well as a presentation of econometric models consistent with economic theory. Furthermore, a detailed discussion on the development of a choice experiment is provided, which in particular focuses on the design of the experiment and tests of validity. Finally, a discussion on different ways to calculate welfare effects is presented.

Arin, T. and R. A. Kramer (2002). "Divers' willingness to pay to visit marine sanctuaries: an exploratory study." Ocean & Coastal Management 45(2-3): 171.

Entrance fees paid by divers to enter marine sanctuaries constitute a significant potential revenue source to finance coral reef conservation. An exploratory contingent valuation study was carried out among foreign and local tourists in three major dive destinations in the Philippines to examine diver demand for visits to protected coral reef areas. Results indicate that most divers would be willing to pay an entrance fee to marine sanctuaries where fishing, one of the major threats to coral reefs, is prohibited. An econometric model was estimated analyzing the socioeconomic and travel related factors that affect divers' willingness to pay. Results indicate that substantial amounts of revenues may be collected through entrance fees to support coral reef conservation. Most tourists interviewed preferred NGOs as the most trustworthy organization type to collect and manage entrance fees.

Arrow, K. and R. Solow (1993). Report of the NOAA Panel on Contingent Valuation, National Oceanic and Atmospheric Administration.

Bell, F. W. and V. R. Leeworthy (1990). "Recreational demand by tourists for saltwater beach days." Journal of Environmental Economics and Management 18(3): 189.

This analysis deals with tourists that come from significant distances to use principally beach resources. As Smith and Kopp [Land Econom. 56, 64–72 (1980)] have argued, those that use the conventional travel cost method (TCM) do not recognize its potential spatial limitations. One day trips as used by the TCM are certainly inapplicable to those coming from significant distances, such as tourists to Florida. The empirical data are consistent with the thesis that annual consumer demand by individual tourists for Florida beach days is positively related to travel cost per trip and inversely related to on-site cost per day. There are compelling reasons for treating recreational decision making for what we call tourists differently than for residents or those traveling relatively short distances. Employing the on-site cost demand curve for tourists using Florida's beaches, we find the daily consumer surplus to be nearly $34.00

Benson, E. D., J. L. Hansen, et al. (1998). "Pricing residential amenities: the value of a view." The Journal of Real Estate Finance and Economics V16(1): 55.

This study provides estimates of the value of the view amenity in single-family residential real estate markets. A focus on Bellingham, Washington, a city with a variety of views, including ocean, lake, and mountain, allows for differentiation of the view amenity by both type and quality. Results from a hedonic model estimated for several recent years suggest that depending on the particular view, willingness to pay for this amenity is quite high. The highest-quality ocean views are found to increase the market price of an otherwise comparable home by almost 60%; the lowest-quality ocean views are found to add about 8%. For ocean views of all quality levels, the value of a view is found to vary inversely with distance from the water.

Bergstrom, J. C., J. H. Dorfman, et al. (2004). "Estuary management and recreational fishing benefits." Coastal Management 32(4): 417.

Recognition of the benefits to society supported by estuary ecosystem functions and services, and threats to these benefits posed by human activities, has led to various public programs to restore and protect estuaries at the federal, state, and local levels. As available budgets shrink, program administrators and public elected officials struggle to allocate limited restoration and protection funds to the highest priority areas. Economic benefit and cost information can provide useful inputs into this decision-making process by quantifying estuary restoration and protection benefits and costs in commensurate terms. In this paper, a combined actual and intended travel behaviour model is described that can be applied to estimate the recreational fishing benefits of estuary restoration and protection. The model was estimated for recreational fishing in the Lower Atchafalaya River Basin estuary along the Gulf of Mexico, Louisiana, USA coast. Changes in freshwater flows into this estuary may affect redfish and speckled trout game fish populations. The model indicates that changes in catch rates of these two species would have a relatively minor affect on annual fishing trips per angler. However, because total effects may be large when effects per angler are aggregated across total anglers, resource management agencies should consider these changes in recreation benefits when evaluating projects that influence the ecology of coastal estuaries, fish populations, and catch rates. Moreover, in other coastal areas or situations, the responsiveness of angling trips to changes in catch rates may vary because of differences in user populations, environmental conditions, fish populations, and fishing experiences.

Bockstael, N. E., K. E. McConnell, et al. (1989). "Measuring the benefits of improvements in water quality: the Chesapeake Bay." Marine Resource Economics 6(1).

Federal, state and local government agencies ' clean-up efforts of the Chesapeake Bay will be devoted to three major problems: nutrient over enrichment, toxic substances and the decline of submerged aquatic vegetation. Criteria for measuring the Bay 's water quality have been primarily biological and physical. The focus on the human values derived from the Bay includes recreational and commercial activities such as: beach use, boating, and fishing. It is estimated that the annual aggregate willingness to pay for a moderate improvement in the Bay 's water quality is in the range of $10 to $100 million in 1984 dollars. This range was derived by using contingent variation to measure the economic benefits of improved water quality and indirect market methods to measure water quality benefits. The costs of the program include construction of sewage treatment plants, funding of government programs to regulate and monitor agricultural effluents, subsidy of best management practice, installation of industrial waste disposal systems and restrictions on housing development.

Boxall, P. C., W. L. Adamowicz, et al. (1996). "A comparison of stated preference methods for environmental valuation." Ecological Economics 18(3): 243.

This paper presents an empirical comparison of contingent valuation (CVM) and choice experiments which are used to value environmental quality changes. Both of these methods require individuals to state their preferences for environmental qualities. However, choice experiments differ from CVM in that environmental attributes are varied in an experimental design which requires respondents to make repeated choices between bundles of attributes. The empirical application involved the effect of environmental quality changes arising from forest management practices on recreational moose hunting values. Significant differences were found between the values derived from the two methods. However, detailed examination of the implied choice behaviour suggested that respondents ignored substitute recreation areas in the CVM question. Restricting the choice experiment model to consider only the one site where quality was varied, resulted in welfare estimates similar to the CVM model.

This highlights the importance of substitutes in environmental valuation and suggests that choice experiments may be more appropriate than CVM in some cases.

Boyle, K. J. (2003a). Introduction to revealed preference methods. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht, Kluwer Academic Publishers: 259-268.

Boyle, K. J. (2003b). Contingent valuation in practice. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht, Kluwer Academic Publishers: 111-170.

Brown, T. C. (2003). Introduction to stated preference methods. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht, Kluwer Academic Publishers: 99-110.

Cameron, T. A. and M. D. James (1987). "Efficient estimation methods for" closed-ended" contingent valuation surveys." The Review of Economics and Statistics 69(2): 269.

This study examined the willingness to pay for a recreational fishing day in British Columbia, Canada. The data was gathered in 1984 and the sample size was 4,161. The major point of this manuscript, which drew upon the results of an earlier working paper by the authors, was to show how the results of dichotomous choice CVM surveys may be used to "isolate the impact upon resource valuations made by specific site amenities and due to individual user's characteristics." In the example used here, the authors isolated the marginal influence of resource amenities [in their example, recreational fish catch characteristics] upon value [WTP]. Though not the primary emphasized result in this particular manuscript, the analysis of the CVM survey data produced an estimate of mean WTP for a recreational fishing day of $49. Analysis undertaken to isolate the marginal value of an extra fish caught (isolated from extra fish catch of other species, as well as other site amenities important to fishing) indicated that, on average, an extra Chinook salmon adds approx. $14 to the angler's value [WTP]. Values are in 1984 Canadian dollars. The survey population was recreational fishermen on the south coast of British Columbia. The survey established the habits of the fishermen, including where and when they fished, and their expenditures for fishing. For the WTP question, the respondent was asked whether he would still have gone fishing that day if the cost of the day's trip had been $(X) higher [dichotomous choice CVM].

Carson, R. T., R. C. Mitchell, et al. (2003). "Contingent valuation and lost passive use: damages from the Exxon Valdez oil spill." Environmental and Resource Economics V25(3): 257.

We report on the results of a large-scale contingent valuation (CV) study conducted after the Exxon Valdez oil spill to assess the harm caused by it. Among the issues considered are the design features of the CV survey, its administration to a national sample of U.S. households, estimation of household willingness to pay to prevent another Exxon Valdez type oil spill, and issues related to reliability and validity of the estimates obtained. Events influenced by the study's release are also briefly discussed.

Carson, R. T. (2000). "Contingent valuation: a user's guide." Environmental Science & Technology 34(8): 1413-1418.

Contingent valuation (CV) is a survey-based method frequently used for placing monetary values on environmental goods and services not bought and sold in the marketplace. CV is usually the only feasible method for including passive-use considerations in an economic analysis, a practice that has engendered considerable controversy. The issue of what a CV study tries to value is first addressed from the perspective of a policy-maker, and then the controversy over the inclusion of passive-use is taken up in more detail. The major issues and positions taken in the technical debate over the use of CV are summarized from a user's perspective. Key design and implementation issues involved in undertaking a CV survey are examined, and the reader is provided with a set of factors to examine in assessing the quality of a CV study.

Carson, R. T., N. E. Flores, et al. (2001). "Contingent valuation: controversies and evidence." Environmental and Resource Economics V19(2): 173.

Contingent valuation (CV) has become one of the most widely used non-market valuation techniques. CV's prominence is due to its flexibility and ability to estimate total value, including passive use value. Its use and the inclusion of passive use value in benefit-cost analyses and environmental litigation are the subject of a contentious debate. This paper discusses key areas of the debate over CV and the validity of passive use value. We conclude that many of the alleged problems with CV can be resolved by careful study design and implementation. We further conclude that claims that empirical CV findings are theoretically inconsistent are not generally supported by the literature. The debate over CV, however, has clarified several key issues related to non-market valuation and can provide useful guidance both to CV practitioners and the users of CV results.

Carson, R. T., W. M. Hanemann, et al. (1997). "Temporal reliability of estimates from contingent valuation." Land Economics 73(2): 151.

In 1992 the National Oceanic and Atmospheric Administration (NOAA) convened a panel of prominent social scientists to assess the reliability of natural resource damage estimates derived from contingent valuation (CV). The panel recommended that "time dependent measurement noise should be reduced by averaging across independently drawn samples taken at different points in time." In this paper we examine the temporal reliability of CV estimates. Our findings, using a CV instrument designed to measure willingness to pay for a program to protect Prince William Sound, Alaska, from future oil spills, exhibited no significant sensitivity to the timing of the interviews.

Christie, M., N. Hanley, et al. (2006). "Valuing the diversity of biodiversity." Ecological Economics 58(2): 304.

Policy makers have responded to concerns over declining levels of biodiversity by introducing a range of policy measures including agri-environment and wildlife management schemes. Costs for such measures are relatively easy to establish, but benefits are less easily estimated. Economics can help guide the design of biodiversity policy by eliciting public preferences on different attributes of biodiversity. However, this is complicated by the generally low level of awareness and understanding of what biodiversity means on the part of the general public. In this paper we report research that applied the choice experiment and contingent valuation methods to value the diversity of biological diversity. Focus groups were used to identify ecological concepts of biodiversity that were important and relevant to the public, and to discover how best to describe these concepts in a meaningful and understandable manner. A choice experiment examined a range of biodiversity attributes including familiarity of species, species rarity, habitat, and ecosystem processes, while a contingent valuation study examined public willingness to pay for biodiversity enhancements associated with agri-environmental and habitat re-creation policy. The key conclusions drawn from the valuation studies were that the public has positive valuation preferences for most, but not all, aspects of biodiversity, but that they appeared to be largely indifferent to how biodiversity protection was achieved. Finally, we also investigate the extent to which valuation workshop approaches to data collection can overcome some of the possible information problems associated with the valuation of complex goods. The key conclusion was that the additional opportunities for information exchange and group discussion in the workshops helped to reduce the variability of value estimates.

Curtis, J. A. (2002). "Estimating the demand for salmon angling in Ireland." The Economic and Social Review 33(3): 319.

This paper reports the results of a count data travel cost model for estimating the demand and economic value of salmon angling in Co. Donegal, Ireland. Angling quality, age and nationality were found to affect angling demand, while estimated consumer surplus per angler per day was approximately IR£138 based on a truncated negative binomial model allowing for endogenous stratification.

Hanley, N., R. E. Wright, et al. (1998). "Using choice experiments to value the environment." Environmental and Resource Economics 11(3): 413.

This paper we outline the "choice experiment" approach to environmental valuation. This approach has its roots in Lancaster's characteristics theory of value, in random utility theory and in experimental design. We show how marginal values for the attributes of environmental assets, such as forests and rivers, can be estimated from pair-wise choices, as well as the value of the environmental asset as a whole. These choice pairs are designed so as to allow efficient statistical estimation of the underlying utility function, and to minimise required sample size. Choice experiments have important advantages over other environmental valuation methods, such as contingent valuation and travel cost-type models, although many design issues remain unresolved. Applications to environmental issues have so far been relatively limited. We illustrate the use of choice experiments with reference to a recent UK study on public preferences for alternative forest landscapes. This study allows us to perform a convergent validity test on the choice experiment estimates of willingness to pay.

Holmes, T. P. and V. Adamowicz (2003). Attribute-based methods. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht, Kluwer Academic Publishers: 171-220.

King, O. H. (1995). "Estimating the value of marine resources: a marine recreation case." Ocean & Coastal Management 27(1-2): 129.

This paper discusses the concept of economic value in relation to the appraisal of marine environmental resources. The difficulties of placing monetary values on environmental goods and services for which there is no market are briefly reviewed. A case study is presented which uses contingent valuation to estimate the user value associated with a recreational beach. The paper concludes that economic valuation of environmental resources is feasible and can improve the information basis of public decision-making in marine and coastal environments.

Lee, C. K. and S. Y. Han (2002). "Estimating the use and preservation values of national parks' tourism resources using a contingent valuation method." Tourism Management 23(5): 531.

Leggett, C. G. and N. E. Bockstael (2000). "Evidence of the effects of water quality on residential land prices." Journal of Environmental Economics and Management 39(2): 121.

We use hedonic techniques to show that water quality has a significant effect on property values along the Chesapeake Bay. We calculate the potential benefits from an illustrative (but limited) water quality improvement, and we calculate an upper bound to the benefits from a more widespread improvement. Many environmental hedonic studies have almost entirely ignored the potential for omitted variables bias—the possibility that pollution sources, in addition to emitting undesirable substances, are likely to be unpleasant neighbours. We discuss the implications of this oversight, and we provide an application that addresses this potential problem.

Loomis, J., P. Kent, et al. (2000). "Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey." Ecological Economics 33(1): 103.

Five ecosystem services that could be restored along a 45-mile section of the Platte river were described to respondents using a building block approach developed by an interdisciplinary team. These ecosystem services were dilution of wastewater, natural purification of water, erosion control, habitat for fish and wildlife, and recreation. Households were asked a dichotomous choice willingness to pay question regarding purchasing the increase in ecosystem services through a higher water bill. Results from nearly 100 in-person interviews indicate that households would pay an average of $21 per month or $252 annually for the additional ecosystem services. Generalizing this to the households living along the river yields a value of $19 million to $70 million depending on whether those refusing to be interviewed have a zero value or not. Even the lower bound benefit estimates exceed the high estimate of water leasing costs ($1.13 million) and conservation reserve program farmland easements costs ($12.3 million) necessary to produce the increase in ecosystem services.

Loomis, J. B. and D. M. Larson (1994). "Total economic values of increasing gray whale populations: results from a contingent valuation survey of visitors and households." Marine Resource Economics 9(3): 275.

The consistency of an individual's willingness to pay (WTP) responses for increases in the quantity of an environmental public good (whale populations) is tested along three lines. First, we test whether WTP for 50% and 100% increases in whale populations are statistically different from zero. Second, we ask whether the incremental WTP from a 50% increase to a 100% increase is statistically significant. Finally, we test whether there is diminishing marginal valuation of the second 50 percent increment in gray whale populations. The paired t-tests on open-ended WTP responses supported all three sets of hypotheses. Both visitors and households provided WTP responses that were statistically different from zero and increased (but in a diminishing fashion) for the second increment in WTP. In this survey both visitors and households provided estimates of total economic value (including non-use or existence values) for large changes in wildlife/fishery resources that were consistent with consumer theory.

Loomis, J. B. and D. S. White (1996). "Economic benefits of rare and endangered species: summary and meta-analysis." Ecological Economics 18(3): 197.

The economic value of rare, threatened and endangered species to citizens of the USA has been measured using the contingent valuation method for 18 different species. Annual willingness to pay (WTP) range from a low of $6 per household for fish such as the striped shiner to a high of $95 per household for the northern spotted owl and its old growth habitat. A regression analysis of WTP values shows that over half of the variation in WTP is explained by the change in the size of the population, whether the payment is one-time or annual, whether the respondent is a visitor or non-user and whether the species is a marine mammal or bird. This illustrates that the contingent valuation method can provide meaningful estimates of the anthropocentric benefits of preserving rare and endangered species. Thus, economic techniques are available to perform broad-based benefit-cost analyses of species preservation. However, the Safe Minimum Standard approach is offered as an alternative for endangered species preservation decisions. The values reported in this paper are most useful to assess whether the costs are likely to be disproportionate to the benefits. To date, for even the most expensive endangered species preservation effort (e.g., the northern spotted owl) the costs per household fall well below the benefits per household found in the literature.

Louviere, J. J., D. A. Hensher, et al. (2000). Stated Choice Methods, Cambridge University Press New York.

Marzetti Dall'aste Brandolini, S. (2006). "Investing in biodiversity: The recreational value of a natural coastal area." Chemistry and Ecology 22: 443.

This essay focuses on the comparison between the recreational value of a natural beach area and the recreational value of a developed beach area nearby. Within the EU DELOS (2000–2003) framework, a survey by questionnaire was carried out in 2002 in Lido di Dante, a well-developed tourist resort in Italy. It consists of the application of the Contingent Valuation Method (CVM) in the value of enjoyment version (VOE) for assessing the non-marketable recreational use (such as sunbathing, walking, and swimming) of the Lido di Dante beach areas in the status quo and in hypothetical scenarios of erosion and artificial defence. The project of defence from erosion, considered in this exercise, is paid with public funds. Foreigners were interviewed. It is highlighted that the recreational value in the situation of erosion is lower than that of the status quo, and that the individual loss of enjoyment would be considerable, while the implementation of the project would give a mean gain. Among the explanatory variables of the recreational beach use, the beach quality ratings seem to be important, while income is not significant when it is specified. The comparison of the values for the different beach areas highlights that in Lido di Dante, the daily use value in Euros of the natural beach area is higher than that of the developed beach area. This case study shows that, from a recreational point of view, investing in a natural area is successful and that a sustainable coastal development requires defence projects to be selected also in order to preserve biodiversity.

McDaniels, T. L. and W. Trousdale (2005). "Resource compensation and negotiation support in an aboriginal context: using community-based multi-attribute analysis to evaluate non-market losses." Ecological Economics 55(2): 173.

Compensation for losses of non-market values experienced by aboriginal peoples, due to adverse impacts on their land or resource base caused by others, is an important issue for law and social justice. Yet the standard methods of economic valuation as a basis for determining compensation are not always suited to addressing the diverse values of aboriginal people. This paper discusses an approach to valuation that employs concepts and methods of decision analysis, informed by behavioural decision research, in an applied context. It uses a multi-attribute value assessment as a basis for characterizing the relative significance of resource damages that affect deeply held, complex, intangible values. We draw on the experience of conducting analyses for three Metis settlements in Alberta, Canada, to illustrate the approach using a case study. Interpretations of the results as a basis for negotiation regarding compensation are examined.

Morey, E. R., W. D. Shaw, et al. (1991). "A discrete-choice model of recreational participation, site choice, and activity valuation when complete trip data are not available." Journal of Environmental Economics and Management 20(2): 181.

A discrete-choice model of the demand for site-specific recreational activities is developed and estimated. It simultaneously predicts both how many trips the individual will take and which site will be chosen on each trip. The model is formulated to estimate demand when the data set reports the total number of trips in a given time period, but the actual destinations for only a subset of the total. The model also includes a correction for sample-selectivity bias. The application is marine recreational fishing. The consumer's surplus associated with any change in supply conditions is derived and used to assess the impact of changes in species availability.

Parsons, G. R. (2003). The travel cost model. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht, Kluwer Academic Publishers: 269-330.

Parsons, G. R. and M. Powell (2001). "Measuring the cost of beach retreat." Coastal Management 29(2): 91.

We estimate the cost over the next 50 years of allowing Delaware's ocean beaches to retreat inland. Since most of the costs are expected to be land

and capital loss, especially in housing, we focus our attention on measuring that value. We use a hedonic price regression to estimate the value of land and structures in the region using a data set on recent housing sales. Then, using historical rates of erosion along the coast and an inventory of all housing and commercial structures in the threatened coastal area, we predict the value of the land and capital loss assuming that beaches migrate inland at these historic rates. We purge the losses of any amenity values due to proximity to the coast, because these are merely transferred to properties further inland. If erosion rates remain at historic levels, our estimate of the cost of retreat over the next 50 years in present value terms is about $291 million (2000$). The number rises if we assume higher rates of erosion. We compare these estimates to the current costs of nourishing beaches and conclude that nourishment make economic sense, at least over this time period.

Pate, J. and J. Loomis (1997). "The effect of distance on willingness to pay values: a case study of wetlands and salmon in California." Ecological Economics 20(3): 199.

Most contingent valuation studies in the literature utilized a pre-determined geographic market area for their sample frame. In other words, they did not include variables that would measure the extent of the geographic areas over which to aggregate willingness to pay. These studies implicitly assumed that the effects of geographic distance were moot; an assumption that could have led to an understatement of the aggregate benefit values computed in these studies. The overall goal of this study was to determine if distance affects willingness to pay for public goods with large non-use values. The data used came from a contingent valuation study regarding the San Joaquin Valley, CA. Respondents were asked about their willingness to pay (WTP) for three proposed programs designed to reduce various environmental problems in the Valley. A logit model was used to examine the effects of geographic distance on respondents' willingness to pay for each of the three programs. Results indicate that distance affected WTP for two of the three programs (wetlands habitat and wildlife, and the wildlife contamination control programs). We calculate the underestimate in benefits if the geographic extent of the public good market is arbitrarily limited to one political jurisdiction.

Shrestha, R. K., A. F. Seidl, et al. (2002). "Value of recreational fishing in the Brazilian Pantanal: a travel cost analysis using count data models." Ecological Economics 42(1-2): 289.

Recreational fishing value of the Brazilian Pantanal is measured using travel cost method (TCM). We compare non-linear, Poisson and negative binomial count data models to estimate recreational fishing trip demands. The count data and truncated models are used primarily to account for non-negative integer and truncation properties of recreational fishing trips as suggested by the recreation valuation literature. The results reveal that non-linear and truncated count data models perform relatively well in our study. The economic values of recreational fishing in terms of consumer surplus (CS) are derived using non-linear and truncated models. We estimate the CS values from $540.54 to $869.57 per trip resulting in the total social welfare estimate range from $35 to $56 million. The study demonstrates a relatively high value of recreational fishing in the Pantanal in comparison to similar studies conducted in other parts of the world. The findings of this study would be important for resource management decisions in the Pantanal and could serve as a reference in valuing similar resources in other ecosystems around the world.

Smith, V. K. and R. B. Palmquist (1994). "Temporal substitution and the recreational value of coastal amenities." The Review of Economics and Statistics 76(1): 119.

This paper proposes a method for measuring the effects of substitutions in the timing of recreational use on people's willingness to pay for nonmarketed resources. Using the three markets (peak, pre-peak, and post-peak) for weekly rentals of vacation properties along the Outer Banks of North Carolina, we are able to control for changes in the mix of site characteristics selected at different times and estimate the effects of temporal substitution on tradeoffs between other characteristics. Proximity to the ocean was found to be a significant determinant of temporal substitution between the peak and pre-peak seasons with ocean front properties having 1.9% to 4.7% smaller discounts for pre-season rentals relative to other properties.

Stevens, T. H. (2005). "Can stated preference valuation help improve environmental decision making." Choices 20(3): 189.

Decisions about preservation, protection, or development of environmental "commodities" like ground water, atmospheric visibility, open space, wildlife, wetlands, and forests are often made without good information about the value of preservation relative to the cost. Clearly, the economic cost of preservation is often substantial. The cost of preserving wildlife habitat, for example, often totals thousands of dollars per acre. Difficult choices must be made because protection of habitat for one species may mean less money available to restore habitat for another. In order to make good choices, better information about the relative value of competing uses is necessary. But, much of the economic value derived from preservation of natural environments falls outside the normal workings of the market. In fact, research suggests that most of the value of preservation is often existence (or passive use) value that can only be measured using contingent valuation, or related stated preference methods.

Taylor, L. O. (2003). The hedonic method. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht, Kluwer Academic Publishers: 331-394.

Turner, R. K. and I. J. Bateman (2003). "Editor's note: the Exxon Valdes contingent valuation study." Environmental and Resource Economics V25(3): 255.

Wallmo, K. Threatened and endangered species valuation: literature review and assessment, Unpublished Paper: NOAA Fisheries: Office of Science & Technology.

Economic valuation of threatened or endangered (T&E) species has produced value estimates for over forty species, consisting primarily of mammals, fish, and birds. Because the economic value of T&E species cannot be reflected by a market price, the majority of these studies have relied on the contingent valuation (CV) method. The CV method estimates the economic value of a T&E species by placing survey respondents in a hypothetical market setting created for a particular species, or suite of species, and asking them their willingness to pay to either avoid a total loss of a population (prevent extinction) or increase the population's size. Respondents pay for, or pay to prevent, the population change described in the hypothetical market through a specified payment vehicle. Often the payment vehicle is a contribution to a preservation or trust fund, though other payment vehicles include increased taxes, increased commodity prices, lifetime memberships to an organization, and increased park fees. Additionally, the frequency of payment and the payment amount are specified in the hypothetical market. Some studies ask respondents an open-ended question concerning their maximum willingness to pay, while other studies use a dichotomous choice format, asking respondents to say yes or no to a specified bid amount(s). While estimating value through hypothetical markets and unobserved behaviour is not without critics (see Diamond and Hausman 1994 for a critical review of the CV method), contingent valuation has been upheld by the US District Court of Appeals (Department of Interior 1989), and has been approved for use in cost-benefit analyses (US Water Resources Council 1983). In addition, the NOAA Panel on Contingent Valuation (Arrow et al. 1993) found the method to produce credible value estimates when specific survey development and implementation protocols are followed.

Wardley, I. D. (1993). The value of an ocean view in Oak Bay, British Columbia: A Comparison of the hedonic pricing and contingent valuation methods for estimating intangibles. Department of Economics. Victoria, British Columbia, University of Victoria.

Benefit transfer methodology

Allen, B. P. and J. B. Loomis (2006). "Deriving values for the ecological support function of wildlife: an indirect valuation approach." Ecological Economics 56(1): 49.

We describe a method that combines economic willingness-to-pay estimates for higher trophic-level species with basic information available about ecosystem relationships to derive estimates of partial willingness-to-pay for lower level species that might be of direct policy interest. This method is intended as a quasi-benefit transfer method for use in benefit–cost analysis. Our method makes it possible to establish partial willingness-to-pay estimates for the large number of species of immediate or potential policy interest using only data available in non-market valuation and biology and ecology literature. We provide a partial estimation of indirect values for the predator–prey relationships that support golden eagles in the Snake River Bird of Prey area as an example of how to operationalize our approach.

Bergstrom, J. C. and L. O. Taylor (2006). "Using meta-analysis for benefits transfer: theory and practice." Ecological Economics 60(2): 351.

Meta-analysis, or the "study of studies", attempts to statistically measure systematic relationships between reported valuation estimates for an environmental good or service and attributes of the study that generated the estimates including valuation methods, human population and sample characteristics, and characteristics of the good or service itself. In this paper, we discuss the general theory behind and practice of the emerging use of meta-analysis for benefits transfer. We believe that meta-analysis may prove to be a useful tool for benefits transfer in particular applications if it is carefully conducted following systematic protocols for model development, data collection, and data analysis and interpretation. However, before widespread application of this method, more convergent validity tests are needed. One of the greatest strengths of using meta-analysis for benefits transfer is the ability to combine and summarize large amounts of information from previous studies. This strength can also lead to one of the greatest weaknesses of this method which is the loss of important valuation details across time and space in the aggregation process.

Brouwer, R. (2000). "Environmental value transfer: state of the art and future prospects." Ecological Economics 32(1): 137.

The main objectives of the paper are to (1) give an overview of the state of the art of environmental value transfer, (2) discuss its prospects and potential role in CBA as a decision-support tool, and (3) provide further guidelines for proper use and application. Environmental value or benefit transfer is a technique in which the results of studies on monetary environmental valuation are applied to new policy contexts. The technique is controversial, not least because of academic and political reservations over the usefulness and technical feasibility of economic valuation tools to demonstrate the importance of environmental values in project or programme appraisals. Testing of environmental value transfer so far has been unable to validate the practice. Taking into account the conditions set out in the literature for valid and reliable value transfer, most transfers appear to result in substantial transfer errors. This paper discusses why and addresses the question of which factors may have been overlooked. It is argued that the problem is much more fundamental than previously acknowledged. Strict guidelines in terms of quantitative adjustment mechanisms to valid value transfer are meaningless if the more fundamental issue of differences in the very nature of the values elicited is not addressed at the same time.

Downing, M. and T. Ozuna (1996). "Testing the reliability of the benefit function transfer approach." Journal of Environmental Economics and Management 30(3): 316.

This article presents an experiment designed to test the reliability of the benefit function transfer approach using contingent valuation methods. The experiment uses data collected from anglers surveyed across eight contiguous Texas Gulf Coast bay regions over three distinct time periods. Results indicate that the benefit function transfer approach tends to over-estimate benefits, implying that, at least for the case of recreational saltwater fishing in Texas, the benefit function transfer approach is not reliable.

Johnston, R. J., E. Y. Besedin, et al. (2006). "Characterizing the effects of valuation methodology in function-based benefits transfer." Ecological Economics 60(2): 407.

Meta-analyses have demonstrated that willingness to pay (WTP) estimates vary systematically according to methodological factors. The benefits transfer literature provides little guidance with regard to the treatment of such effects. Transfers are typically conducted by ignoring such effects, using ad hoc adjustments, or otherwise suppressing information regarding the sensitivity of WTP to methodological attributes. This paper illustrates a means to characterize methodological effects within benefits transfer, based on an application of the common bootstrap. Drawing from meta-analysis, the approach characterizes the sampling distribution of WTP with respect to patterns of methodological variation present in underlying studies. Results provide a means to characterize the extent of variation associated with predefined groups of methodological attributes, providing transparent information on the sensitivity of WTP not typically available in benefits transfer.

Loomis, J. B. (1992). "The evolution of a more rigorous approach to benefit transfer: benefit function transfer." Water Resources Research 28(3): 701.

The desire for economic values of recreation for unstudied recreation resources dates back to the water resource development benefit-cost analyses of the early 1960s. Rather than simply applying existing estimates of benefits per trip to the study site, a fairly rigorous approach was developed by a number of economists. This approach involves application of travel cost demand equations and contingent valuation benefit functions from existing sites to the new site. In this way the spatial market of the new site (i.e., its differing own price, substitute prices and population distribution) is accounted for in the new estimate of total recreation benefits. The assumptions of benefit transfer from recreation sites in one state to another state for the same recreation activity is empirically tested. The equality of demand coefficients for ocean sport salmon fishing in Oregon versus Washington and for freshwater steelhead fishing in Oregon versus Idaho is rejected. Thus transfer of either demand equations or average benefits per trip are likely to be in error. Using the Oregon steelhead equation, benefit transfers to rivers within the state are shown to be accurate to within 5-15%.

Loomis, J. B. (2006). "Estimating recreation and existence values of sea otter expansion in California using benefit transfer." Coastal Management 34(4): 387.

This article demonstrates how benefit transfer can quantify tourism and existence values. Existing literature values of sea otters and a meta analysis yield benefit estimates of several million dollars for the increased number of sea otters expected by USFWS in the next decade if the "no otter zone" is eliminated and otters allowed to expand along the Santa Barbara coast. These benefit estimates of sea otter expansion exceed the costs to commercial fishing. Thus the benefit transfer approach can contribute to a more complete economic analysis of endangered species recovery or critical habitat efforts than the current USFWS approach.

Loomis, J. B. and R. S. Rosenberger (2006). "Reducing barriers in future benefit transfers: needed improvements in primary study design and reporting." Ecological Economics 60(2): 343.

Original research provides many social benefits, including additions to our stock of knowledge. Benefit transfer is a formal process whereby our stock of knowledge, rather than original research, is used to inform decisions. Any shortcoming in this stock directly affects our ability to conduct valid and reliable benefit transfers. This paper discusses three general criteria that are necessary for valid benefit transfers and how original research designs and reporting of results unnecessarily constrain the potential of benefit transfers. We make several suggestions regarding how original research, through improved design and reporting, might increase the validity and reliability of benefit transfers. We also recommend that repositories for original research surveys and data be developed to insure long-term availability of study information.

Ready, R. and S. Navrud (2006). "International benefit transfer: methods and validity tests." Ecological Economics 60(2): 429.

The use of value estimates measured in one country to value policy changes in another country would seem to introduce some unique issues and challenges, even when the good being valued is identical. These issues include, how should values be converted from one currency to another; how to account for differences in measurable characteristics when those can vary markedly between countries (especially income); and how to account for differences between countries in culture and shared experiences that are difficult to quantify. However, these challenges in international benefit transfer are not that different from those encountered in transfers between regions within a country, and transfer errors are comparable to those seen in intra-country transfers.

Rosenberger, R. S. and J. B. Loomis (2003). Benefit transfer. A Primer on Non-market Valuation. P. A. Champ, K. J. Boyle and T. C. Brown. Dordrecht, Kluwer Academic Publishers: 445-482.

Rosenberger, R. S. and T. D. Stanley (2006). "Measurement, generalization, and publication: Sources of error in benefit transfers and their management." Ecological Economics 60(2): 372.

Convergent validity tests of benefit transfer accuracy show errors to range from a few percentage points to 100% and more. This paper discusses three potential sources of errors that affect the accuracy of benefit transfers. (1) The measurement of values is subject to random errors and the caprices that arise from the many judgments and technical assumptions required by the researchers who conduct the primary studies. Measurement error occurs when researchers' decisions affect the transferability of measures of value or as the result of sampling. (2) Generalization error occurs when a measure of value is generalized to unstudied sites or resources. Generalization error is inversely related to the correspondence between study sites and policy sites. (3) Publication selection bias occurs when the objectives for publishing research limit benefit transfer applications of research outcomes. Criteria for selecting which research results are published may be at odds with the needs of benefit transfer practitioners. Several means for overcoming these sources of error are offered: standardized application of tested methods; closer adherence to benefit transfer protocol; the establishment of an e-journal with explicit criteria for fully recording, reporting, and disseminating research, which has the primary objective of estimating empirical measures of value.

Shrestha, R. K. and J. B. Loomis (2001). "Testing a meta-analysis model for benefit transfer in international outdoor recreation." Ecological Economics 39(1): 67.

The economic values of outdoor recreation are estimated using a benefit transfer approach in which one applies existing consumer surplus measures to value the resources at a new site. In this article, a benefit transfer study was conducted based on meta-analysis of existing research in outdoor recreation use values of the United States from 1967 to 1998. The meta-analysis method was used to estimate a meta-regression model, resulting in a benefit transfer function that could be applied to estimate a wide range of recreation activity values in other countries. The estimated meta-model was tested using original out-of-sample studies from countries around the world for international benefit transfer purposes. The tests reveal that there is mixed evidence in using meta-analysis of existing studies in outdoor recreation in the United States to value the recreational resources in other countries that are used by tourists. In the best case, 18 correlation coefficients between meta-predicted and out-of-sample values were positive and significant at the 5% level or greater, but nine of the 18 t-tests indicated a significant difference between the two sets of values at the 10% level. However, the absolute average percentage error of the meta-predictions was 28%, which may be acceptable for many benefit transfer applications.

Smith, V. K., S. K. Pattanayak, et al. (2006). "Structural benefit transfer: an example using VSL estimates." Ecological Economics 60(2): 361.

This paper describes and illustrates a method for benefits transfer referred to as preference calibration or structural benefits transfer. This approach requires selection of a preference model, capable of describing individual choices over a set of market and associated non-market goods to maximize utility when facing budget constraints. Once the structure is selected, the next step involves defining the analytical expressions for the tradeoffs being represented by the set of available benefit measures. These algebraic relationships are used with the benefit estimates from the literature to calibrate the parameters of the model. The calibrated model then offers the basis for defining the "new" tradeoffs required for the policy analysis, i.e., for 'transferring benefits'. A new application is used to illustrate the structural benefits transfer logic. It involves the benefits for mortality risk reductions, measured with labour market compensation a worker would accept to be willing to work with added risk. The measure is usually labelled the value of a statistical life (VSL). Our application indicates that we should not have expected differences in these measures for the economic value of risk reductions with age. The calibrated estimates were not greatly different for combinations of risk levels, labour supply choices, wages, and non-wage income for older adults. Thus, simple adjustments relying on value per discounted life year remaining seem questionable.

Spash, C. L. and A. Vatn (2006). "Transferring environmental value estimates: issues and alternatives." Ecological Economics 60(2): 379.

Environmental value transfer needs to be understood in the context of scientific information use in general. This provides a different perspective upon the reasons why benefit transfer in particular appears so controversial and raises concerns over the limited types of validity testing being undertaken by those supporting such applications as ecosystem services valuation. Another key issue, which we emphasise, is the unintentional challenge to standard economic theory raised by the models used to conduct value transfers. Existing value transfer practice reveals the need for a more inclusive approach if environmental values are to be addressed. We argue that there are robust alternative means for including multiple environmental values in decision processes, these cannot be dismissed out of hand, and analysts should be expanding their understanding of the available approaches which include attitude and norm measures, multi-criteria analysis and participatory deliberative institutions.

Walsh, R. G., D. M. Johnson, et al. (1992). "Benefit transfer of outdoor recreation demand studies, 1968-1988." Water Resources Research 28(3): 707.

The accumulation of studies on outdoor recreation demand creates an opportunity to apply the growing science of reviewing research for purposes of benefit transfer. The process involves developing an understanding of the variables that explain the observed difference in estimates. This paper illustrates how the results of previous studies could be adjusted to develop some tentative estimates of nonmarket values for future policy analysis. Also, the evaluation of some potentially important variables should help improve statistical analysis and the allocation of resources to new studies. The challenge is to build each subsequent work on the knowledge gained from previous ones. In this experimental phase, there is a need to examine additional variables that might conceivably be more important than those considered in the past.

Wilson, M. A. and J. P. Hoehn (2006). "Valuing environmental goods and services using benefit transfer: the state-of-the art and science." Ecological Economics 60(2): 335.

The purpose of this special issue of Ecological Economics is to elucidate the state-of-the-art and science of environmental benefit transfer and to assist in the design and reporting of future benefit estimation research. Compiling the insights of thirty-two international experts from seven countries, the special issue reviews the latest developments in transfer techniques, as well as ongoing efforts to standardize and validate them. Taken together, the papers in this special issue provide fresh answers to some long-standing questions, offer original research insights on state-of-the-art issues and identify fruitful areas for future research. This introductory paper provides background and context for the issues addressed by the contributing authors. Its purpose is to place the interdisciplinary thinking contained here in a comparative context, highlighting the need for integration and collaboration to maintain the momentum that has propelled environmental benefit transfer into a widely used approach for estimating the economic value of environmental goods and services worldwide.

Other methodologies

Anderson, E. E. (1989). "Economic benefits of habitat restoration: seagrass and the Virginia hard-shell blue crab fishery." North American Journal of Fisheries Management 9(2): 140.

Since the early 1960s, water pollution has caused the disappearance of much of the seagrass (predominantly eelgrass Zostera marina) and other submerged aquatic vegetation in Chesapeake Bay. Seagrass beds appear to serve as preferred habitat for the blue crab Callinectes sapidus during early stages of its life history, and there is a statistically significant relationship between the abundance of submerged aquatic vegetation and catch per unit of effort in the Virginia hard-shell blue crab fishery. Virginia seagrass beds might be partially or fully restored through a combination of pollution abatement and replanting. I developed a simple simulation model with minimal data requirements to generate rough estimates of some of the economic benefits that would accrue from seagrass restoration. The estimated net economic benefit to Virginia hard-shell blue crab fishermen of full seagrass restoration is about US$1.8 million per year, and additional annual benefits of about $2.4 million should accrue to U.S. hard-shell blue crab consumers.

Arnason, R. (2000). "Economic instruments for achieving ecosystem objectives in fisheries management." ICES Journal of Marine Science 57(3): 742.

An aggregative model of fisheries is developed in the context of the ecosystem. Rules for optimal harvesting are derived and their content is examined. An important result with obvious practical implications is that it may be optimal to pursue unprofitable fisheries in order to enhance the overall economic contribution from the ecosystem. Another interesting result is that modifications of single-species harvesting rules may be required even when there are no biological interactions between the species. The possibility of multiple equilibria and complicated dynamics and their implications for sustainability are briefly discussed. Equations for the valuation of ecosystem services are derived. Only two classes of economic instruments capable of optimal management of ecosystem fisheries have been identified so far, namely (a) corrective taxes and subsidies (Pigovian taxes) and (b) appropriately defined property rights. Of these, Pigovian taxes are informationally demanding perhaps to the point of not being feasible. In contrast, property-rights-based regimes are informationally much more efficient and therefore appear to constitute a more promising overall approach to the management of ecosystem fisheries. The employment of the latter for the management of ecosystem fisheries is discussed and some of the implications are explored.

Bell, F. W. (1997). "The economic valuation of saltwater marsh supporting marine recreational fishing in the southeastern United States." Ecological Economics 21(3): 243.

This paper is concerned with placing an economic value on the contribution of wetlands in supporting recreational fishing in the southeastern United States. A production function first links the recreational catch to angler fishing effort and wetlands. The parameters of the recreational fisheries production function are estimated using cross-sectional data by states. To simplify the mathematics, the estimated elasticities are substituted into a Cobb-Douglas production function. For simplicity, a linear demand curve for recreational fishing is postulated which shifts when there is an increase or decrease in the catch (success rate). Therefore, incremental changes in wetlands will via the production function provide incremental changes in the catch which will in turn shift the recreational demand curve, thereby increasing or decreasing consumer surplus. Using a discount rate of 8.125%, the perpetual flow of consumer surplus per incremental acre of wetlands has an estimated asset value of $6,471 and $981 on the East and West Coast of Florida respectively in 1984 dollars. If commercial fisheries and other economically useful functions of wetlands are added to recreational fisheries, it may be more efficient for the State of Florida to acquire more coastal land for preservation from development.

Farber, S. (1987). "The value of coastal wetlands for protection of property against hurricane wind damage." Journal of Environmental Economics and Management 14(2): 143.

The paper has attempted to place a value on wetlands for their role in reducing wind damage to property because of diminished storm intensities. The discounted value of the loss of a one mile strip of wetlands along Louisiana's gulf coast was estimated to be between $1.1 million and $3.7 million in 1980 dollars, using discount rates of 8% and 3%, respectively. Although it may not be too meaningful to place this on a per acre basis, this increased cost of property damage amounted to between $7 and $23 per acre. In order to place this in perspective, the market value of Louisiana wetlands is under $200 per acre. This market value is derived primarily from the mineral and hunting rights accompanying the surface area. This hurricane protection value is only one of many pure or quasipublic goods produced by wetlands. In order to make decisions regarding costly projects designed to retard wetlands erosion, such as revegetation or sediment transfers; or to consider wetlands destroying developments, such as pipeline canal construction, the value of these public goods must be estimated. The current study adds to our knowledge of these values. The next stage in this line of research is to evaluate the benefits that wetlands provide by reducing storm tidal surge. Flood damages to low-lying coastal areas are considerably greater than wind damage, and wetlands areas may be more useful for flood protection to these areas than for reducing storm intensities. Unfortunately, establishing a flood damage function similar to the wind damage function used in this study is difficult since it must consider unique hydrologic features of affected coastal areas.

Knowler, D. (2002). "A review of selected bioeconomic models with environmental influences in fisheries." Journal of Bioeconomics V4(2): 163.

Bioeconomic models are integrated economic-ecological models, with all the advantages and disadvantages of such models. Most bioeconomic modelling seeks appropriate levels of stock and catch to assist resource managers, normally with environmental conditions assumed constant. However, bioeconomic models can be used to analyse the welfare effects of changes in environmental quality as well. This latter application is the subject of this review. The review concentrates on the commercial harvesting of fish stocks, where population dynamics are influenced by environmental quality. In the first part of the paper, the basic static and dynamic bioeconomic models are described and then extensions are considered that take account of the influence of environmental quality on habitat and, by inference, on sustainable catch levels and measures of economic surplus. The second part of the paper describes a series of case studies from the empirical bioeconomic literature that apply some of the theoretical innovations described earlier.

Knowler, D. (2005). "Reassessing the costs of biological invasion: Mnemiopsis leidyi in the Black sea." Ecological Economics 52(2): 187.

Invasions of ecosystems by exotic species have been the focus of a growing body of research in applied biology and ecology, but relatively little attention has been paid to their economic consequences. Even where economic estimates have been made these often make ad hoc assumptions about the biological relationships of interest and lack grounding in economic theory. This paper develops an integrated ecological-economic approach to assess the economic consequences of invasion for a commercially harvested endemic species whose population dynamics are altered by the invader. As a case study, the Black Sea anchovy fishery represents an interesting example of such a situation. In the early 1980s, the comb jelly Mnemiopsis leidyi invaded the Black Sea, eventually becoming established and experiencing a population explosion with dire consequences for the commercial anchovy fishery. In modeling the population dynamics of the Black Sea anchovy (Engraulis encrasicolus), the influence of Mnemiopsis is incorporated as a structural change in the anchovy stock-recruitment relationship. Then the economic loss associated with this structural change is assessed, using a discrete, dynamic bioeconomic model. It is shown that Mnemiopsis had a dramatic effect on the potential sustainable harvest from an optimally managed anchovy fishery but these losses were at least an order of magnitude lower than estimates cited elsewhere.

Knowler, D. J., B. W. MacGregor, et al. (2003). "Valuing freshwater salmon habitat on the west coast of Canada." Journal of Environmental Management 69(3): 261.

Changes in land use can potentially reduce the quality of fish habitat and affect the economic value of commercial and sport fisheries that rely on the affected stocks. Parks and protected areas that restrict land-use activities provide benefits, such as ecosystem services, in addition to recreation and preservation of wildlife. Placing values on these other benefits of protected areas poses a major challenge for land-use planning. In this paper, we present a framework for valuing benefits for fisheries from protecting areas from degradation, using the example of the Strait of Georgia coho salmon fishery in southern British Columbia, Canada. Our study improves upon previous methods used to value fish habitat in two major respects. First, we use a bioeconomic model of the coho fishery to derive estimates of value that are consistent with economic theory. Second, we estimate the value of changing the quality of fish habitat by using empirical analyses to link fish population dynamics with indices of land use in surrounding watersheds. In our example, we estimated that the value of protecting habitat ecosystem services is C$0.93 to C$2.63 per ha of drainage basin or about C$1322 to C$7010 per km of salmon stream length (C$1.00=US$0.71). Sensitivity analyses suggest that these values are relatively robust to different assumptions, and if anything, are likely to be minimum estimates. Thus, when comparing alternative uses of land, managers should consider ecosystem services from maintaining habitat for productive fish populations along with other benefits of protected areas.

Loomis, J. (2005). Economic Benefits of Expanding California's Southern Sea Otter Populations, Report prepared for Defenders of Wildlife. 34.

eventual expansion of southern sea otter populations and range would provide more than $100 million in annual economic benefits to California households. These benefits derive from recreation, tourism, ecosystem services, option value and existence value. The majority of these benefits are associated with existence value - the value people place on just knowing that sea otters are being saved from extinction and their populations increasing to levels where the species could be removed from the federal list of threatened species.

Loomis, J. B. (1989). "Bioeconomic approach to estimating the economic effects of watershed disturbance on recreational and commercial fisheries." Journal of Soil and Water Conservation 44(1): 83.

The change in value of recreational and commercial fisheries caused by timber harvesting and road building on two national forests was measured using an improved bioeconomic approach. Hydrologic models were linked with fisheries models to predict the change in catchable fish populations due to watershed disturbances from road building and timber harvests. A simple bioeconomic model of recreational fishing, estimated using the travel-cost method, was applied to measure the incremental change in economic value of the fisheries under different levels of watershed disturbance. The results indicated that, for the Siuslaw National Forest, clearcutting on about 87,000 acres resulted in a loss of about 84,000 salmon and 24,000 steelhead trout over the 30-year period studied. The economic value of these lost fish to recreational and commercial anglers is $2 million. For the Porcupine-Hyalite Wilderness study area in Montana, the results indicated a $3.5 million loss in the value of trout fishing over a 50-year period from timber harvesting in the Gallatin and Yellowstone River drainages.

Lynne, G. D., P. Conroy, et al. (1981). "Economic valuation of marsh areas for marine production processes." Journal of Environmental Economics and Management 8(2): 175.

The relationship of natural marsh-estuarine systems to the economic productivity of marine systems is not well understood, at least in any quantitative sense. An approach is developed for relating blue crab economic productivity on Florida's Gulf Coast to marsh availability in the area. Previous efforts have not always applied economic concepts appropriately in attempts at such quantification. The marginal value productivity of marsh is shown to vary with alternative levels of marsh and effort in the fishery. The interaction and subsequent interdependence is shown to be statistically significant. Data availability on marginal response to marsh changes poses a severe obstacle to further progress.

Massey, D. M., S. C. Newbold, et al. (2006). "Valuing water quality changes using a bioeconomic model of a coastal recreational fishery." Journal of Environmental Economics and Management 52(1): 482.

This paper develops and applies a structural bioeconomic model of a coastal recreational fishery. We combine a dynamic fish population model, a statistical model of angler catch rates, and a recreation demand model to estimate the value of water quality changes for the Atlantic Coast summer flounder fishery. The model predicts that improving water quality conditions in Maryland's coastal bays alone would have relatively small impacts on the fishery as a whole. However, water quality improvements throughout the range of the species could lead to substantial increases in fish abundance and associated benefits to recreational anglers from increased catch rates. We also estimate an alternative version of the catch function, with no direct measure of fish abundance included, and we compare results from this "reduced form" approach to results from our structural model.

McConnell, K. E. and J. G. Sutinen (1979). "Bioeconomic models of marine recreational fishing." Journal of Environmental Economics and Management 6(2): 127.

The theory of recreational fishing is developed and conditions are derived for optimal management policy, with special attention given to functional relationships that must be empirically verified. Determinants of the optimal allocation between commercial and recreational fishing effort are derived. The theory is extended to include selected peculiar features of recreational fishing: Some anglers sell their catch; a small proportion of the fishing population accounts for a large proportion of the catch; and anglers throw back a fraction of what they catch. Optimal policies are derived under these more realistic conditions.

Patterson, M. G. (2002). "Ecological production based pricing of biosphere processes." Ecological Economics 41(3): 457.

Ecological pricing theory and method is reviewed, and then applied to the valuation of biosphere processes and services. Ecological pricing values biosphere processes, on the basis of biophysical interdependencies between all parts of the ecosystem, not just those that have direct or obvious value to humans. The application of the ecological pricing method to the biosphere for 1994, indicates that the total value of primary ecological inputs (services) to be nearly $US 25 trillion. This compares with $US 33 trillion obtained in the Costanza et al. (1997) study. Our analysis also indicated a good correspondence between the shadow ecological price and the observed market price for all marketable goods, except fossil fuel which was undervalued by the market.

Pendleton, L. H. (1995). "Valuing coral reef protection." Ocean & Coastal Management 26(2): 119.

Past economic valuations of tropical marine parks inaccurately measure their economic benefits because they value the resource protected and not the protection provided. Instead, the economic benefit of a marine park should be measured as the savings from avoided losses in reef value that would result in the absence of park protection, net of any costs of protection. Proponents of marine parks posit that reef quality will decline in the absence of active park protection. The economic benefit of the marine park is the value of avoided reef degradation. An economic framework is developed to show how marine parks and protected areas ought to be valued. An example using data from the Bonaire Marine Park is given.

Sanchirico, J. N. and J. E. Wilen (2001). "A bioeconomic model of marine reserve creation." Journal of Environmental Economics and Management 42(3): 257.

This paper employs a dynamic and spatial model of renewable resource exploitation to investigate the effects of marine reserve creation. The model combines a metapopulation model incorporating resource patch heterogeneity and dispersal with a behaviourally based spatially explicit harvesting model that assumes that fishermen choose location in a manner that eliminates spatial arbitrage opportunities. The combined spatial bioeconomic model is used to simulate the effects of reserve creation under various ecological structures. We identify parameter configurations and ecological dispersal processes that give rise to a double-payoff in which both aggregate biomass and harvest increase after an area of the fishery is set aside and protected from exploitation.

Sumaila, U. R., T. J. Pitcher, et al. (2000b). Evaluating the benefits from restored ecosystems: a Back to the Future approach. Microbehaviour and Macroresults: Proceedings of the 10th biennial conference of the International Institute of Fisheries Economics & Trade.

We argue in this paper that the present fishery policy goal of sustaining current levels of ecosystem resources will foreclose future options for the

generation of food, wealth and services from ocean resources. Hence, only a policy of rebuilding of ecosystems can reverse this trend. A novel methodology, termed Back To The Future, defines ecosystem policy goals with which to guide this rebuilding process. In the Back to the Future method, models of past ecosystems are reconstructed using information about the presence and abundance of species derived from historical documents, archaeology, local and traditional environmental knowledge (LEK and TEK). The reconstructed ecosystems are then subjected to economic evaluations to determine the potential market and non-market (that is, social and ecological) values that can be derived from each of them. A comparison of the different values under the different alternative ecosystems is carried out to assess the trade-offs involved in implementing different rebuilding scenarios. A novelty of the proposed approach is that, for almost the first time, the Back to the Future methodology provides the TEK of aboriginal and indigenous peoples with a valuable, direct role in resource management and science.

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