Discussion Paper:
Non-market Economic Values & the South-East Marine Region

Prepared for

National Oceans Office

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September 2001

AU1-077

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1. INTRODUCTION

The South-east Marine Region, comprises waters off Victoria, Tasmania, Macquarie Island, southern New South Wales and eastern South Australia, which extend from the low water mark out to the 200 nautical mile limit of Australia's Exclusive Economic Zone (EEZ). The Region includes areas of the continental shelf beyond the EEZ, that are claimed by Australia under the United Nations Convention on the Law of the Sea (UNCLOS) (NOO 2001a). The area is depicted in Figure 1.

The total area of the Region exceeds two million square kilometres, encompassing three large ecosystems (NOO 2001b):

- South-eastern;
- Sub-antarctic (South Tasman Rise south of Tasmania); and
- Macquarie.

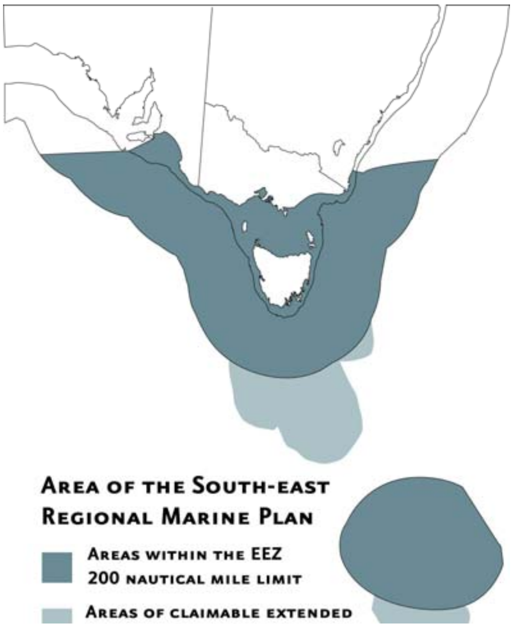

Figure 1 Area of the South-east Marine Region

The natural resources and oceanographic and biological services of the Region support a range of stakeholders, including the commercial fishing and tourism industries, endangered species, such as the blue whale, and educational sectors involved in research. The marine environment also contributes generally to human welfare through the functions of climate and atmospheric gas regulation.

These goods and services have value to society whether or not they are actually traded in markets. It is the purpose of this discussion paper to explore the concepts of non market economic values associated with environmental goods and services, with particular reference to the South-east Marine Region. The paper provides:

- an overview of the concepts associated with economic values of natural areas;
- a detailed examination of the non-market economic values associated with the South-east Marine Region;
- a brief discussion of the applications of economic values in decision making; and
- an overview of the economic instruments that may be used to protect the values identified.

2. ECONOMIC VALUES OF NATURAL AREAS – CONCEPTUAL FRAMEWORK

2.1 Introduction

The South-east Marine Region, like all natural areas, provide a range of goods and services to the community, from fish stocks for commercial and recreational exploitation through to biodiversity conservation. These goods and services, provided by the environment, have values to society whether or not they are actually traded in markets.

One of the central themes of environmental economics and sustainable development is the need to place proper values on the goods and services provided by natural environments. The main reason for this is that many of these goods and services are provided outside the market system and hence the observable price paid by producers and consumers for them is zero. With a zero observable price there is a serious risk of overusing the resource (Pearce et al 1991).

There are two key value frameworks for considering environmental goods and services:

- An ethical framework; and
- An anthropocentric framework.

2.2 Ethical framework of value

Natural areas are sometimes considered to have 'intrinsic' values that are quite separate to any value derived from their ability to serve human needs (Brown et al. 1993) or their relationship to human preferences. This view is reflected in the World Charter for Nature, adopted by the United Nations General Assembly in 1982, which states that "every form of life is unique, warranting respect regardless of its worth to man, and, to accord other organisms such recognition, man must be guided by a moral code of action." Similarly, the "World Ethic for Sustainability" proposed by the World Conservation Strategy (IUCN/UNEP/WWF 1991) recognises that nature has to be cared for in its own right, and not just as a means of satisfying human needs.

Such an ethical framework of value does not lend itself to the analysis of tradeoffs, which are inevitably involved when policy or development proposals impact on the environment. It is, therefore, difficult to incorporate into decision making in any meaningful way. Nevertheless, the anthropocentric or human preference focus of economic valuation, to be discussed in Section 2.3 does not, preclude a concern for survival and well-being of other species. Individuals can value the survival of other species, not only because of the uses people make of them, but also because of an altruistic or ethical concern. The latter can be the source of existence or non use values, a form of economic value discussed in Section 2.3.2 (Freeman 1993).

2.3 Anthropocentric framework of economic value

The economic concept of value is based on the premise that the purpose of economic activity is to increase the well-being of individuals who make up the society, and that each individual is the best judge of how well off he or she is in a given situation (Freeman 1993); that is, anthropocentric economic values are based on individual's preferences. People express their preferences through the choices and tradeoffs that they make or are willing to make between different goods and services, given certain constraints, such as those on income and available time.

2.3.1 Measure of Value

The conceptual base for providing an understanding of net economic benefits or value of goods and services, including environmental goods and services, is the supply and demand, or market, model. Refer to Figure 2.

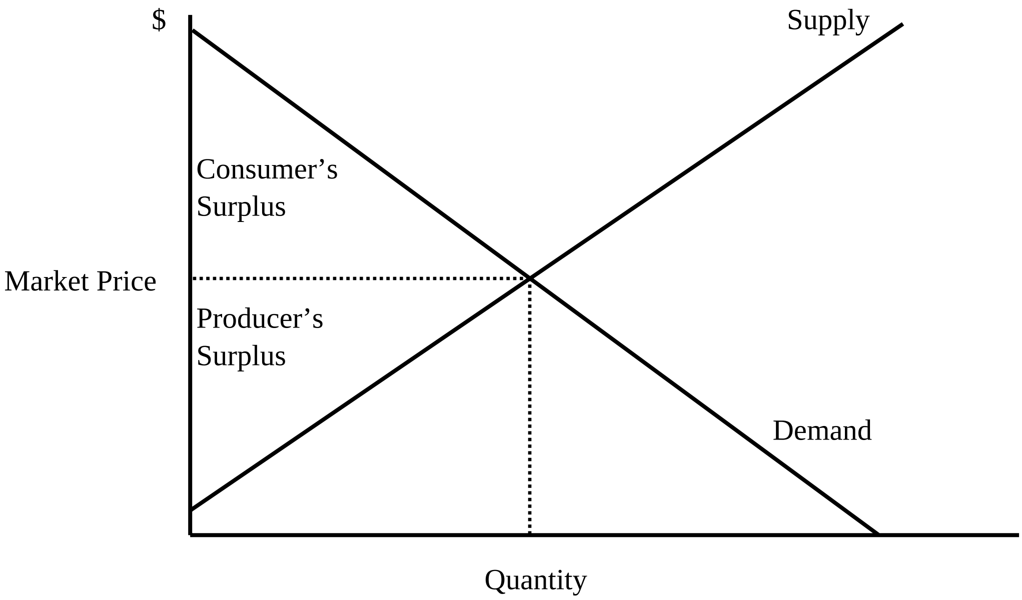

Figure 2 Measures of Economic Value

The supply curve indicates the quantity of a good or service supplied at varying prices and the marginal cost of producing more of the good or service. Generally, the higher the price the more produce that will be supplied, as more producers find it profitable to sell (RACAC 1996).

The demand curve indicates the maximum amount that consumers are willing to pay for incremental increases in quantity of the good or services (Edwards 1990). Generally, people are willing to pay more for the first unit consumed than subsequent units and overall demand increases as price decreases.

In a competitive market the interaction of supply and demand determines the market price.

The market price of a good is often mistakenly assumed to be its economic value, with goods and services that are not provided in competitive markets implicitly assumed to have zero value. However, the market price for a good or service (even where it is zero) only reflects the minimum amount that people who purchase the good are willing to pay for it. These purchasers will only purchase the good if their willingness to pay for the good is equal to or greater than the market price. Many people are actually willing to pay more than the market price for a good. This amount that people are willing to pay above what they actually pay is the correct **measure** of the value of a good or service to consumers and is referred to as consumer's surplus. In the demand and supply model, it is the area below the community demand curve, but above the price line.

Market goods generated from the environment also result in economic benefits to producers. The market price represents the price actually received by producers while the supply curve represents the minimum payment that producers would be willing to receive for the goods they provide. If producers receive a higher price than the minimum price they would sell their output for, they receive a benefit from the sale i.e. producer surplus.

This, however, does not mean that in the absence of markets for goods and services they have no value. The model can also be conceptualised where no market exists, which is the case for many environmental goods and services. In such cases, the concepts of individual's willingness to pay for a good (driven by their preferences) is just as real as in the case of a marketed good, but will not always be directly observable and measurable in dollars. The value of the good to individuals will, however, be implicit in the actions and underlying preferences of people (RACAC 1996). Thus anything from which an individual gains satisfaction and is willing to pay for is deemed to be of value (DEST et al. 1995)

Producer's surplus values from environmental goods and services can be identified for all goods and services that are traded in markets. Consumer's surplus measures of the values of environmental goods and services can be identified for both market goods and non-market goods.

While producer's surplus and consumer's surplus is the appropriate ***measure*** of economic value, these measures may be generated for a range of goods and service values provided by environmental resources. When considering the values of environmental goods and services it is useful to consider them within a total economic value framework.

2.3.2 Total Economic Value Framework

The total economic value of an environmental resource is generally considered to comprise both the use values as well as non use values generated by that resource.

TOTAL ECONOMIC VALUE	=	DIRECT USE VALUES
	+	ECOLOGICAL FUNCTION VALUES
	+	OPTION VALUES
	+	QUASI OPTION VALUES
	+	VICARIOUS USE VALUES
	+	BEQUEST VALUES
	+	EXISTENCE VALUES

Reference: Young (1992); DEST et al (1995).

Direct use values are those that arise from the physical use of environmental resources (DEST et al. 1995) and may include commercial or market activities such as commercial fishing, guided fishing trips, boat tours, etc, as well as non-commercial or non-market activities such as recreation (James and Gillespie 1997).

Ecological function value[1] is the value of the ecological services and functions provided by an environmental resource. The concept attempts to capture indirect ecological values due to the

[1] Some economists consider ecological function values as a special category of environmental values, but they can usually be decomposed into the other categories of use and nonuse value.

interconnectedness of species through a variety of food chain and nutrient cycles (Young 1992). Ecological function values may include waste assimilation functions, life support functions such as the provision of clean air water and other resources (James and Gillespie 1997).

> "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." (Costanza et al. 1997).

Non-use values comprise *option values*, *quasi-option values*, *vicarious use values*, *bequest values* and *existence values*.

Option values relate to the benefit of maintaining the right to use resources without necessarily doing so. It may include future use by existing individuals or by future generations.

Quasi-option values refer to the welfare obtained from the opportunity to get better information by delaying a decision that may result in irreversible environmental damage.

Vicarious use values are gained by people from the knowledge that others may be enjoying use of a natural environment, for instance, for recreational activities, commercial activities, etc.

Bequest values refer to the maintenance of environmental attributes for the benefit of future generations.

Existence value is the satisfaction that the community derives from simply knowing that certain things exist (including because of ethical concerns), for example, rare species or special ecosystems (James and Gillespie 1997).

These values are presented diagrammatically in Figure 3.

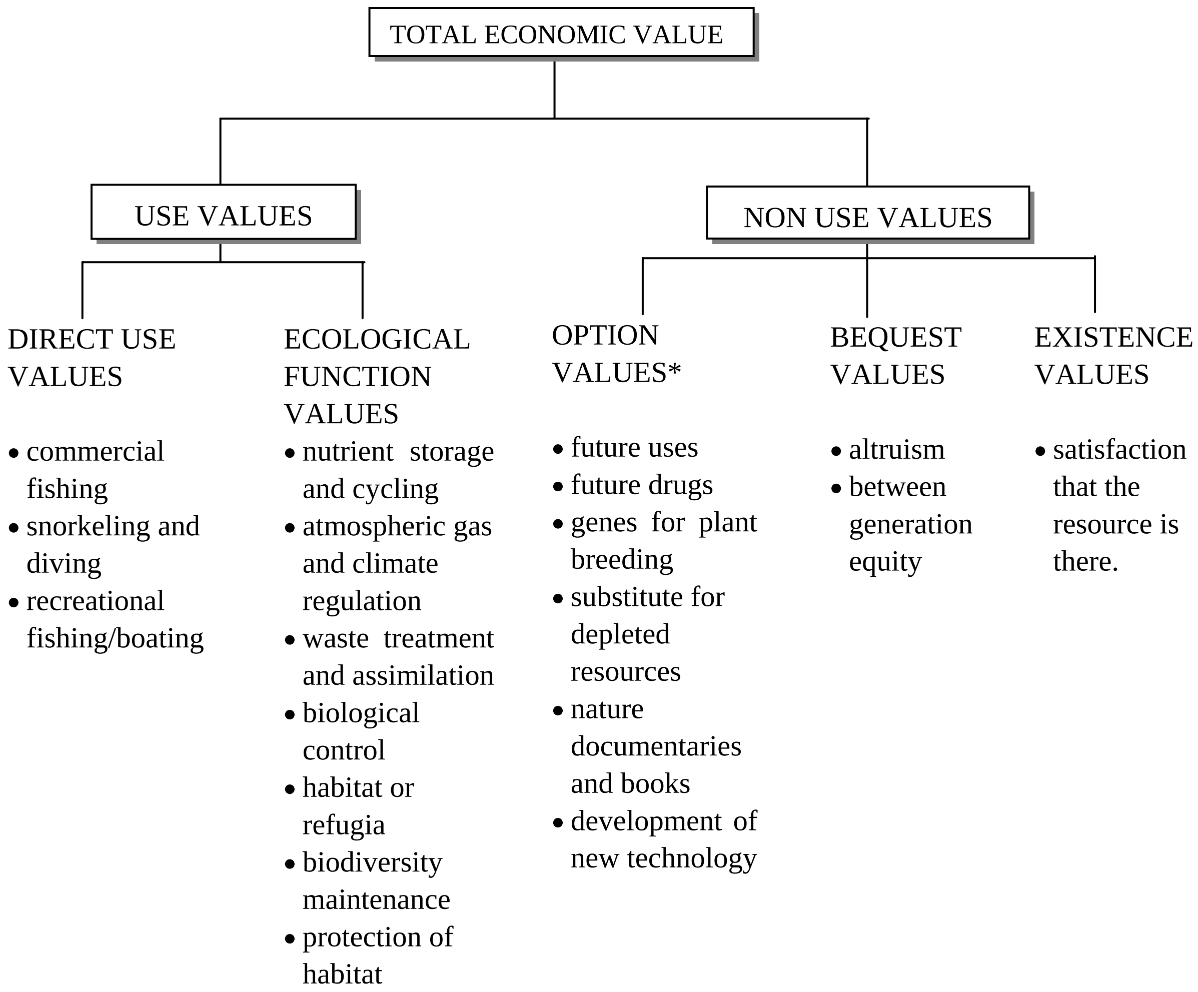

Figure 3 Components of Total Economic Value: Use and Non-use Values
* includes option, vicarious and quasi-option values
Adapted from Young (1992), p. 23.

2.3.3 Economic valuation methods

Many welfare aspects of goods and services do not show up in markets and thus may be unpriced. However, the concepts of social benefits and social costs (or consumers' surplus and producers' surplus) apply to goods and services, even though they may not always be directly observable in markets. Economists have developed specific economic valuation techniques to measure non-market changes in welfare. While there are many different classifications of these non-market valuation techniques[2], they can conveniently be classified as:

- market-based techniques such as the productivity changes method, human capital approach, defensive expenditures, replacement/repair expenditures, shadow projects and the opportunity cost method;

[2] Refer to Abelson (1996).

- surrogate market techniques such as the wage differential method, property value approach and travel cost method; and
- hypothetical market or survey techniques such as the contingent valuation method, constructed markets, contingent ranking, choice modelling and the Delphi technique (James and Gillespie 1997).

The benefit transfer technique is also sometimes used to value non-market changes in welfare. The technique borrows values from other studies and applies these values to the study site in question.

James and Gillespie (1997) provide a description and comparison of each of these non-market valuation techniques. This is reproduced in Appendix 1.

Survey techniques, however, remain the most suitable techniques for measuring the value of ecosystem functions and nonuse values of environmental resources. A recent review of these techniques by Morrison, Blamey, Bennett and Louviere (1996) suggest that the paired comparisons, contingent rating and contingent ranking techniques have theoretical problems and that choice modelling is still in its developmental phase. Therefore, the contingent valuation method (CVM) has been, and remains, the best known and most widely applied stated preference technique for measuring the value of ecosystem functions and non use values.

Nevertheless, the CVM is a controversial technique. In its most widely known application in Australia - the Resource Assessment Commission's estimation of the environmental damage[3] that would result from mining at Coronation Hill, adjacent to Kakadu National Park in the Northern Territory[4] - the CVM was heavily criticised[5]. This criticism paralleled the debate in the United States of America (USA) which surrounded the use of the CVM to estimate, for litigation purposes, the value of the environmental damage that resulted from the grounding of the Exxon Valdez. In essence, the controversy arose because the CVM is based on the use of what respondents say they would do in certain hypothetical circumstances. The hypothesis put forward by the critics is that these expressions of intentions may not be what would actually happen. The contention is that CVM value estimates are, therefore, biased and unreliable (Bennett et al. 1997).

Numerous types of potential bias have been put forward in the non-market valuation literature. They include:

- strategic bias, where respondents, perceiving an opportunity to influence policy outcomes, misrepresent their preferences deliberately;
- hypothetical bias, where respondents believe that the questioning is hypothetical and of little or no policy relevance and so not worth taking the time to consider their preferences carefully;
- "warm-glow" bias, where respondents gain enjoyment from the process of offering to pay to a "good cause" rather than from the good being valued; and,
- payment vehicle bias, where the instrument of collection of CVM bids is not a neutral factor in people expressing their preferences.

(Bennett et al. 1997).

[3] The questionnaire asked respondent's willingness to pay to avoid the environmental damage associated with mining. This is equivalent to estimating the environmental damage costs of mining.
[4] See Imber, Stevenson and Wilks (1991).
[5] For a review of the Coronation Hill controversy, see Bennett (1996).

Considerable research has focused on determining the extent to which these biases occur. Much of this research has been undertaken in the USA, where the legal standing of CVM as a technique, suitable for the estimation of damages in litigation, has provided extra impetus to proving (or disproving) the validity of the method. A culmination of this research came in the findings of a panel of experts, specifically convened by the US National Oceanic and Atmospheric Administration (the NOAA Panel), to assess the validity of the CVM. The NOAA panel found, with some caveats, that the CVM was a technique capable of providing estimates of environmental damages (based on individual's preferences) that are useful as a starting point for the determination of damage payments in the judicial process[6]. The caveats primarily consisted of a set of recommendations as to what CVM practices would constitute an acceptable application of the technique (Bennett et al. 1997).

[6] See Portney (1994) for a succinct outline of the NOAA Panel's findings.

3. ECOLOGICAL FUNCTION AND NON USE VALUES OF MARINE AREAS

3.1 Introduction

The productive capacity of the marine environment is substantial with oceans estimated to provide more than 35 percent of the planet's primary production (Lalli and Parsons 1993). The South-east Marine Region contributes to this capacity, producing a range of environmental goods and services from which holders of fishing rights, the tourism industry, recreationists and researchers derive value from direct use. Activities associated with this use include:

- tourism and recreation[7];
- shipping (cargo transport);
- mineral and chemical extraction;
- oil and gas exploration, extraction and production;
- wild commercial[8], recreational, charter and Indigenous fishing;
- off shore aquaculture;
- research, education and monitoring;
- food production;
- bioprospecting (pharmaceutical and other industrial uses);
- ship building, maintenance, and ports etc;
- harvesting of shearwater chicks for their feathers, flesh and oil;
- defence training exercises and ship building);
- kelp harvesting[9];
- collection of coral and sponges; and
- other uses.

In addition to the direct use values listed, the South-east Marine Region delivers a range of ecological support services and functions which exhibit indirect use value. As discussed in Chapter 2, the marine environment also exhibits nonuse economic values such as option, existence and bequest values, which are explored further in Section 3.3.

It should be noted that some aspects of ecological function values manifest themselves through 'use' or 'indirect use', whereas the community may also express some willingness to pay for these ecological function values even if some of the community is not directly affected. Some economists consider ecological function value as a special category of environmental values, but they can usually be decomposed on the categories of use and nonuse values. It, therefore, becomes somewhat arbitrary

[7] Activities may include sailing, boating, snorkelling, scuba diving, whale-watching and long distance game fishing.
[8] Commonwealth wild fisheries include tuna, billfish, eastern school whiting, John Dory, gemfish, morwong and blue eye trevalla. State fisheries include rock lobster, abalone, octopus, baitfish, sea urchins, eels etc (NOO 2001a).
[9] Kelp, found off the beaches of King Island, are harvested for alginate and as food in abalone mariculture (Kennelly 1995).

separating studies between those of ecological function values and those of nonuse values. Nevertheless we have made some separation, particularly as many of the studies in the area of valuation of the environment have made such distinctions.

3.2 Ecological Function Values

As outlined in Chapter 2, ecological function values are derived from the "services provided by well-functioning ecosystems". Benefits or services provided by the functioning of ecosystems are usually derived from the support and protection of other economic activities (Spurgeon 1992). Typically, these services, such as waste assimilation or nutrient cycling, occur in the background and are not a part of the direct use choices of individuals. However, damage to these functional benefits would result in a reduction in the welfare of the humans affected (Toman 1997; Costanza et al. 1997). For example, the commercial fishing industry is affected indirectly by the quality and variety of habitats and nutrients in the marine environment. Changes to the level of nutrients and degradation of nursery sites for juvenile fish are likely to impact on fish stocks. The long term sustainability of the industry is dependent on the sustainability of the ecosystem services that the marine environment provides (Costanza et al. 1997).

The ecosystem services provided by the marine environment are also valuable to people for the purposes of survival, material gain and for enjoyment, through recreation and leisure activities. Further, humans fundamentally rely on natural ecosystems for life-support functions, including the provision of clean air, climate regulation, water and other resources (James and Gillespie 1997).

The ecosystem services are characterised by interdependence with a change or damage to one impacting on the others (Brown and Spink 1997). Table 1 provides a summary of the range of ecosystem services associated with the marine environment and examples of their functions.

Table 1 Ecosystem Services of the Marine Environment

Ecosystem service	Ecosystem function
Nutrient storage and cycling	Storage, internal cycling, processing and acquisition of nutrients
Atmospheric gas and climate regulation (often termed global life support)	Regulation of atmospheric composition, global temperature, precipitation and other climatic processes.
Waste treatment and assimilation	Waste treatment, pollution control and detoxification through recovery of mobile nutrients and removal or breakdown of compounds
Biological control	Regulation of populations including predator control of prey species.
Biological support (often termed habitat or refugia)	Habitat for resident and transient populations, including nurseries, habitat for migratory species and regional habitats for locally harvested species.
Biodiversity maintenance	Interdependence of species with each a link in the food chain, some responsible for making nutrients available or as a food source to other organisms.
Protection of terrestrial and other marine habitats	Coral and rocky reefs reduce wave action and the impact of strong currents on terrestrial and other marine habitats.

Source: The groupings were derived from Costanza et al. (1997) and Moberg and Folke (1999).

A number of authors have estimated the values of the ecosystem services presented in Table 1.

Costanza et al (1997) estimated the average global value of 17 ecosystem services across 16 biomes based on published studies and some original calculations. The studies used different methods to value the range of ecosystem services including willingness to pay surveys. The results for the six marine biomes and 12 associated ecosystem services are presented in Table 2 as averages in 1994 US$ per ha per year. The estimated value of global ecosystem services was US$16-54 trillion with approximately 63% contributed by marine systems.

Cartier and Ruitenbeek (1999), in a study for the World Bank, compiled estimates of the ecological function values of the marine environment. An excerpt from this report is presented in Appendix 2, providing a summary of the estimates collated by the authors.

The following sections, from 3.2.1 to 3.2.7, explore in more detail each of the ecosystem services in Table 1.

Table 2 Summary of average global value of annual ecosystem services

	Ecosystem services (1994 US$ha per year)														
Biome	Area (ha x 10^6)	Gas Regn	Climate Regn	Disturbance Regn	Nutrient Cycling	Waste Treatment	Biological Control	Habitat/ Refugia	Food Production	Raw Materials	Genetic Resources	Recreation	Cultural	Total Value per ha ($ha per year)	Total global flow value ($ per year x 10^9)
Estuaries	180			567	21,100		78	131	521	25		381	29	22,832	4,110
Seagrass/ algae beds	200				19,002					2				19,004	3,801
Coral Reefs	62			2,750		58	5	7	220	27		3,008	1	6,075	375
Shelf	2,660				1,431		39		68	2			70	1,610	4,283
Total Coastal	**3,102**			**88**	**3,677**		**38**	**8**	**93**	**4**		**82**	**62**	**4,052**	**12,568**
Open Ocean	**33,200**	**38**			**118**		**5**		**15**				**76**	**252**	**8,381**
Total Marine	**36,302**													**577**	**20,949**
Tidal marsh/ Mangroves	165			1,839		6,696		169	466	162		658		9,990	1,648
Total	**36,467**	**1,262**		**576**	**15,324**	**1,108**	**284**	**53**	**863**	**39**		**363**	**2,716**		**22,597**

Source: Adapted from Costanza et al. (1997, Table 2, p.256).

Note: Row totals are in $/year x 10^9. Column totals are also in $/year x 10^9 and are the sum of the products of per ha services in the table and the area of each biome.

Note: Open cells indicate a lack of known information rather than the ecosystem service lacking value. For example, that the open ocean does not contribute to climate regulation is clearly inaccurate, however, Costanza et al. (1997) were unable to locate a value in the available information.

3.2.1 Nutrient Storage and Cycling

The pelagic and demersal food chain is dependent on the concentrations of nutrients, such as nitrates and phosphates, available in the marine environment. The water resource and its inhabitants recycle atmospheric and marine nutrients through microalgae or phytoplankton taking up nutrients and making these nutrients available to a wide range of other organisms, including zooplankton, fish, squid etc, via the food chain (Polunin 1983; DEST 1993). The level of nutrient in turn regulates the abundance of phytoplankton.

The most productive waters of the world are found in regions of upwelling, which bring nutrients accumulated in the seabed and deeper waters to the surface (Kingsford 1995). Upwelling is dependent on the convergence of currents where there is a mixing of cool and warm water (NOO 2001a) and physical structures on the sea floor (Moberg and Folke 1999). In the South-east Marine Region, offshore fishery resources occur in deep water on the continental slope off eastern and western Tasmania and rely on the nutrient rich waters resulting from convergence and physical structures on the seabed (refer Figure 4). The deepwater demersal trawl fishery, which extends to the Cascade Plateau and South Tasmanian Rise, depends on the concentration of food resulting from discontinuities in the seabed and seamounts causing intensified bottom currents. The currents create a suitable environment for filter feeding invertebrates, a food source for commercial fish species (Moberg and Folke 1999).

Offshore and onshore fisheries of the region also depend on the location of the front between the subtropical and subantarctic water masses, the Subtropical Convergence. Nutrient levels, with associated phytoplankton, zooplankton and fish productivity are substantially higher south of this front (Crawford et al. 2000). Some zooplankton drift into sites of convergence and others may be attracted to the abundant food in these regions. Sites of convergence are particularly important for marine animals such as rock lobsters, crabs and fish which spend part of their life in the plankton as larvae before settling as adults in reefs or estuaries (Kingsford 1995).

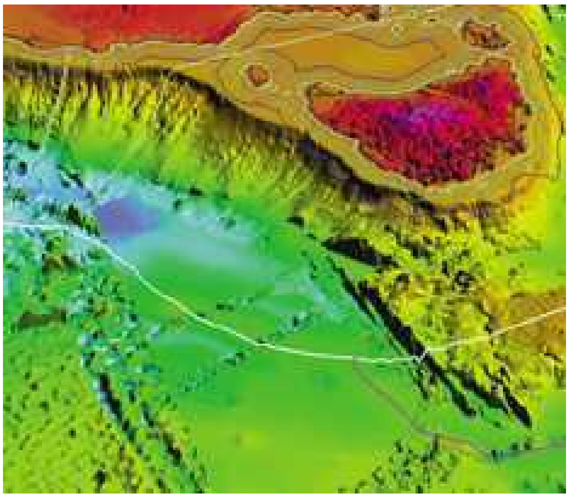

Figure 4 The continental slope off south-western Tasmania
(Courtesy of the Australian Geological Survey Organisation as presented in NOO 2001a)

In terms of economic value, Costanza et al. (1997) estimated that the nutrient cycling function of the marine environment contributes US$4 trillion per year to human welfare.

3.2.2 Atmospheric Gas and Climate Regulation (or Global Life Support)

The marine environment plays a significant role in regulating the earth's climate. Models of the interaction between the ocean, atmosphere and terrestrial biosphere demonstrate that the circulation of water in the oceans has a considerable impact on onshore climates, affecting the atmosphere's temperature, moisture content, stability, rainfall and winds (Linacre and Geerts 1997) and, therefore, productivity of terrestrial systems.

The oceans are also a critical factor in regulating the composition of atmospheric gas suitable for human, animal and plant occupation. Oceans are involved in maintaining oxygen and carbon dioxide levels in the atmosphere by dissolving carbon dioxide, which governs the greenhouse effect. Warm water dissolves less of the gas than cold water, so as oceans warm up, less carbon dioxide is dissolved resulting in accelerated global warming (DEST 1993; Linacre and Geerts 1997; Costanza 2000).

The existence and composition of the atmosphere is also dependent on photosynthesis of microalgae or phytoplankton and macroalgae. Phytoplankton absorbs carbon dioxide and releases oxygen during photosynthesis. This global support role, that is the cycling of gases, is argued to be larger than that of tropical rainforests (Kingsford 1995). Macroalgae, such as the kelp forests of the South-east Marine Region, also make an important contribution to climate regulation services, with kelp forests absorbing significant quantities of carbon through photosynthesis. The total amount of carbon produced per day per area in kelp forests is comparable to that recorded in terrestrial grasslands (Kingsford 1995).

The ability of the marine environment to regulate the climate is impacted negatively by trawling of the seabed. Trawling causes large pulses of carbon to be released to the water column and atmosphere through removing and oxidizing accumulated organic material; increasing oxygen demand (Watling and Norse 1998).

The ecological function value of gas regulation by the marine environment was estimated by Costanza et al. (1997) to contribute a total of approximately US$1.2 trillion per year to human welfare.

3.2.3 Waste Reception, Treatment and Assimilation

Estuaries, reefs, open oceans and the seafloor provide an important ecosystem service of waste treatment and assimilation. This is particularly the case for the assimilation of non-point source discharges into marine areas such as discharge from the bilge of ships, effluent from pulp mills, organic waste from offshore acquaculture and waste heat from electricity generating plants (Tisdell 1985; de Groot 1992; DEST 1993).

The minimum economic value for waste assimilation can be estimated from the cost of infrastructure required to perform a similar service[10]. De Groot (1992) estimated the organic waste treatment value of the natural environment to be US$58/ha, based on the cost of alternative technology that would be needed to replace the ecological function. The estimate is based on the total recycling capacity of the Galapagos sea shelf and the unit cost of recycling organic waste. Costanza et al. (1997) provides another estimate of the global value of waste assimilation by coral reefs and tidal marshes/mangroves, contributing a total average of US$1.1 trillion per year to human welfare.

3.2.4 Biological control

The balance of organisms in the marine environment is controlled through a complex interrelationship of many factors including the predator control of prey species. The habitat of the marine environment contributes to this relationship, providing hiding places from predators assisting in the regulation of population and species interactions of fish communities, as has been demonstrated for coral reefs, rock reefs, seagrass beds and kelp beds (Heck and Orth 1980; Ebeling and Hixon 1991). Costanza et al.

[10] Requires people to actually show that they would make the investment and empirical observations should be conducted to prove that the expenditures will be undertaken (James and Gillespie 1997).

(1997) estimated that the global value of biological control, provided by the marine environment, to be US$0.3 trillion per year.

3.2.5 Biological Support (Habitat or Refugia)

A variety of habitats are represented in the South-east Marine Region, including kelp forests, soft sediment substrata, caves, crevices, boulders, the open ocean, continental slopes, seamounts and submerged rocky reefs. These habitats provide surfaces for feeding, nutrients, shelter and points of anchor, supporting a range of species important to the commercial fishing, tourism and education industries.

Habitats may be grouped according to whether they are physical structures, structure forming organisms or the open ocean itself (Moberg and Folke 1999). Table 3 provides examples of the types of habitats in the Region and the biological support function they deliver.

Table 3 Habitats of the South-east Marine Region and their and Ecological Functions

Habitat Grouping	**Ecological Function**
Physical Structures	
Soft sediment habitats	Conducive to seagrass meadows, which dominate soft sediments in shallow sheltered environments, providing nursery habitat for juveniles of commercial fish species.
Hard rock substratum	Provides habitat for kelp to anchor, with kelp forests acting as refugia for juvenile fish species and as regulators of climate and atmospheric gas composition.
Crevices and boulders	Numerous types of large animals, harvested for food, are found including sea urchins, snails, octopuses, lobsters and abalone, hiding in crevices or under boulders during the day and grazing at night.
Cobbles, pebbles, sand ripple crests	The juveniles of many fish species and other mobile fauna rely on small-scale habitat features such as cobbles, pebbles and sand ripples, sponges and amphipod tubes. Sponges and amphipod tubes themselves are dependent on benthic structures such as cobbles.
Rocky reefs	Rocky reefs are present close to the mouths of estuaries in the south and west of Tasmania providing habitat and protection values. The rocky shores off the Victorian Coast at San Remo in Western Port Bay supports an unusually diverse assemblage of animals and plants of approx. 600 species of larger invertebrates, including over 130 opisthobranch molluscs which is one quarter of the known southern Australian opisthobranch fauna.
Seamounts[11]	Currents speed up around the peaks providing plankton for invertebrates to feed on, and higher order animals to feed on invertebrates. The surface of the peaks also provides habitat for species to feed and shelter.

[11] Seamounts are cone shaped remnants of extinct volcanoes, between 200-500 metres high (Hill et al. 1997).

Table 3 continued…

Habitat Grouping	**Ecological Function**
Structure Forming Organisms	
Sponges and amphipod tubes	Extensive beds of sponges in the Bass Strait provide juveniles of many fish species, and other mobile fauna, small-scale habitat features to shelter and feed.
Corals	Recreation value is derived through corals providing a food source to turtles and fish attracting tourists and scientists.
Kelp forests	Kelp forests are one of the most common and important underwater habitats throughout temperate areas of the world, including the South-east Marine Region, providing nursery services for juveniles of economically important fish and invertebrate species, habitat for sea urchins, snails, octopuses, lobsters and abalone. They also promote the growth of encrusting algae, sponges and sea squirts.
Seagrass beds	The marine embayments and estuaries support extensive seagrass beds, mudflats, mangroves and saltmarshes, all considered nurseries for commercial fish species.
Open Ocean	The open ocean of the South-east Marine Region, particularly Bass Strait, provides habitat for migrating populations of the southern right whale, larval fish of King George Whiting and the larval stages of the southern rock lobster, supporting commercial fishing and the marine tourism industry.

Source: Spurgeon (1992), Kennelly (1995), Environment Australia (1997), Watling and Norse (1998), Crawford et al. (2000), O'Hara (2000), NOO (2001b) and Commonwealth of Australia (2001) were key resources used in the preparation of Table 3.

A significant example of biological support in the South-east Marine Region, which results in indirect use values, is the area defined as the Macquarie Island Marine Park, located in the Southern Ocean. Macquarie Island and its surrounding territorial waters out to 13 nautical miles, was listed as a World Heritage Area in 1997 due to its outstanding geological and aesthetic values. Macquarie Island is home to a large variety of wildlife including Elephant and Fur Seals, which breed on the island as do Royal, King, Gentoo and Rockhopper penguins. The Royal Penguin is only found on Macquarie Island (Environment Australia 1999).

The area is characterised by an abundance of a few species located on Macquarie Island and along the Macquarie Ridge, partly due to the extremely harsh environment and geographic position. The habitat of the Marine Park and Macquarie Ridge, supports 20 breeding species of seabirds, four breeding species of seals and the Royal penguin. The highly productive waters of the Park extend south-east beyond the edge of the EEZ providing pelagic feeding opportunities to a number of predators and a large number of the estimated 3.5 million seabirds and 100,000 seals. The high endemism of the animals contribute significantly to tourism and research values. ANARE operates a research station at the northern end of the island which is involved in biology, botany, auroral physics, meterology and medication research (Environment Australia 1999).

The value of the marine environment, as a fish nursery, was estimated by De Groot (1992), for the Galapagos Island National Park. Based on an assessment of dependence of the fisheries of the Dutch Wadden Sea on estuaries, and the similarity of the estuarine conditions with those of the Galapagos Island, de Groot estimated that 10% of the Galapagos fishery was dependent on the inlets and lagoons of the Park. This resulted in an estimate of the nursery function value of US$7 per hectare per year (Cartier and Ruitenbeek 1999).

3.2.6 Biodiversity Maintenance

The principal form of indirect use value is the ecological function of biodiversity (Young 1992). The diversity, distribution, and interdependence of life are crucial to its survival, giving greater resilience to ecosystems and organisms and subsequently the health of dependent systems (DEST 1993).

The interdependence of the species is characterised by each being a link in the food chain with some species responsible for making nutrients available and at the same time being a food source for other organisms. Microorganisms play a major role in the chain, maintaining biological diversity through their role in contributing to the nutrient-supply and regulation of atmospheric gases. The existence of macroorganisms and corals is dependent on the continued availability of these microorganisms. Human beings themselves are dependent on the food chain for their well-being, survival and enjoyment (Crawford et al 2000).

Although the waters surrounding Australia are generally considered to have low productivity, there are areas of the South-east Marine Region with exceptional species richness, particularly where there is convergence and strong currents resulting in high concentrations of nutrients and microorganisms. Sampling in the East Gipsland marine area of $1.2m^2$ revealed 353 benthos species and sampling of the benthic systems of the Eastern Bass Strait revealed benthic activity exceeded the next highest diversity values recorded for marine benthose elsewhere in the world (Parry 1996). Further, the sea floor is a storage area for nutrients with organic matter drifting to settle for continued assimilation. The few macrofaunal samples collected from shelf sediments in the South-east Marine Region have been found to possess exceptionally high species richness, with numbers of species collected in the north eastern shelf samples amongst the highest recorded worldwide[12] (Crawford et al 2000).

The Tasmanian Seamounts, which lie 170 kms south of Tasmania, provide a specific example of the interaction of species and ecological functions resulting in the maintenance of biodiversity and subsequently products of use to the commercial fishing and tourism industries. Studies of the area have discovered approximately 850 species on the seamounts (Koslow and Gowlette-Holmes 1998; Richer de Forges et al. 2000; NOO 2001a). The species richness is due, in part, to the influence of the seamounts on ocean currents, which increase in speed as they move around the peaks, providing plankton and other organic organisms for corals and other invertebrate suspension feeders to feed on (Commonwealth of Australia 2001). Orange roughy, a species of commercial value, prey on a range of deepwater species including fishes, squids and prawns, which feed on the plankton (Koslow et al. 1998). The interactions of the ecosystem services maintain the level of biodiversity, which in turn provides for the survival of the individual species and dependent industries.

Few studies have attempted to put a value on biodiversity, however, maintenance of biological diversity for the Great Barrier Reef World Heritage Area was estimated by Hundloe, Vanclay and Carter (1987) to be $A15.6 million.

[12] This finding is based on comparisons with survey work that has occurred to date and may change with further research.

3.2.7 Protection of Terrestrial and Other Marine Habitats

Underwater structures, such as rocky and coral reefs, provide protection values through reducing the impact of wave and water current energy on shorelines. It could be argued that aquaculture, located in bays or estuaries, are also afforded protection value by the shoreline structures reducing the impact of storms, wind, wave action etc.

Studies assessing the protection value of the marine environment have generally concentrated on coral reefs. Gustavson (1998) valued coastal protection from the average shoreline value of land within Montego Bay Marine Park that was identified as vulnerable to erosion. The value was estimated to be US$1.07 million per hectare in early 1998 for approximately 100 hectares of land at risk of erosion should the protective function of the coral reefs be compromised (Gustavon 1998).

3.3 Non-use values

Chapter 2 provides a clear description of non-use values, which refer to the benefits individuals may obtain from environmental resources without directly using or visiting them (DEST et al.1995). They can be classified in a variety of ways, however, they are generally considered to comprise option values, existence values, vicarious use values and bequest values.

Table 4 provides an excerpt from Cartier and Ruitenbeek (1999), who collated values estimated by other authors for option, existence and bequest values associated with marine and other natural environments. Following the tables, Sections 3.3.1 to 3.3.4 explore in more detail non-use values as they relate to the South-east Marine Region.

Table 4 Studies Estimating Option and Existence Values for Habitats (Adapted from tables in Cartier and Ruitenbeek 1999)

Ecosystem and Original Study	Valuation Results	Miscellaneous Notes including Secondary Sources
Existence and Option Value, Great Barrier Reef (Hundloe *et al.* 1987)	CVM: A$45 million/yr consumer surplus or A$4/visit WTP to ensure that the Great Barrier Reef is maintained in its current state; based on a 1986 mail survey of Australian citizens 15+ yrs old; estimate excludes respondents who had visited the Reef.	As reported in Hundloe (1980).
Inspiration and Spiritual Values, Galapagos National Park (de Groot 1992)	Expenditures: $0.20/ha/yr for cultural/artistic inspirational use, based on sales of books and films; $0.52/hr/yr for spiritual use, based on donations.	Inspiration value is classified as productive use value; spiritual value as conservation value. Both are included here as they are both arguably vicarious use values.
Total Value, including Option Value, Galapagos National Park (de Groot 1992)	US$120/ha/yr which is equal to the total value of all the Park's conservation and productive use values combined.	Conservation values include inter alia habitat/refugia value, recreation; productive uses include food, construction materials etc.
Existence Value, Brazilian Amazon (Gutierrez & Pearce 1992)	CVM Studies: $30 billion total based on arbitrary WTP estimates from various CV studies; aggregated across the OECD adult population.	As reported in Pearce & Moran (1994).
Conservation Value, Blanket Peat Bog Scotland (Hanley & Craig 1991)	CVM: $580/ha NPV of conserving the area; based on a mail survey; WTP of non-users was $21.60, WTP of users was $43.70; average WTP ($30/household) was applied to the regional population, put on a per ha basis, and discounted at 6%.	Study was CBA of two options (i) conservation of the area; and (ii) conversion to block plantations. Option (ii) yielded a NPV of minus $1590/ha. As reported in Barbier *et al.* (1997).
Minimum Option Value, Massachusetts Wetlands (Danielson & Leitch 1986)	$343/acrea; based on average annual amount paid by US Fish and Wildlife Service in 1980 to owners of unaltered wetlands for preservation easements.	As reported in Pearce & Moran (1994).

Table 4 continued…

Ecosystem and Original Study	Valuation Results	Miscellaneous Notes including Secondary Sources
Conservation Value, Kakadu Conservation Zone, Australia (Imber *et al.* 1991)	CVM: A$124/yr for 10 yrs average WTP to avoid a major mining development impact scenario; and A$52.80/r for 10 yrs to avoid a minor impact scenario; based on a nationwide in-person survey.	A major criticism of the study was the "embedding effect." As reported in Munasinghe and McNeely (1994).
Existence Value, Nadgee Nature Reserve, Australia (Bennett 1984).	CVM: At lease A$20, or A$2/yr in perpetuity WTP of Canberra residents for the continued existence of the Reserve; based on an in-person survey of 544 residents, bid curve analysis, and a 10% real interest rate.	Coastal area with high diversity of habitats; managed with emphasis on non-participatory benefits.
Existence Value Prince William Sound, Alaska (Carson *et al.* 1992)	CVM: Median $31/household one-time tax for measures to prevent future oil spills like that of the Exxon Valdez; based on in-person survey of 1043 US citizens; WTP aggregated over affected households yield $2.8 billion in total lost non-use value.	Natural resource damage assessment done for the State of Alaska. As reported in Pearce & Moran (1994) , and Carson *et al*. (1996)
Valuation Studies Associated with World Bank Research Committee Project		
Non-use Value Montego Bay Coral Reefs (Spash *et al.* 1998)	CVM: Survey design specifically targeted to dealing with lexicographic preferences through probing of zero bids and analysis of zero bids using tobit estimation. Expected WTP for tourists ranged from $1.17 to $2.98 for 25% coral reef improvement; for locals range was $1.66 to $4.26. Upper values were for respondents perceiving strong moral duties and rights; lower were for no such duties/rights. Based on population characteristics, non-use NPV of Montego Bay reefs estimated to be US$19.6 million.	Summary available at: http://www.island.net/~hjr
Non-use Value Curaçao Coral Reefs (Spash *et al.* 1998)	CVM: Similar survey design as Montego Bay study, above. Expected WTP for tourists ranged from $0.26 to $5.82; for locals range was $0.19 to $4.05. Based on population characteristics, non-use NPV of Curaçao reefs estimated to be US$4.5 million.	Summary available at: http://www.island.net/~hjr

3.3.1 Option Values

Spurgeon (1992) describes options values as being "equivalent to an insurance premium guaranteeing the supply of something in the future which may otherwise become unavailable" (Spurgeon 1992, p. 534). This includes the potential value of increased information in the future. The documentation of Indigenous peoples' use of plants has often been the source of ideas on developing plant species for wider use and/or economic benefit, particularly food crops which are currently under utilised that have the potential to become important (DEST 1993).

Option values associated with the natural environment are also associated with the future possibility of discovering new biological resources. To ensure the option is available the maintenance of biodiversity is essential. In an assessment of tropical rainforests, Mendelsohn and Balick (1995, cited in Cartier and Ruitenbeek 1999) estimated that the number of new drugs to be found from 125,000 plant species was 375. The level of diversity required to result in this number is high suggesting that scientists and pharmaceutical companies may have option values for conserving biodiversity to ensure there is the option to discover new bioresources in the future for medicinal or industrial applications. Potential products might include sunscreens from corals, instant adhesives from barnacles (DEST 1993).

3.3.2 Existence Values

Existence values, while similar to option values, relate to the community deriving satisfaction from knowing things exist, such as a rare ecosystem or species (James and Gillespie 1997). For example a person living in a Melbourne may be willing to pay for the conservation of a natural area, such as the Tasmanian Seamounts at 1,970 metres depth, that they may never visit.

There is evidence that such a value exists outside of the studies presented in Table 4. Donations of money to environmental organisations such as "Save the Whale Fund" (Spurgeon 1992) and the "World Wildlife Fund" (WWF), provides evidence that such a value exists even though they may never be involved with whales or other wild life that the WWF strives to protect.

Studies involving the valuation of existence and option for the value of marine environments are rare with Cartier and Ruitenbeek (1999) finding only a few studies. Hundloe et al (1987) used the contingent valuation method to estimate the value of coral sites within the Great Barrier Reef to vicarious users. The estimated willingness to pay to ensure the reef is maintained in its (then) current state was AU$45 million per year. Carson et al. (1992) also used the CVM in a damage assessment of the Exxon Valdez oil spill in the State of Alaska. The authors estimated that US households would be willing to pay a once- off tax of $2.8 billion to prevent future oil spills, such as the Exxon Valdez disaster in Prince William Sound, from occurring again. Prince William Sound is similar to the South-east Marine Region in that it is home to whales, seals, dolphins, a range of shore birds, seabirds, marine invertebrates (shellfish) and fish.

To further investigate the value of $2.8 billion, an alternative study using the travel cost method estimated the lost values for recreational use, as a result of the Exxon Valdez spill, to be $3.8 million for 1989 and no loss from 1990 onwards. The second valuation assessed direct use values and the results raised questions as to the accuracy of the first valuation, which included use and nonuse values (Breedlove 1999). Some indication of the relative value of non-use benefits as compared to use benefits can be gauged from examining other studies in Australia. Bennett et al. (1996) found that in studies of natural areas, where both recreation and conservation values are important, tend to indicate that the willingness of individuals to pay for the conservation benefits may be three times their willingness to pay for direct recreational use of the area. This suggests that, although the magnitude of existence and use values estimated by Carson et al (1992) may be in an overestimate, the community considers conservation of the marine environment as having existence value.

Example of existence values include:

- Social value including spiritual values, cultural and heritage values;
- Artistic values;
- Protection values (such as a reserve being a safe haven);
- Historical Value; and
- Intrinsic

Social value

Human cultures evolve with their environment and the conservation of biological diversity can be important for cultural identity throughout Australia. Biological diversity conservation can contribute to the conservation of Aboriginal cultural identity through hunting and gathering, educating children in relationships to the land and sea and to other aspects of their culture (DEST 1993). Social, cultural and spiritual values in relation to the natural environment, such as coral reefs, represent the benefits communities have derived or continue to derive from the connections and associations that have been established with an environment over time and the knowledge that those connections will continue (Spurgeon 1992). De Groot (1992) estimated the inspirational and spiritual value for the Galapogas National Park of US$0.52/ha with the estimate based on expenditure on donations.

Artistic values

Artistic values can include amenity enjoyed through books and photographs of marine areas. De Groot (1992) measured the artistic and inspiration value of Galapogas National Park of US $0.20/ha/yr, based on expenditure on books and films.

Protection Values

The South-east Marine Region provides sanctuary to 24 species of whale and all species of seal, with the entire Region classified as an Australian Whale Sanctuary (NOO 2001a). Blue Whales, which are listed as an endangered species, feed and travel through the region. The Tasmanian Seamount Reserve also provides protection to a range of species and habitat that are untouched by the influences of fishing due to their depth. It is conceivable that the community values reserves for the protection that they provide to endangered animals.

Historical Value

Macquarie Island Marine Park and Tasmanian Seamounts have historical value as they are significant examples of the major stages in the earth's evolutionary history.

Intrinsic

Many people recognise the 'intrinsic' value of species and ecosystems, independent of any direct or indirect utility to humans. Growing consensus that organisms have rights regardless of whether their utility can be measured of if they have utility. It is subjective and cannot be valued monetarily (Spurgeon 1992), however, the presence of reserves or sanctuaries which provide a safe haven, may be considered recognition that humans believe animals have a right to safety or protection.

In a study of the non-use benefits of marine biodiversity in coral reef conservation at Montego Bay, Jamaica, an expected willingness to pay for coral reef improvement of US$3.24 per person was estimated. This figure was adjusted using results from a similar study, undertaken for Curaçao, which depended heavily on whether respondents believed that marine systems possessed inherent rights or that humans had a duty to protect marine systems. Following adjustment, the biodiversity of Montego Bay was estimated to have a net present value of US$13.6 million to tourists and US$6.0 million to Jamaican residents, which translated to approximately $460,000/ha, or $46,000/ha/yr on an annualized basis (Ruitenbeek and Cartier 1999).

3.3.3 Vicarious Use Values

Vicarious use values are gained by people who do not visit an area, but are derived from the knowledge that others may be enjoying use of a natural environment for recreational uses, such as diving or educational purposes, such as marine mammal research (James and Gillespie 1997). They are often considered existence values with vicarious users often providing the values of existence and option.

3.3.4 Bequest Values

Bequest values refer to the maintenance of environmental attributes for the benefit of future generations (James and Gillespie 1997). Bequest values may include option, existence and vicarious use values for future generations, for instance potential pharmaceutical benefits. A number of literature review studies have not uncovered valuations estimating separate bequest values for marine protected areas. However, bequest values are generally captured within willingness to pay studies, which cover all nonuse values.

4. APPLYING ECONOMIC VALUES

Natural resources, such as the South-east Marine Region are valuable assets that yield flows of services to people, some of which are traded in markets and some of which are external to markets. Public policies and the actions of individuals and firms can lead to changes in the flows of these services, thereby creating benefits and costs (Freeman 1993) or changes in total economic value accruing from the resource.

The most common application of use and non use environmental resource values for decision making is, therefore, in a benefit cost analysis framework which:

- estimates the extent to which a community as a whole is made better off 'with' the resource allocation compared to 'without' it i.e. use and non use value increases;
- estimates the extent to which the community is made worse off 'with' the resource allocation compared to 'without' it i.e. use and non-use value decreases; and
- compares these two figures to determine the net gain or loss to the community.

When examining the net gain or loss to the community from a policy or resource allocation, economists are concerned with incremental changes in the total economic value of a resource rather than the total economic value itself. These incremental changes in values are very different to total economic values and are sensitive to the policy scenario, environmental attributes affected and population demographics. Consequently, full economic assessment of policy scenarios for the management of marine resources may require specific application of relevant non-market valuation methods.

Benefit-cost analysis is only one of many possible analyses that contribute to public decisions about the natural environment. Because it focuses only on economic benefits and costs, benefit-cost analysis determines the economically efficient policy or management options. This may or may not be the same as the most socially acceptable option, or the most environmentally beneficial option. Economic values are based on aggregation of peoples' preferences, which may not coincide with what is best, ecologically, for a particular ecosystem. However, public decisions must consider public preferences, and benefit-cost analysis including ecosystem and non market valuation is one way to do so.

5. INSTRUMENTS TO ACHIEVE IDENTIFIED OUTCOMES

As identified above, benefit cost analysis, including a consideration of how economic values change under different scenarios, aids in the assessment of the economic desirability of a specific proposal; that is, it helps to identify desirable objectives or outcomes.

Once desirable objectives or outcomes are identified it is then important to identify mechanisms for achieving the desired outcome. These may come in a variety of forms and combinations including those listed in Table 5.

However, no single approach will be appropriate in all circumstances and a single instrument on its own is unlikely to achieve environmental objectives. Consequently, a mix of instruments, including regulatory ones, is likely to be required for to achieve the desired policy outcomes (Gillespie 2000).

Table 5 Instruments available for meeting desired outcomes

ECONOMIC INSTRUMENTS	REGULATORY INCENTIVES	INFO/EDUCATION/ MOTIVATION	VOLUNTARY INSTRUMENTS
Charges Levies - environmental, tourism etc Royalties Emission and Effluent Charges User/entry charges Product charges Administrative charges Tax differentiation (environment taxes) **Subsidies** Grants Soft loans Tax allowances • accelerated depreciation; • transferable tax credits; • exemptions from or reductions of local government rates; • exemptions from capital gains tax- donations; • deductibility of non-income producing expenditure; • exemptions from land tax; and • rate rebate (Income Tax Assessment Act). **Deposit Refund Systems** **Market Creation** Transferable permit schemes • pollution, quotas, fishing shares, clearing rights, drainage rights, easements etc. Market intervention Liability insurance **Enforcement Incentives** Non-compliance fees Performance bonds/security deposits/assurance bonds	Legislation • prohibitions, precautionary standards/regulations, approval processes Environmental Planning Instruments • SEPPs REPs, LEPs - zoning etc Conditional/unconditional consents/permits/ resource security: • Determinations, development consent, building approval, harvesting permits, collecting permits, clearing permits, harvesting licences, export licences, breeding licences, bioprospecting permit Conditional/unconditional leasing Offset schemes Conditional resource security Easements Compensation payments Enforcement • forfeiture of rights • Director liability • audit/monitoring Covenants under the Conveyancing Act Conservation Orders under the Heritage Act Interim Protection Orders under the National Parks and Wildlife Act	Field days Displays Demonstration properties Extension officers Access to free advice – hotlines Education forums Extension officers Research Monitoring State of environment reporting Accreditation Schemes and Awards • special status agreements • labelling • industry accreditation • environmental prizes • self regulation Empowerment • third party rights to challenge decisions • rights of access to information • co-management Leverage Mechanisms • cross compliance • conditional grants	International agreements State agreements Management agreements Voluntary conservation agreements Wilderness protection agreements Joint management agreements

Source: Adapted from CSIRO in press and OECD (1994).

* property rights approaches refer to approaches that "provide incentives for individuals to conserve the environment by clarifying the rights to and responsibilities in common property" (BIE 1992, p 8). Property rights mechanisms are included in the economic instruments, voluntary and regulatory categories above.

** there are numerous categorisations of instruments. This categorisation is but one.

6. CONCLUSION

The scientific and economic literature, explored in this discussion paper, demonstrates that the marine environment delivers a range of environmental goods and services that contribute either directly or indirectly to human welfare. The contribution made, whether in support of the commercial fishing industry or providing the service of nutrient cycling, has value and may be measured in monetary terms by applying the concepts of total economic value, which includes non-market economic value.

Various methods have been applied to estimate the non-market values of the marine environment such as the contingent valuation method, travel cost method and choice modelling. While the magnitude of the dollar values estimated for the non-use values of the marine environment, using these methods, are sometimes debated, what is not generally debated is that the community values the natural resource and derives utility from its existence.

For planning in the South-east Marine Region, identification and estimation of the non-market economic values associated with different planning and policy options would provide significant input into the decision making process. The estimated non-market values may be incorporated into a benefit cost analysis framework allowing for public decisions to consider community preferences in relation to the environment.

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APPENDIX 1: TECHNIQUES FOR VALUING ENVIRONMENTAL IMPACTS

Market-Based Techniques

Productivity Changes Method

This approach can be used when an environmental change leads to changes in production levels, costs or prices. Dose-response functions are usually needed to estimate physical changes in production in relation to changes in environmental conditions.

Where changes occur only in output levels and/or costs, changes in producers' surplus can be estimated. If the change in productivity also results in a change in price, changes in consumers' surplus also need to be considered. Before using this approach prices and costs may need to be adjusted to reflect shadow prices.

Human Capital Approach

Changes in labour productivity can be measured using the human capital approach. This provides an estimate of the forgone earning stream resulting from adverse environmental effects. It is frequently used as a means of partially assessing the damage cost of adverse health effects resulting from environmental pollution or other deleterious impacts.

Results obtained using the human capital approach should not be interpreted as the value of human life. Most economists prefer to avoid placing direct values on life, although it is possible to obtain implicit policy values by observing the expenditures by public authorities to reduce mortality rates (for example, safety features for transport infrastructure) or the willingness to pay by individuals to reduce the statistical risk of premature mortality.

Defensive Expenditures

Defensive expenditures indicate the minimum amount that people would be willing to pay to prevent an environmental impact. These expenditure do not necessarily correspond to the environmental benefits resulting from the defensive measures. However, if people are observed to be actually making such expenditures (for example, the construction of levees to prevent flood damage) it can be presumed that their valuation of environmental protection benefits will be at least as great as the costs incurred.

Replacement/Repair Expenditures

These expenditures are typically undertaken after environmental damage has occurred, such as the application of fertiliser to offset soil loss or the cleaning costs incurred by households after soiling from air pollution. It is spurious to make estimates of such costs and assume that they can be equated with environmental benefits. Empirical observations or surveys should be undertaken to prove that the expenditures will be undertaken. In addition, it is possible to presume only that this represents a minimum value for the associated environmental benefits.

Shadow Projects

Expenditures on shadow projects (man-made replications of lost or damaged ecosystem functions or attributes) are a special instance of replacement cost. The same qualifiers apply in using the costs of shadow projects to value the environment as with defensive and replacement expenditures.

Opportunity Cost Method

The opportunity cost method is applicable in situations where environmental improvement involves a sacrifice of some other, more easily valued economic benefit. A common application is the calculation of threshold environmental values, as described in section 4.3.5 above.

Surrogate Market Techniques

Wage Differential Method

The wage differential method values differences in environmental quality or risk in terms of the wages accepted by workers in different locations or jobs. Statistical techniques are used to estimate the implicit values. The method is difficult to apply in Australia as most wages are determined by other processes.

Property Value Approach

In a competitive market, property asset prices and rents reflect the value of service from a property, including productive and consumptive environmental services. The hedonic price method can be used to estimate the implicit price of environmental attributes. A common application is the use of house prices to estimate environmental values. The analysis can be conducted using statistical models. Property differentials generated by differences in environmental quality may alternatively be assessed by property valuation experts. Property owners are also often aware of the effects of environmental change on the value of their properties and may be asked for their valuations by means of interviews or questionnaires.

Travel Cost Method

The travel cost method assumes that the willingness to pay for recreation at a particular site can be inferred from the cost of travel by visitors to the site. To apply the method, an on-site survey is undertaken to ascertain the frequency of visits, distances travelled, the cost of travel (including the implicit value of time), details of each visiting group and other socio-economic information. Population statistics must be obtained for different zones of trip origin, and visitation rates by zone are calculated. A regression equation is derived showing the relationship between visitation rates and travel costs. This equation is then used to simulate the effect of hypothetical entry charges to derive a demand curve for recreation at the site. The area under the demand curve and above the price line gives an estimation of the consumers' surplus.

Variations of the travel cost model allow for substitute sites, congestion externalities and individual versus zonal models.

To estimate changes in benefits for a particular site resulting from a change in environmental quality, such as a deterioration in water quality, it is necessary to predict a downward shift in the demand curve, indicating a lower visitation rate and lower consumer surplus for those still visiting the site. The decrease in benefits is measured as the difference in total area between the original and new demand curves.

Hypothetical Market or Survey Techniques

Contingent Valuation Method

The contingent valuation method establishes a hypothetical market for an environmental good or service and uses a survey questionnaire to elicit people's willingness to pay for some change in the supply or quality of the good or service. CVM can be used to measure use values as well as non-use values. It is the only known method of directly measuring existence values and prospective values in an economic evaluation.

CVM is subject to a wide range of potential biases, thus careful consideration must be given to the kind of scenario conveyed to respondents, the type of question asked (for example open ended questions, payment card method, bidding game techniques, dichotomous choice) the specified payment vehicle and the statistical models applied. The technique is generally expensive, and unless the CV survey is carefully designed and administered to minimise biases, the results should be viewed with caution.

Constructed Markets

Constructed markets are contrived situations in which money actually changes hands for a usually non-marketed good. They are mainly designed to test CVM results, for instance the importance of free riding, or the difference between willingness to pay and willingness to accept. Constructed markets may be considered a complement to CVM rather than a substitute for it.

Contingent Ranking

Contingent ranking asks people how they rank alternative combinations of environmental and other attributes rather than how much they would be willing to pay. From such a ranking, a maximum likelihood estimator routine can be used to estimate an indirect utility function. Contingent ranking has been shown to be inconsistent with theoretical principles. Choice modelling is a step forward from this method.

Choice Modelling

Choice modelling is a stated preference technique in which respondents choose their most preferred resource use option from a number of alternatives. Each alternative exhibits a number of attributes such as land affected, impacts on threatened species, household cost etc. Through statistical means (multinominal, nested or mother logit) choice models produce estimates of the value in changes in individual attributes as well as the value of aggregate changes in environmental quality. Choice modelling can thus be used to produce estimates of the value of multiple resource use alternatives.

Choice modelling has been applied to evaluation of choices involving consumer goods, transportation, tourism and the selection of landfill sites. There have been only a few applications that have valued environmental goods. Nevertheless the technique appears to have considerable potential for providing a useful and valid estimates of environmental values that may be particularly suited to benefit transfer.

Delphi Technique

This approach uses direct questioning of experts or community representatives to place a value on particular goods. It is usually applied in an iterative fashion, in group sessions, to achieve a consensus result.

Benefit Transfer Method

The benefit transfer technique borrows the values from so-called “study sites” for application to a site that must be evaluated (the “policy site”). The values may be transferred as:

- unadjusted unit values (for example, the typical value of a recreation visit);
- adjusted unit values (derived by substituting different values for explanatory variables in a study-site regression model); or
- meta-analyses of comparable study sites (the compilation of large data banks from numerous studies to permit generalised statistical analysis of economic values.

The robustness of the method depends largely on the quality of results for the study sites and the presence of similar conditions at both the study site and the policy site. Criteria for reliable use of benefit transfer are:

- the study and policy site should be similar;
- the environmental change under consideration at the policy site is similar to the proposed change at the study site; and
- the socioeconomic characteristics and preferences of the population should be similar.

The NSW EPA (1995) has developed a comprehensive environmental economics database (ENVALUE) to facilitate benefit transfers in benefit-cost analyses.

Summary of Main Environmental Valuation Techniques

A summary of environmental valuation techniques, compiled by the NSW EPA (1993) is shown in Tables A1 and A2. It assesses the techniques against a number of criteria.

Table A1. Comparison of Environmental Valuation Techniques considering "use" criteria

	Reliability of results	Data requirements	Timing	Ease of application	Technical development	Accumulated expertise
Market-based techniques						
Productivity Approaches	High	Medium	Low	High	High	High
Opportunity Cost	High	Medium	Low	High	High	High
Defensive Expenditure	High	Medium	Low	High	High	High
Special features: based on market transactions, assumes no distortions in market prices.						
Surrogate market techniques						
Property Market	High	High	Medium	Medium	High	Medium
Special features: assumes mobility and perfect information						
.						
Wage Differential	Medium	Medium	High	Medium	Medium	Medium
Special features: main techniques for valuing risks to life, assumes mobility and perfect information						
Travel Cost	Medium	Medium	Low	High	High	High
Special features: use limited to recreation benefits						
Hypothetical market or survey techniques						
Contingent Valuation	High	Medium	High	Low	High	High
Special features: the only technique that covers existence values can suffer from a lot of biases						
Delphi Technique	Medium	Low	Low	Medium	Medium	Low
Special features: applicable to a wide range of impacts						

Table A2. Comparison of Environmental Valuation Techniques considering "impact" criteria

Source: EPA (1993) p 28.

	Health Impacts		Aesthetic Impacts	Ecosystem Impacts	Recreation Impacts	Production Impacts/ Material Damage
	Illnesses	Mortality				
market-based techniques						
Productivity Approaches	Yes	-	Yes	Yes	Yes	Yes
Opportunity Cost	Yes	-	Yes	Yes	-	Yes
Defensive Expenditure	Yes	Yes	Yes	Yes	-	Yes
surrogate market techniques						
Property Market	-	Yes	Yes	-	Yes	-
Wage Differential	Yes	Yes	Yes	-	-	Maybe
Travel Cost	-		Yes	-	Yes	-
hypothetical market or survey techniques						
Contingent Valuation	Yes	Yes	Yes	Yes	Yes	Yes
Delphi Technique	Maybe	-	Maybe	Yes	Maybe	Maybe

APPENDIX 2: STUDIES ESTIMATING THE ECOLOGICAL FUNCTION VALUES OF MARINE HABITAT, COLLATED BY CARTIER AND RUITENBEEK (1999)

Table A2 Summary of Estimates of Habitat Valuation Studies (Adapted from Cartier and Ruitenbeek 1999)

Ecosystem and Original Study	Approach: Utility	Approach: Prodn	Approach: Rent	Valuation Results	Miscellaneous Notes including Secondary Sources
Indirect Uses – Ecological Functions					
Coastal Protection, Philippine Coral Reefs (McAlister 1991b)		*		Replacement Costs: US$22 billion; based on construction costs of concrete tetrapod breakwaters to replace 22,000 sq km of reef protection	As reported in Spurgeon (1992).
Coastal Protection, Indonesia Coral Reefs (Cesar 1996)		*		Productivity Change: NPV of coastal protection/sq km of reef; $9000-$193,000 (blast fishing); $12,000-$260,000 (coral mining); based on replacement costs, the rate of reef destruction from each activity, and the rate of decline in reef's ability to protect.	CBAs for each reef-destroying activity include the cost of protective function losses. For each activity, reef destruction reduces the protective capability of the reef. The reef's loss of protective capability is linked linearly to its protective value.
Organic Waste Treatment, Galapagos National Park (de Groot 1992)		*		Replacement Costs: $58/ha/yr based on the costs of artificial purification technology; applies to marine area only.	Classified as a conservation value of the Park, in the category of "regulation functions".
Biodiversity Maintenance, Galapogos National Park (de Groot 1992)		*		Shadow Price: $4.9/ha/yr which equals 10% of the market value of any activity reliant on biodiversity maintenance.	Classified as a conservation value of the Park, in the category of "regulation functions".
Nature Protection, Galapagos National Park (de Groot 1992)	*			$0.55/ha/yr nature protection; based on the park budget and the idea that money invested in conservation management should be seen as productive capital because of the environmental functions and socio-economic benefits provided by conservation.	Classified as a conservation value of the Park, in the category of "carrier functions".
Habitat/Refugia Galapagos National Park (de Groot 1992)		*		Benefit Transfer: $7/ha/yr; based on the similarities of the Dutch Wadden Sea and Galapagos estuarine areas, it was assumed that 10% of fishery in Galapagos depends on the nursery function provided by inlets and mangrove lagoons.	Classified as a conservation value of the Park, in the category of "regulation functions".

Table A2 continued…

Ecosystem and Original Study	Approach: Utility	Approach: Production	Approach: Rent	Valuation Results	Miscellaneous Notes including Secondary Sources
Nitrogen Retention & Recycling, Gotland, Sweden (Gren 1995)	*	*		$34/kg NPV for nitrogen abatement from wetland restoration; based on (i) $100/person/yr WTP for improved water quality; (ii) a surface/ground water hydrological model; and (iii) the nitrogen absorptive capacity of wetlands.	As reported in Barbier *et al*. (1997).
Natural Predator, Greater and Lesser Antilles (Narain & Fisher 1994)		*		Productivity Change: $670,000/1% decline in Anolis Lizard population; based on value of lost output when the lizard is not there to feed on crop destroying insects.	As reported in Barbier *et al*. (1994).
Valuation Studies Associated with World Bank Research Committee Project					
Indirect Uses – Ecological Functions					
Coastal Protection, Montego Bay Coral Reefs (Gustavson 1998)		*		Productivity Change: NPV US$65 million (1996); based on land values at risk or vulnerable to coastal erosion along foreshore. Author notes this is upper value and is dependent on erosion incidence assumptions in absence of reef, which are highly speculative.	Full text available at: http://www.island.net/~hjr