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Guide to the Ex-Ante Socio-Economic Evaluation of Marine Protected Areas

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TABLE OF CONTENTS

Abstract

A marine protected area (MPA) potentially offers a wide range of use and non-use benefits that include: critical habitat protection, conservation of marine biodiversity, recovery of threatened and endangered marine species, and increased biomass of targeted marine species. To assess whether such benefits exceed the potential costs, we provide the first-ever comprehensive ex-ante socio-economic guide to the evaluation of MPAs. Our framework shows how to quantify four key values of MPAs: consumptive, non-consumptive, indirect, and non-use values, and how to use decision tools to determine the desirability of establishing MPAs. Overall, the guide offers the promise of improved information and better decision making for marine protected areas.

Key words: Marine Protected Areas, use value, non-use value, benefit-cost analysis

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1. Introduction

A MPA is commonly defined as "…any area of intertidal or sub-tidal terrain, together with its overlying water and associated fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" [1]. 'No take' areas, or Category I or II zones managed mainly for science, wilderness for ecosystem conservation and recreation under the World Conservation Union's Guidelines, are locations where no harvesting is permitted [2]. Such zones often form a part of larger MPAs where there may be multiple-use areas, or Category VI zones, that allow for some consumptive use, and are managed for the sustainable use of natural ecosystems.

Empirical evidence of the benefits of MPAs in fisheries, especially for overexploited species, is supported in various case studies synthesized by [3]. Côté, Mosquiera and Reynolds [4] in a meta-analysis of 19 MPAs show that abundance of targeted fish species was 28 per cent higher within such areas. Such benefits, at least for some MPAs, have spilled over to adjacent exploited areas as evidenced by increased catches per unit of effort and increased population size in these areas [5, 6], in addition to harvests of larger and often higher valued individuals [7]. These positive payoffs, however, must be set alongside any potential losses that may arise from a lack of access to fishing grounds or other harvesting costs. These possible losses could, for example, include higher fuel costs to harvest fish when fishing outside of traditional fishing areas.

A key factor in modeling the consumptive use effects of MPAs in fisheries is the net spillovers, or the net rate of transfer of larvae, juveniles and adult fish from MPAs to harvested areas.

Transfers represent a trade-off in the sense that the more mobile are fish between MPAs and a harvested area, the less protection provided by a no-take area [8, 9, 10]. Thus, the greater is the net transfer out, the larger is the size of the MPA required to maintain the same level of protection from harvesting. Although a low transfer rate provides increased protection from fishing, for a given MPA size, it also reduces the potential consumptive benefits to fishers as less fish spillover to harvested areas.

To assist decision makers to determine whether it is desirable to establish a MPA, its location and size we provide a guide to the ex ante socio-economic evaluation of MPAs. This guide does not replace or substitute for scientific analysis [11] or the need to incorporate uncertainty and stakeholder engagement [12] into the evaluation of MPAs. Instead, it complements these approaches by providing a socio-economic framework of analysis. We separately discuss the costs and benefits associated with consumptive use, the benefits of non-consumptive use and indirect use, and the costs and benefits of non-use or passive use from MPAs. The use values are of particular interest in terms of fisheries while the non-use values are of importance in terms of biodiversity and habitat. We show how these values of MPAS can be incorporated into three key decision-making tools: benefit-cost analysis (BCA), comparative risk analysis (CRA), and risk-benefit analysis (RBA).

2. Total Economic Value of MPAs

Figure 1 presents a summary of values that can be generated from a MPA. The total economic value (TEV) of MPAs consists of use and non-use values. The use values include both consumptive (such as fishing) and non-consumptive uses obtained from direct use of species for recreational purpose, such as whale watching or marine wildlife viewing activities.

Non-consumptive use values arise from activities that do not subtract from or diminish the quality of the environment. In terms of non-consumptive benefits, MPAs can increase aesthetic and recreational values because of higher population densities and/or larger individuals both within no-take areas and adjoining areas [7]. Bohnsack [13] summarizes these benefits under three headings:

1. Protect ecosystem structure, function and integrity;
2. Increase knowledge and understanding of marine systems; and
3. Improve non-consumptive opportunities.

In addition to Bohnsack's three categories, MPAs may also reduce the probability of extinction or extirpation by helping to ensure a minimum viable population [14, 15]. Thus MPAs can perform a vital role in the conservation of endangered species. If properly regulated and monitored, whale watching and 'ecotourism' are examples of non-consumptive use. The establishment of MPAs, especially 'no take' areas close to the coast and in accessible locations, is also likely to encourage and increase non-consumptive use.

Another potentially important value of MPAs is their indirect use value. It represents the value of ecosystem services associated with species conservation and habitat protection. These values are separate to any direct use (consumptive or non-consumptive) values or non-use values and could include extra benefits associated with MPAs such as enhanced ecosystem resilience that might arise from reduced habitat damage [16] and an increased ability to assist in ecological cycling. Indirect use value reflects the contribution of the endangered species to surrounding habitats or ecosystems. In terms of ecosystem integrity, MPAs can potentially generate three principal payoffs:

1. A more desirable population structure (characterized by age, gender or individual size) within a MPA can increase breeding success and mean recruitment into the harvested population [3, 13, 17, 18];
2. A greater number (and possibly a greater level of abundance) of species, especially populations harvested outside of the MPA [4, 19]; and
3. Positive harvesting spillovers for adjacent areas [6].

Non-use values of a MPA arise from conservation of threatened, endangered and rare marine species. Non-use values are the benefits obtained without any direct or indirect use. This consists of two components: existence value and bequest value. Existence value reflects benefits from knowing that the species protected by a reserve exists, even if it is never utilized or experienced [20, 21]. Bequest value refers to benefits from ensuring the ecosystem services of MPAs are available for future generations [22].

3. Methods for Assessing the Costs and Benefits of Consumptive Use from MPAs

Several techniques and methods can be employed to assess the consumptive use values of MPAs. Ideally, a comprehensive bioeconomic model is required to fully assess both the benefits and costs. The advantage of the bioeconomic approach is that it allows decision makers to determine the impacts of MPAs on harvest, incomes and fishing effort. The approach provides importance guidance in terms of vulnerability, assists in the identification process for candidate MPAs, and can be used to evaluate issues of uncertainty and the adequacy of MPAs.

For some bioregional marine areas there may be insufficient data or financial resources to undertake detailed bioeconomic studies and alternatives must be used in terms of assessing the costs and benefits of MPAs. These tools include gross value of production (GVP), effort displacement methods and spatial productivity assessments.

3.1. Gross Value of Production Losses

The most simplistic way of assessing the costs of MPAs is to calculate the expected losses in terms of GVP to fishers from the establishment of 'no take' areas. Although this approach requires the least amount of data it also overestimates the losses associated with a MPA. For instance, even in well-managed and profitable fisheries, the economic profit to harvesters as a proportion of the total landed value of fish is unlikely to exceed 20 percent. Thus the estimated impact or cost/loss to fishers on the basis of GVP will likely be many times greater than the actual loss. The other deficiency with a GVP approach is that it ignores the potential benefits of MPAs that may arise from spillovers, or the offsetting payoffs from fishing in a different area.

3.2. Bioeconomic Models

Bioeconomic models form the core of fisheries economics and combine measures of revenues and costs with an underlying biology, or stock-recruitment relationship. To capture the full impacts of MPAs, bioeconomic models must be stochastic, account for 'normal' uncertainty, or the usual fluctuations in stock and harvest in a fishery, as well as 'unusual' events that may more dramatically affect the fishery over time.

An approach that incorporates uncertainty into bioeconomic models of marine reserves has been developed by Grafton et al. [23]. This method allows decision makers to assess the impact and the benefits of MPAs, in addition to their costs, in terms of positive spillovers from protected to harvested areas. They show that MPAs increase resilience and allow for quicker recovery following a negative shock that benefits fishers. In other words, even if harvesting is optimal, the population is persistent and there exists no uncertainty over the size of the current population, a MPA can increase economic profits and reduce the recovery time for a harvested population in the presence of negative shocks. The reason a MPA has economic value is because it allows for spillovers of fish from the MPA to the harvested population following a negative shock that can, in turn, raise economic profits. In this sense, MPAs act a 'hedge' against negative shocks provided the sensitivity to the shock is not greater in the MPA than in the harvested population.

3.3. Effort Displacement Models

An important cost issue of MPAs is the reallocation of fishing effort following their establishment as it would be expected to change the average value of landings and costs, especially if the stock abundance is not constant across the fishery. Two approaches that can be used to estimate fishing effort displacement are the stochastic frontier method and the random utility method. Both require individual vessel level data to generate suitable estimates of the impact of MPAs on fishers.

The frontier approach imposes no a priori assumption about fisher behavior and simply uses spatial catch and effort data and individual fisher characteristics to model the impact of spatial closures on effort and catches [24]. This approach can also be used to estimate the impact on costs and profits if there are adequate economic data at an individual vessel level. The method requires the statistical estimation of a model, such as the one shown below in Equation (1):

$$\ln V_{ijt} = \beta_0 + \beta_1 \ln K_{ijt} + \beta_2 \ln Effort_{ijt} + \beta_3 (\ln K_{ijt})^2 + \beta_4 (\ln Effort_{ijt})^2 + \beta_5 \ln K_{it} \ln Effort_{ijt} + \sum_{m=2}^{12} \beta_m D_m + v_{ijt} - u_{ijt} \quad (1)$$

where V_{ijt} is the total value of landings in area *i* by vessel *j* at period of time *t*, K_{ijt} is a measure of boat capacity or engine power of the vessels *j* operating in region *i* at time *t*, $Effort_{ijt}$ is the total calculated effort in region *i* by vessel *j* at time *t,* D_m is a dummy variable representing each month in the fishing year, v_{it} is a stochastic error term and u_{it} is a an error term representing the 'inefficiency' associated with region *i* at time *t*. The u_{it} error term might be further parameterized to estimate the effects of management, such as input restrictions, on individual fisher efficiency.

Estimates of the effort displacement equation before the introduction of MPAs would provide information on the effect of the value of landings in each area, conditional on seasonal abundance and major inputs into fishing. This would allow decision makers to build a spatial picture of a fishery to indicate what changes in spatial fishing patterns and revenues might be realized with the introduction of MPAs.

The random utility modeling (RUM) imposes particular assumptions about fisher behavior to model effort displacement. The approach models a sequential set of economic decisions made by fishers to determine whether they should go fishing and where they should fish [25]. Assuming fishers are motivated by net returns, it is possible to show how effort changes with the establishment of marine reserves [26]. Schneider [27] has used this approach to predict the redistribution of fishing effort by divers for abalone in New Zealand following the creation of a network of no-take areas. The method has also been used to estimate the effort displacement associated with the closure of the European anchovy (*Engraulis encrasicolus)* fishery [28].

3.4. Stock-adjusted Productivity

Productivity represents the ratio between outputs and inputs and is a key indicator of economic performance. An understanding and measurement of productivity of fishers is useful in assessing the impacts of MPAs.

Explaining productivity performance, or understanding the causes of declines or increases in productivity by vessel and over time, is as important as measuring it. An easy-to-apply method is available that 'decomposes' changes in relative profit performance into differences in output prices and input prices, adjusted for their importance in the catch (outputs) and fishing effort (variable inputs), and fixed inputs, such as vessel size [29]. The approach can also be used to account for spatial differences in productivity and, thus, assess the impacts of MPAs while explicitly accounting for changes in prices and fish stocks. Unlike the effort displacement approach, profit decompositions are not a statistical method but, instead, generate indexes to make comparisons across vessels and over time. As a result, the method can be used with as few as two observations.

A key step in calculating productivity is to calculate the profits of all vessels and adjust them for differences in the size of fish stocks, or abundance, over different periods. Typically a reference vessel is picked as the benchmark that has the greatest profit per unit of the stock. A stock-adjusted productivity approach has been applied in both Canadian and Australian fisheries while Fox et al. [30] have used this method to evaluate the effects of a structural adjustment package in a fishery in terms of productivity. The decomposition approach could also be applied to assess productivity differences based on spatial locations after accounting for differences in input use and fish stocks provided there exists spatial vessel-level data.

4. Assessing the Benefits of Non-Consumptive Use and Indirect Use from MPAs

Non-market valuation techniques are used to estimate non-consumptive economic values associated with marine biodiversity protection. Non-market valuation techniques can be divided into two different methods: revealed preference (RP) and stated preference (SP) approaches. RP makes inferences about non-market values of marine resources (such as whales) based on observations of actual choices or travel behaviors of the visitors (or tourists, travellers), but only in terms of use values. The travel cost method (TCM) and hedonic pricing method (HPM) belong to the RP class of non-market valuation techniques.

4.1. Travel Cost Method (TCM)

TCM estimates the non-consumptive use values of outdoor recreational sites (see [7, 31, 32]). In a TCM, an analyst first estimates a demand function for recreational travel by accounting for monetary and non-monetary expenditures related to recreational travel. The demand function relates the number of visits that users/travelers/tourists make to the travel cost incurred, site characteristics, socioeconomic characteristics of the user population and substitute site information. The demand function can be written in the following form:

$$TRIP_i = \beta_0 + \beta_1 (TRIPCOST_i) + \beta_2 (TRIPCOST\_SUB_i) + \beta_3 (SOCIO\_DEMOG_i) + \beta_4 (SITE\_SPECIFIC_i) + \varepsilon_i \quad (2)$$

where $TRIP_i$ is the number of trips by individual *i* to the site over a specific time period and $TRIPCOST_i$ refers to the cost of round trip to the site incurred by each individual *i*. The variable $TRIPCOST\_SUB_i$ represents the costs of trips to substitute sites, $SOCIO\_DEMOG_i$ denotes socio-demographic characteristics such as age, income, gender, education, of the traveler and $SITE\_SPECIFIC_i$ refers to the recreational facilities offered by the site such as swimming, diving, fishing. The βs are regression coefficients and ε stands for random error.

After the demand function is estimated based on available data, estimates of the consumer surplus (CS) can be obtained by calculating the area below the demand function and above the implicit price from visiting the site so as to obtain a traveler's willingness to pay (WTP) to visit the site. The CS for an average sample visitor can be calculated by integrating the travel demand function, given in Equation (2), from an initial travel cost ($TRIPCOST = TRIPCOST_0$) to the choke price ($TRIPCOST = TRIPCOST_M$) at which the demand to visit the site becomes zero, that is,

$$CS = \int_{TRIPCOST_0}^{TRIPCOST_M} (TRIP)\ (TRIPCOST)\, dx \quad (3)$$

The average visitor CS can then be aggregated over the total tourist population by multiplying by the number of visitors to a site each year.

4.2. Hedonic Pricing Method (HPM)

The HPM assumes that consumers' valuations of a good depend upon a number of characteristics embodied within the good [33]. By obtaining measures of these characteristics and incorporating them into a regression model, consumers' WTP for each individual attribute of the good can be estimated. The hedonic price function can be expressed in the following form:

$$P = \beta X_i + \varepsilon \qquad (4)$$

where P is the market price of the good in question, X_i a vector of attributes of the good, β is a vector of parameters of the hedonic model to be estimated and ε is the error term. In the case of an ex ante evaluation of a MPA, the price could refer to the amount charged to passengers on a wildlife watching vessel and the vector of attributes could include the observed species along with other environmental and socio-economic characteristics.

The HPM has been employed to investigate the relationship between marine fish quality and fish prices [34, 35] by examining various fish attributes such as size, color, odor, tenderness flavor, freshness and ease of preparation. The approach could also be adapted to develop estimates the values of the attributes associated with MPAs.

4.3. Hedonic Travel Cost Method (HTCM)

TCM and HPM can be combined to estimate recreational demand function attributes for marine reserves. This approach is known as the Hedonic Travel Cost Method (HTCM). Brown and Mendelsohn [36] first applied this method to estimate a demand function for recreational fishing sites. This method is applied in two stages. In the first stage, a hedonic demand model is estimated by regressing price (e.g. fishing licence fee) on fishing site characteristics. In the second stage, the number of trips made by a recreational fisher is regressed over monetary and non-monetary travel cost incurred and socio-demographic characteristics of the fishers.

4.4. Indirect Use Values

The multiple indirect benefits associated with an environmental asset (including MPAs) are difficult to quantify in monetary terms. At present, applications that estimate indirect use values are mostly limited to terrestrial environments, especially forests and wetlands [37]. In many cases, the assigning of monetary values to the indirect use values of MPAs will be impossible in the absence of some functional relationship between the ecosystem services at the site and marketed goods and services [38]. Where such information is unavailable, it is still advisable to describe the possible ecosystem services and processes, and how they may be affected by the establishment of MPAs, as part of the overall assessment and decision making process.

5. Assessing the Benefits of Non-Use Values from MPAs

Economists rely predominantly on SP techniques to measure non-use values people attach to marine biodiversity. The contingent valuation method (CVM) and choice experiment (CE) approach are two SP techniques that have been widely applied over the past 30 years to estimate economic benefits of conservation policies (see for example [20, 21, 39]). SP methods employ public surveys to ask the affected (or relevant) group of population about their willingness to pay (WTP) to protect the threatened and endangered marine species and habitats within MPAs by constructing a hypothetical market or referendum.

5.1. Contingent Valuation Method (CVM)

CVM is used to estimate WTP for an action, or the monetary amount or hypothetical payment by an individual required to ensure that she or he is as well off in utility or welfare terms *after* the provision of a desirable good or service as before. To calculate WTP, individual welfare is represented by utility functions that are used to estimate how much utility (or satisfaction) an economic agent derives from consumption of different goods or services. In the case of an MPA designed to protect marine mammals from extinction, the utility functions could be written in the following form:

Without MPA: $$V^0 = \alpha^0 X + \beta^0 Y + \lambda^0 \ MM + \varepsilon^0 \tag{5}$$

With MPA: $$V^1 = \alpha^1 X + \beta^1 (Y - WTP) + \lambda^1 \ MM + \varepsilon^1 \tag{6}$$

In Equations (5) and (6), V^0 is the base line utility function without the MPA. The individual is given the choice of paying a money amount (which reflects their WTP) to finance the MPA which will help protect the marine mammals from threats. V^1 describes the new (and higher) utility function after implementation of the MPA. The term *MM* stands for the marine mammal species status, *Y* denotes income, *X* is the vector of individual-specific attributes affecting utility while α , β and λ refer to the regression coefficients, and ε is a random error term. The change in utility due to the proposed policy intervention is obtained by subtracting Equation (5) from Equation (6), that is,

$$V^1 - V^0 = (\alpha^1 - \alpha^0)X + Y(\beta^1 - \beta^0) - \beta^1 WTP + (\lambda^1 - \lambda^0) \ MM + (\varepsilon^1 - \varepsilon^0) \tag{7}$$

By definition, the individual WTP is an amount that makes (V^1 - V^0) = 0.

This implies:

$$\alpha X + \beta Y - \beta^1 WTP + \lambda \ MM + \varepsilon = 0 \tag{8}$$

where, $\alpha^1 - \alpha^0 = \alpha,\ \beta^1 - \beta^0 = \beta,\ \lambda^1 - \lambda^0 = \lambda$ and $\varepsilon^1 - \varepsilon^0 = \varepsilon$ and which simplifies to:

$$WTP = \frac{1}{\beta^1}[\alpha X + \beta Y + \lambda MM + \varepsilon] \qquad (9)$$

To obtain an estimate of Equation (9), respondents are generally asked to pay a pre-specified bid amount by creating a hypothetical situation. Estimation of the probability that individual respondents say 'Yes' (accept the bid level) or 'No' (rejects the bid level) is undertaken as a function of the offered bid level and a set of theoretically expected explanatory variables. Mean WTP per respondent per year is estimated using Equation (9) and then aggregated over the relevant group of population to estimate the total non-use benefit from a MPA.

5.2. Choice Experiment (CE)

CE has an advantage over CVM in that it allows the analyst to estimate the values associated with different attributes of an environmental good or service. In a CE study, respondents are presented with a sequence of choices between alternative goods or scenarios. The scenarios are described by a number of characteristics or attributes, which have multiple levels that differ among the alternatives. Respondents are asked a series of questions in which a unique 'choice set' is presented each time. Before the choice sets are presented to the respondents, there is a description of the scenario, the research issues, the proposed policy changes, and the implications for the environmental attributes that are being modeled.

CE follows a similar utility maximization framework as CVM but allows for different attributes associated with a MPA to be incorporated explicitly in the utility function. For example, the utility functions with a MPA designed to reduce the threats to endangered species, can be written in the following way:

Without MPA: $V_0 = \gamma_0 B_0 + \gamma_0 HS_0 + \gamma_0 BW_0 + \lambda Y$

$$= V^0 + \lambda Y \tag{10}$$

With MPA: $V_1 = \theta + \gamma_1 B_1 + \gamma_1 HS_1 + \gamma_1 BW_1 + \lambda(Y - WTP)$

$$= V^1 + \lambda(Y - WTP) \tag{11}$$

In Equations (10) and (11), θ refers to a constant, γ_is and λ refer to estimated coefficients, B stands for belugas, HS for harbour seals, BW for blue whales and Y for income. V_0 denotes individual utility from the current state of three threatened and endangered marine mammal species that would be protected better with a MPA. V_1 refers to the utility from an endangered species recovery policy following the establishment of an MPA. The maximum WTP (*WTP**) that would be paid is the amount that leaves an individual indifferent between V_0 and V_1 given the utility functions specified by equations (10) and (11). This implies,

$$V^0 + \lambda Y = V^1 + \lambda(Y - WTP^*)$$

$$WTP^* = \frac{-1}{\lambda}(V^0 - V^1) \tag{12}$$

An analyst would estimate the coefficient values ($\gamma_i, \theta, \lambda$) using standard statistical procedures based on the choices of respondents in the survey. After the parameter values are obtained, individual estimates of WTP for different conservation programs can be estimated using Equation (12). The estimated WTP values can be aggregated across the relevant group of population to estimate the total non-use value of species protection associated with an MPA.

6. Decision Tools for Establishing MPAs

The various methods to estimate the benefits of MPAs ultimately require an approach to determine whether the benefits outweigh the costs. One commonly used tool is benefit-cost analysis (BCA). This approach evaluates the incremental monetary costs and benefits associated with a given policy relative to the status quo. All relevant costs and benefits associated with each alternative policy options would be identified using the methods outlined previously.

A MPA involves a stream of future costs and benefits over time. Thus a discount rate should be applied to calculate the present value of these benefits and costs. At the final stage of a BCA, a net present value (present value of net benefits) is calculated for each project under consideration by subtracting the present value of the total economic cost from the present value of the total economic benefit, that is,

$$NPV = PV(TB) - PV(TC) \quad (13)$$

where, NPV stands for 'Net Present Value', TB refers to 'Total Benefit', TC refers to 'Total Cost' and PV denotes 'Present Value'. The standard decision rule is that if NPV > 0 then establishing a MPA is worthwhile. When multiple projects are being evaluated, the option that produces the highest internal rate of return (IRR), or the discount rate that benefits exactly equal costs, is commonly viewed as the preferred policy.

Comparative risk analysis (CRA) is another approach to evaluate policy alternatives. It is a tool that compares the risks involved with each alternative policy following a risk analysis (hazard identification, dose-response assessment, exposure assessment and risk characterization). Based on the magnitude of assessed risk levels, competing policy alternatives are ranked. A common decision rule is to select the policy that involves the lowest amount of risk. If only one policy is under consideration, then the level of assessed risk associated with the policy is compared against the threshold of acceptable risk. Trade-offs may also be made by comparing the NPV of policies with their risks.

Risk-Benefit Analysis (RBA) is a compromise between CRA and CBA. In a RBA, risks are valued in monetary terms and are treated as costs [40]. The common decision criterion whether a given policy under consideration is desirable is given below,

$$NPV_R = PV(TB) - PV(TC) - \mathrm{PV}\ (\mathrm{Risks}) > 0 \tag{14}$$

where NPV_R denotes 'Net Present Value Adjusted for Risks'.

It is also possible to incorporate risk directly into BCA if analysts are able to assign probability distributions to uncertain costs and benefits with either objective and/or subjective information. Using risk modeling with probability distributions it is possible, with Monte Carlo simulations, to map out a cumulative probability distribution for net present values associated with a particular project or policy decision [41]. This risk-based approach to BCA allows the decision maker to evaluate the range of possible values and the probability that the NPV will have a particular value. In addition to undertaking risk analysis, sensitivity analysis in terms of the effect of changes in the discount rate on the NPV should also be undertaken.

One of the disadvantages of applying BCA in MPA evaluation is that it ignores the distribution of the benefits and costs across different stakeholders. Distributional issues are likely to be important for MPAs because the non-use values provide benefits that may be distributed over a large area and population while the costs may be limited to a much smaller number of individuals. In such cases, a transfer of the benefits from the potential winners to the potential losers in the form of compensation may be appropriate. Regardless of whether compensation is actually paid, a table of the potential 'winners' and 'losers' provides a guide to decision makers of the distributional impacts of MPAs and should be included as part of the overall information provided by the analyst.

7. Concluding Remarks

Decision makers face a great deal of uncertainty when estimating the benefits and costs associated with marine protected areas. Although there are a number of tools available from the life sciences to investigate the risks and the potential benefits of marine protected areas, until now there has been little guidance for those undertaking an ex ante socio-economic evaluation.

To assist decision makers in the socio-economic analysis of marine protected areas, we present some of the approaches available to estimate the costs and benefits of consumptive use and non-use values. Where data is available, bioeconomic models offer the most complete approach for assessing the costs and benefits associated with consumptive use. Non-consumptive values can be estimated using travel cost and hedonic methods, and non-use values using stated preference techniques.

After estimates of the benefits and costs are obtained, various decision tools can be used to assess whether it is worthwhile to establish marine protected areas and also assess the distributional effects. Two of these decision tools include: comparative risk assessment and benefit-cost analysis. The decision tools and the methods for estimating the benefits of reserves offer the promise of improved information and better decision making in terms of marine protected areas.

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Caption

Fig 1. Total Economic Value of MPAs