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Assessing the Benefit Produced by Marine Protected Areas: The Case of Porto Cesareo Marine Protected Area (Italy)

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Abstract: The article focuses on the integrated environmental accounting model called 'eValue', developed for protected areas and applied in the research programme coordinated by the Italian Ministry of the Environment and aimed at implementing an environmental accounting system for Italian Marine Protected Areas (MPAs). eValue adopts a cost-benefit analysis approach. Financial accounting based on costs and revenues is integrated with environmental accounting, which reflects environmental costs and environmental revenues, i.e., environmental benefits. The environ-mental costs assess the impacts related to human activities in the MPA expressed by calculating the carbon footprint and the environmental benefits of the marine ecosystem services calculated by applying monetary valuation techniques. The values thus estimated flow into the annual flow account, where the value produced (or consumed) by the MPA is estimated by difference. The eValue model was applied to the Porto Cesareo MPA (Italy). eValue showed that the annual benefit-cost ratio reaches a value of 3.4. Furthermore, the ratio of net benefit to public funding is 3.7, completely covering the number of public transfers and thus summarizing the MPA overall value for money.

Keywords: environmental accounting; life cycle assessment; marine ecosystem service; indica-tors; cost benefit analysis; Porto Cesareo Marine Protected Area; CICES

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1. Introduction

Part of the public believes that Marine Protected Areas (MPAs) restrict economic activity, adding costs to businesses and limiting opportunities for growth and employment, even for those sectors that benefit from improved marine biodiversity and environmental conditions [1].

In contrast, there is consolidated scientific evidence that protected areas provide a range of fundamental services to the constituents of human well-being, the so-called Ecosystem Services (ES). ES have been defined as "the benefits that people obtain from ecosystems" [2–5] and, more recently, as "the contributions of ecosystems to the benefits that are used in economic and other human activity" [6] (p. 27). Use incorporates direct physical consumption (provisioning services, such as food and water), enjoyment (cultural services, such as recreational, spiritual, religious, and other non-material benefits) and indirect receipt of services (regulating services, such as the regulation of floods, droughts, land degradation, and disease; supporting services, such as soil formation and nutrient cycling). Further, ES encompass all forms of interaction between ecosystems and people including both in situ and remote interactions [6,7]. This implies that humanity is highly dependent on well-functioning ecosystems and natural capital, which are the basis for a steady flow of ES from nature to society [8]. Expressing the value of ESs in monetary units is critical for policy makers, who can then assess the cost-effectiveness of policies, make effective decisions about resource allocation among competing uses [9], and draw attention to the economic benefits of biodiversity, including the rising costs of biodiversity loss and ecosystem degradation [5]. Failure to consider all economic values of biodiversity and ES in decision making is one of the factors contributing to their overexploitation and thus loss and degradation. Environmental accounting systems demonstrate their support as informing policies to shape future policies or strategies for biodiversity [10]. In 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [11] showed how marine biodiversity is declining at unprecedented rates, and the Intergovernmental Panel on Climate Change [12] issued a warning about the impact of climate change on the oceans and cryosphere. Building on these documents, the United Nations organization supported the adoption of the goal of ensuring that at least 30% globally of land and marine areas are conserved through protected area systems [13], and the European Commission published the EU Biodiversity Strategy 2030, with the goal of putting European biodiversity on a path to recovery by 2030 with benefits for people, the climate and the planet [14].

Consequently, measuring changes in the state of the environment and the relationship with economic and other human activity is crucial to ensure that ecosystems and biodiversity are integrated into decision-making processes [6]. Since the 1980s the United Nations Statistical Commission undertook a review of the System of National Accounts (SNA) and proposed a System for Integrated Environmental and Economic Accounting (SEEA) in order to integrate environmental accounting into economic accounting. The aim was to provide policy makers with descriptive metrics and statistics to monitor the interaction between the economy and the environment, as well as to serve as a tool for strategic planning and policy analysis to identify more sustainable development paths. The work led to the publication of the Handbook of National Accounting: Integrated Environmental and Economic Accounting (known as SEEA 1993) [15], updated in 2003 [16] and subsequently revised and adopted into the SEEA Central Framework (SEEA-CF) which is the international statistical standard [17]. Ecosystem accounting has arisen out of work on environmental accounting which was supported firstly by the System of Environmental-Economic Accounting 2012-Experimental Ecosystem Accounting (SEEA 2012 EEA) [18]. In March 2013, the Statistical Commission encouraged the use of SEEA 2012 EEA by international and regional agencies and countries. Given the level of interest, testing and experimentation, in 2017 the revision of the SEEA 2012 EEA was determined and led in 2021 to the recognition as international statistical standard as System of Environmental-Economic Accounting-Ecosystem Accounting (SEEA-EA). The SEEA-EA complements the measurement of the relationship between the environment and the economy described in the SEEA-CF by accounting for ecosystems in five accounts. Biophysical information (the ecosystem extent and the ecosystem condition account) is reported, ESs are assessed in physical and monetary terms (the ESs flow account in physical terms and the ESs flow account in monetary terms) and the value of natural capital is estimated (the monetary ecosystem asset account) [6].

SEEA-EA incorporates the findings presented in a range of other technical materials on ecosystem accounting, as developed in the period from 2013 to 2020 in EU. At EU level, the EU Biodiversity Strategy to 2020 [19] adopted the TEEB recommendation to factor the economic value of biodiversity into decision making and reflected in EU and national level accounting and reporting systems, while the European Environment Agency, together with Eurostat, supported the adoption of the SEEA. To support the implementation of the EU Biodiversity Strategy target, the Mapping and Assessment of Ecosystems and their Services (MAES) initiative was set up and the MAES working group established in order to draw the methodological approach [20]. Then, the Knowledge Innovation Project-Integrated system of Natural Capital and ecosystem services Accounting in the EU (KIP-INCA) was developed and drafted an EU environmental accounting framework [21]. Subsequently, the project LISBETH "Linking accounts for ecosystem Services and Benefits to the Economy Through bridging" was meant to facilitate the use of INCA accounts in traditional economic analytical tools [22]. Thanks to the application of these approaches, the recent EC Communication on "EU Biodiversity Strategy for 2030—Bringing nature back into our lives" made a step forward. The EC Communication gave evidenced, on one side, to the fact that the targets defined under the Convention on Biological Diversity are insufficient to adequately protect and restore nature and, to the other side, that enlarging protected areas is also an economic imperative [23] (p. 4).

Based on these theoretical foundations, in 2013 the Italian Ministry of the Environment and Protection of Land and Sea financed the development and implementation of the integrated environmental accounting system in the Italian MPAs. The project aimed to assess the MPA's ecological and economic value, with particular reference to the ES generated in each protected area [24] and the aggregated net benefit returned to the economy. Within this framework, the economic value of MPA was assessed by applying the integrated environmental accounting model called "eValue" [25] applied to MPAs contributes to the debate at the local scale and is intended to be a tool to support communication, policy, and social acceptability goals. In terms of a communication tool, it aims to demonstrate that the wealth produced within the MPA is greater than the public investment and that the establishment of a protected area should not be understood as a limiting factor in the economic development of the area, but as an opportunity to create economic, social, and environmental wealth. In terms of a policy tool, the results will demonstrate to decision makers, stakeholders, and funding agencies that, in addition to being invaluable in general terms, protected areas are at least as valuable as estimated by the application of integrated environmental accounting. In terms of a social acceptability tool, integrated environmental accounting highlights the reserve effect, i.e., an effect related to the establishment of the MPA that increases the abundance of fish, due to the management effectiveness of the protected area, as well as the increase in tourist attraction, due to the presence of environmental values. The eValue is based on a Cost Benefit Analysis (CBA) approach. There are relatively few comprehensive CBAs of MPAs currently available from either within or outside Europe, making it difficult to draw overall conclusions about the net benefits of individual MPAs or MPA networks in Europe. Despite being unable to account for a comprehensive representation of benefits, these studies suggest that the overall welfare benefits of MPAs exceed total costs [1]. Studies on marine systems estimated that the calculated benefits significantly outweigh the estimated costs [1] and that every euro invested in marine protected areas would generate a return of at least 3 EUR [26], while protected areas have rates of return on public spending of between $6.2 and $28.2 for every public dollar invested, generating significant income multipliers and creating job opportunities [27].

Section 2 of the paper outlines the methodological approach followed and the eValue integrated environmental accounting model developed to assess the value of the MPA from a socio-economic perspective, while Section 3 describes the results obtained by applying the model to the Porto Cesareo Marine Protected Area (PC-MPA). The result of the environmental accounting highlights what and how much value the MPA was able to create with the funds allocated by the government and funding agencies for nature conservation. The last section provides an analysis of the results and draws the conclusions.

2. Materials and Methods

The eValue integrated environmental accounting model is based on two main annual accounts (Table 1): the stock account and the flow account [28,29]. If we look at the financial accounting system, stock refers to the value of an asset at a balance sheet date, while flow refers to the total value of transactions (sales or purchases, income or expenses) during an accounting period. Stock and flow are related because the stock of available resources is usually augmented by the flow of new investment and depleted by the flow of depreciation.

Table 1. MPA integrated environmental accounting model—eValue [25].

Stock Account	**Flow Account**	
	Costs	**Benefits**
- ES capacity indicators (biophysical and quantitative metric)	(C1) Expenses - Income statement expenses (monetary metric) (C2) Environmental costs - Impact indicator (biophysical and quantitative metric) - Environmental cost indicator (monetary metric) (C) Total costs = (C1) + (C2)	(B1) Revenues - Income statement revenues (monetary metric) (B2) Environmental benefits - ES flow indicator (biophysical and quantitative metric) - ES benefit indicator (monetary metric) (B) Total benefits = (B1) + (B2)
	(NB) Net benefit = (B) − (C)	

2.1. Stock Account

In the eValue model, the stock account refers to the potential or capacity of the ecosystem to provide services, regardless of the capacity of natural resources to provide the ES flow. In the SEEA-EA, ecosystem capacity is defined as the ability of an ecosystem to generate an ES under current ecosystem condition, management and uses, at the highest yield or use level that does not negatively affect the future supply of the same or other ES from that ecosystem [6] (p. 150). In this way for provisioning services, capacity relates to the rates of regeneration, for regulating and maintenance services to the limits or thresholds to the supply of these services, for cultural services measures the maximum number of people able to visit a site. In monetary terms, capacity can be related to the net present value of ES flows at their sustainability thresholds, i.e., using the sustainable ES flow, as determined by the relevant regeneration and absorption rates. Adopting this approach, the stock is referred to as “virtual stock” because it is the capacity to continue generating an ecological process and cannot be accumulated [30]. In the eValue model, we adopted another meaning that considers not so much the capacity of the ecosystem as the consistency of the stock in biophysical terms. In these terms, the stock can be accumulated, as is the case for economic organizations, if the potential flow (or sustainable flow) is greater than the actual flow (the utilization).

2.2. Flow Account

The flow account was constructed according to the conceptual framework of CBA with the aim of integrating the organization’s financial accounts with environmental costs and benefits, which reflects the value of impacts on the environment and benefits from ES provided by the MPA, respectively [1]. Costs and benefits were assessed complying with the UNI EN ISO 14007 “Environmental management—Guidelines for determining environmental costs and benefits” [31] and the UNI EN ISO 14008 “Monetary valuation of environmental impacts and related environmental aspects” [32]. The next sections provide the methodological approach adopted for the cost and benefit assessments.

2.2.1. Costs

Environmental costs refer to what economics calls negative externalities and occur when production or consumption adversely affects the welfare of a third party, without the third-party receiving compensation equal to the cost. For example, tourism produces greenhouse gas emissions due to vehicle traffic as a negative externality; boating due to anchoring is responsible for the eradication of seagrasses, the disappearance of which has a direct impact on coastal erosion and habitat loss for many animal species. The assessment of environmental costs provides a value for negative externalities. The environmental cost was calculated by multiplying an environmental impact indicator by a monetary conversion factor. Environmental impact was estimated by assessing the impact produced by the human activities carried out within the protected area. The indicator used to calculate impacts is the carbon footprint that, through a life cycle assessment approach, allowed for the transformation of impacts on environmental matrices and resource use into CO_2 equivalent emissions. The UNI EN ISO 14064 "Greenhouse gases—part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals" [33] and UNI EN ISO 14067 "Greenhouse gases—Carbon footprint of products—Requirements and guidelines for quantification" [34] standard was adopted and carbon footprint assessed by the OpenLCA software (version 1.7 beta) with the Ecoinvent 3.3 database. In order to give a monetary value to costs, the Social Cost of Carbon (SCC) was adopted as monetary conversion factor [35,36]. The SCC is the marginal cost of damage caused by carbon emissions or the marginal benefit resulting from reduced greenhouse gas emissions [37]. In our analysis, the SCC damage cost was assumed to be 36.92 €/tCO_2 [38]. The SCC applied is aligned with the unit cost of CO_2eq suggested by the EC [39], which varies between 25 €/tCO_2eq in 2010 and 45 €/tCO_2eq assuming a gradual increase until 2030.

The environmental costs of the PC-MPA were calculated with reference to institutional activities, professional fishing and tourism, focusing on bathing, diving, boat hiring, boating and recreational fishing. These activities are a common representative subset of the activities usually authorised in MPAs. In accordance with the above-mentioned standards, the system boundary was defined. For institutional activity the organizational boundary overlapped with the activity of the MPA; for authorised activities within the MPA (professional fishing, bathing, diving, boating and recreational fishing) the boundary included the activities and related inputs of both economic operators (professional fishermen, bathing establishments, diving centres) and users (bathers, divers, recreational fishermen). The inputs included in the reporting boundary were: equipment (e.g., boats), consumables, energy (electricity and fuel) and water in the case of the managing authority and economic operators; transport fuels in the case of users. End-of-waste management was not included. Data were collected through interviews with economic operators and the average value of the data collected over the three-year period (2014–2016) was used. A framework was modelled to inventory the inputs and outputs and assess the impact. In addition, the allocation was estimated by dividing the input flows according to the ratio of activities carried out within the MPA to total activity. With regard to users, data were collected as part of a field survey initiated through the administration of questionnaires to tourists. Finally, the monetary conversion factor gave the environmental impact an equivalent economic value (€/y). This step was performed by multiplying the CO_2eq by the SCC.

2.2.2. Benefits

Environmental benefits estimate the value of positive externalities, which occur when production or consumption positively affects the well-being of a third party, without the latter paying a price equal to the value of the benefit received. For example, the protection of species and habitats within the MPA maintains a high level of biodiversity, which serves as an attraction for birdwatching or diving experiences. Environmental benefits evaluate the externality by assigning a value to the ESs from which the tourist benefits. ES are understood as flows between ecosystem assets and economic units [40]; where economic units, adopting the SEEA-EA definition [6], encompass the various institutional types included in the national accounts, such as enterprises, governments and households. Several ES classifications are available: the Millennium Ecosystem Assessment [4], The Economics of Ecosystems and Biodiversity [5], the Common International Classification of Ecosystem Services (CICES) [40,41]. For the purposes of this research, CICES was chosen because it is functional for the economic valuation of ES and thus can be integrated into an environmental accounting framework and ultimately conforms to SEEA. Most of the ES studies in which CICES has been adopted have focused on the assessment and mapping of terrestrial ES. The most comprehensive reviews of the scientific literature on the application of indicators related to marine and coastal ES were conducted by Liquete et al. [42], who conducted a systematic review of 563 articles, and Lillebø et al. [43], who examined 17 MAES marine pilot cases based on CICES V4.3. This work fed into the review of CICES V5.1 [44] in which a comprehensive list of ESs related to the marine-coastal ecosystem was provided. Finally, von Thenen et al. [45] supplemented CICES V5.1 with examples, selecting a pool of 772 indicators.

Launched in 2013, the environmental accounting of Italian MPAs constitutes the first application at the Italian level of CICES to the marine and coastal ecosystem. Of the thirty-six biotic ES listed by Liquete et al. [42], the seven ESs most representative of the reality of Italian MPAs and for which MPAs already had data useful for calculating indicators were selected. In the eValue model, ESs are first accounted for in physical terms (ES flow indicator) and then in monetary terms (ES benefit indicator). Accounting in physical terms aims to record, in an accounting structure, the flows of ES over an accounting period in physical units such as cubic meters and tonnes. ES and related indicators are reported in Table 2. The second column reports the ES nomenclature adopted in 2013 by CICES V4.3 in line with the work of Liquete et al. [42]. While CICES V4.3 proved to be highly functional for evaluation as it distinguished between capacity, flow and benefit indicators, it did not provide any indicators for scientific and educational ES. In order to bridge the gap, this study experimentally adopted a set of indicators that we felt could fully express the qualitative, quantitative and monetary value of the service-related benefit. In retrospect, it is possible to state that the choice made was scientifically confirmed, since the indicators used are consistent with the pool of indicators of von Thenen et al. [45]. For these ES, the indicators experimentally adopted in the study are listed in Table 2, and their consistency with von Thenen et al. [45] is noted in the footnote. For the purposes of this paper, the CICES V5.1 nomenclature as supplemented by von Thenen et al. [45] and the capacity, flow and benefit indicators given by Liquete et al. [42] were adopted.

Table 2. Identifying relevant ES and indicators for inclusion in this assessment [42,44,45].

Section	CICES V4.3 Nomenclature (from [42])	CICES V5.1 Nomenclature (Integrated by [45])	Code	Capacity Indicator (from [42])	Flow Indicator (from [42])	Benefit Indicator (from [42])
Provisioning	Wild animals and their outputs	Wild marine animals used for nutritional purposes	1.1.6.1	Fish abundance	Commercial and artisanal fish and shellfish landing (t/y)	Fish and shellfish sales (€/y)
Regulation and Maintenance	Mass stabilization and control of erosion rates	Control of erosion rate (1) Buffering and attenuation of mass movement (2)	2.2.1.1 (1) 2.2.1.2 (2)	Indices based on extent of selected emerged, submerged and intertidal habitats (seagrass/seaweed cover (%), vegetation cover and properties (density, stiffness, height)) [2] Coastline slope and coastal geomorphology [2]	Indices based on wave regime, tidal range, relative sea level, storm surge [2]	Indices based on population density, infrastructure, artificial surface, UNESCO sites [2] Replacement cost for damaged infrastructures (€/ha, €/y) [2] Avoided cost for shoreline protection (€/ha, €/y) [2], Avoided loss of human lives (€/ha, €/y) [2]

	Global climate regulation by reduction in greenhouse gas concentrations	Regulation of chemical composition of atmosphere and oceans	2.2.6.1	Carbon sequestration potential (g/C/y), Carbon biomass (t/y) [2]	Primary production uptake ($gC/m^2/y$) [2] Seagrass stock - storage ($gC/m^2/y$)	Market values of carbon (€)
Cultural	Experiential use of plants, animals and land/seascapes in different environmental settings	Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through active or immersive interactions	3.1.1.1	Extent of marine protected areas (km^2) Presence of iconic species	Whale watching, possibility of snorkelling, swimming, boating activities (recreation trips/y)	Willingness to pay Importance and specificity of aesthetic values based on expert knowledge [2]
	Physical use of land/sea-scapes in different environmental settings	Characteristics of living systems that enable activities promoting health, recuperation or enjoyment through passive or observational interactions	3.1.1.2	Marine protected areas coverage (a)	Recreational fishing activities (t/y) Yearly participation rate in recreational activity (% of country population) [2]	Yearly total expenditures generated (USD) Employment supported (full-time equivalents) Importance and specificity of aesthetic values based on expert knowledge [2]
	Scientific	Characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge	3.1.2.1	n.a. [1]	n.a. [1] Peer reviewed articles (n/y, impact factor) [3] -National and international projects (n/y)	n.a. [1] Yearly total project budget generated (€/y) [3] Employment supported (full-time equivalents) in research field
	Educational	Characteristics of living systems that enable education and training	3.1.2.2	n.a. [1] Educational activity (events/y) [3] Educational publications (publication/y) [3]	n.a. [1] Participation in educational events (visits/y) [3] Educational visits (visits/y) [3]	n.a. [1] Participation in educational events (budget/y [3] Educational visits (budget/y) [3]

[1] n.a. = not available, CICESv4.3 did not provide indicators for the ES. [2] Not adopted in the study. [3] Experimentally adopted in this study and coherent with von Thenen et al. [45].

Starting with the "Wild marine animals used for nutritional purposes" ES, the capacity (C), annual flow (F) and benefit (B) indicators accounted for fish abundance (C), commercial and artisanal fish and shell-fish landed in t/y (F) and for the fish and shellfish sales in €/y (B), respectively [42]. The "control of erosion rate" and "mass flows" ES were assessed based on capacity indicators (C) such as indices related to the extent of selected emerged, submerged and intertidal habitats [20,46]. For preventing erosion rate, marine habitats seagrass meadows such as *P. oceanica* and *Cymodocea nodosa*, as well as coralligenous bioconstructions, play a major role. The attenuation effect of *P. oceanica* on the hydrodynamics is related to the wave height attenuation, wave energy decay and reduction in the sediment transport in wave-current [47–49]. Flow indicator (F) accounted for the extent of maintenance and improvement required to provide protection [50]. The seagrass meadows extension was used to assess the "Regulation of chemical composition of atmosphere and oceans" ES. The flow indicator is the potential carbon fixation [42], and we assumed an average annual carbon fixation of 90.5 $gC/m^2/y$ [51–53]. The "characteristics of living systems that enable activities promoting health, recuperation or enjoyment through active or immersive interactions" ES refers to whale watching, the possibility of snorkelling, swimming, and boating activities [42]. Applied to the PC-MPA, the following recreational activities were analysed: sunbathing, diving, boat renting, boating and recreational fishing activities. The analyses focused on the assessment of capacity, flow and benefit indicators expressed in terms of presence of iconic species and habitats (C), visitor flows (F) and willingness to pay (WTP) (B) [42] (Table 2). The presence of resources of high naturalistic and historical-cultural value assessed the capacity of the MPA to generate tourism value. Official statistics [54,55] were used for tourism flow. In order to determine the value tourists place on their experience in the MPA, WTP was assessed through a survey. Questionnaires were administered face-to-face and submitted to samples of bathers, divers, boaters and recreational and sport fishermen without any particular sampling scheme [56]. To obtain WTP estimates, the Contingent Valuation Method (CV) was adopted [57]. The CV stated preference technique creates a simulated market to elicit the expected behaviour as a function of the change proposed by the survey and assess how respondents would react to this change. Part of the survey was devoted to describing the ES of interest in order to obtain the (Hicksian) monetary measure of welfare (i.e., the maximum WTP). The CV survey complied with the requirements: firstly, presentation of the CV scenario, including what the intervention was designed to achieve, how it would be implemented and paid for. Secondly, what would happen in the current status quo if the intervention was not implemented. Furthermore, one question asked for the respondent's WTP for ES. In detail, respondents were asked whether they would pay an increase in trip cost to continue to visit the MPA. Hanemann [58] views the respondent as evaluating the difference in utility associated with access at an increased amount to full income but no access to MPA. If the utility difference is positive for access, the individual answers "yes" and indicates the amount she/he is willing to pay according to an "open-ended" CV format [59]. As result, the recreational demand function was estimated from which the so-called consumer surplus was derived, i.e., the value the consumer assigns to the services provided by the MPA in excess of the fee. The survey assessed the MPA value for each tourism activity. The annual benefit was assessed by adding the estimated WTP for each category of tourist and the market value of the fish catches by recreational fishermen. In the European Union, the sale of fish caught by recreational fishermen is not allowed. However, this catch, and in particular its market value, is a so-called avoided cost, i.e., a cost that the recreational fisherman does not incur by virtue of the fishing activity he carries out. This value is therefore part of the value that the recreational fisherman receives from his activity and in this sense is added to the estimated monetary value. Considering that there is no official data about the harvest in the MPA, it was estimated by asking in the questionnaire for the average daily fish catch per person and the variety of the basket. As anticipated, CICES V4.3 did not foresee any indicators for the ES "characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge". Therefore, new indicators were introduced. For the flow, indicators accounting for the number of publications and research projects were estimated; for the benefit, indicators accounting for the research project budget and the number of researchers and employees expressed in terms of full-time equivalents (FTE) were calculated [42]. No indicator was available for the ES "characteristics of living systems that enable education and training" either. Experimental indicators were introduced as for the previous ES. Flow indicators accounted for the number of educational projects, publications and didactic tools, visitor flows and exhibitions. A benefit indicator assessed the related revenues. In the field of integrated national accounting as stated in the SEEA-EA [6], when people pay to economic units that manage ecosystems, e.g., national park managers, for access to ecosystems, or when payments are made to economic units that support activities in ecosystems (e.g., canoe rental companies), links can be made to the standard national accounts entries. The last ES we evaluated ("characteristics of living systems that allow for activities that promote health, recovery or enjoyment through passive or observational interactions") accurately reports for the economic activities carried out within the MPA. As part of the integrated environmental accounting model, this ES accounts for the benefits that economic actors receive from MPAs. The annual flow indicator assessed marine recreational activities in relation to economic operators and employment generated; the benefit indicator calculated the total annual tourism expenditure generated [42]. The ES benefit aims to assess the impact. In general, the economic impact of tourism is disaggregated into direct, indirect and induced impact. The direct effect on income is constructed from tourism expenditure, while the indirect and induced effects are the contribution of tourism to the activation of other economic sectors and to the households added spending power. The latter are estimated by multiplying the direct impact by the tourism multiplier [60]. The income multiplier is assessed annually at the national level. For the purposes of this research, we referred to 2014 and assumed a value of 1.89 [61]. For benefit indicator assessment the yearly total expenditures generated by tourists (accommodation, food, transport, parking and fees charged for tourism activities, such as bathhouse, diving guide, mooring and general boat maintenance, boat renting, fishing license and general boat maintenance) were gathered through questionnaires submitted to a sample of tourists as part of an in-field sample survey.

Once the economic and environmental benefits and costs have been estimated, the flow account is constructed and in line with the CBA approach [1] the net benefit and value produced or consumed by the MPA is calculated by difference. Finally, from the accounting data estimated in the flow account, some main economic and environmental indicators can be calculated: the ratio of net benefits produced by the MPA to public funding; the return on investment, which corresponds to the economic, environmental and social benefit provided by the MPA per 1 euro of public investment; and the ratio of carbon emissions to carbon sequestration.

3. Results

The PC-MPA, established in 1997 by decree of the Italian Ministry of Environment, is a Marine Reserve of the State. The Public Body responsible of the MPA is a Consortium constituted by the Municipalities of Porto Cesareo and Nardò, and the Province of Lecce, in Apulia Region. The PC-MPA lies in the centre part of the Ionian Sea (South-eastern part of Italy) and includes three marine SACs (Special Areas of Conservation) designated on the basis of the "Habitat Directive" (Dir. 92/43/EEC). In 2011, the PC-MPA has been included in the SPAMI (Specially Protected Areas of Mediterranean Importance) list. It encompasses a surface of 16,654 hectares and a coastline of 32 km. The area is an example of outstanding natural heritage, both for the wild nature of its depths, for the landscape and for the historical-architectural elements, and represents a very important geological and geomorphological laboratory. The Italian approach to MPA management is based on a three-level zoning to which three different protection regimes correspond: Zone A—No Take Zone covering 1.2% of the total area, Zone B—General Reserve with 18.3% of the total area, Zone C—Partial Reserve covering the 80.5% of the MPA, as illustrated in Figure 1. The main town is Porto Cesareo, with 6230 inhabitants, mostly employed in tourism and fishing.

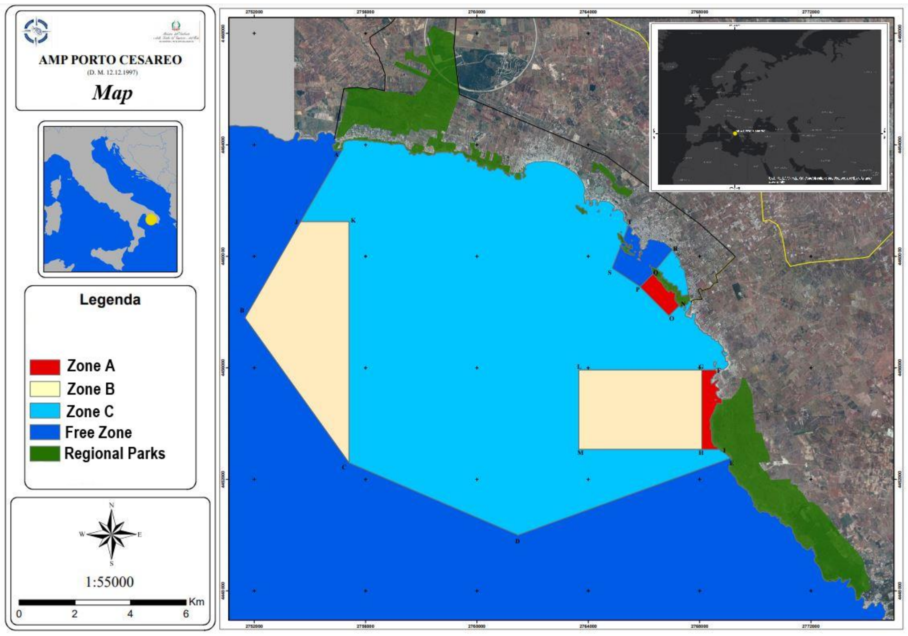

Figure 1. Porto Cesareo MPA zoning [62].

The next sections show the results presented in the following order: revenues from the income statement and the assessment of environmental benefits, the expenditure from the income statement and the assessment of environmental costs, and finally the construction of the flow account.

3.1. Income Statement Revenues and Environmental Benefits

Environmental accounting requires the recording of data over an accounting period, usually coinciding with the fiscal year. In the case of PC-MPA, it was decided to use the average value for the three-year period 2014–2016, in order to smooth out some of the annual fluctuations found in the financial data. Revenues are derived from the PC-MPA income statement. The average of the three years was calculated, and amounted to a total revenue of 783.479,93 EUR.

With regard to benefits, the assessment of ESs was based on the annual flow and benefit indicators suggested by the above-mentioned literature adapted to the local scale and the characteristics of the PC-MPA ecosystem. The “wild marine animals used for nutritional purposes” ES capacity (C) refers to fish abundance within the MPA, which was surveyed based on catches made within the SAMPEI project [63]. The total number of species recorded is 103. Of these, 76 species are represented by fish, 18 by molluscs 7 by crustaceans and 2 by echinoderms. Professional fishing is allowed only in the B and C zones, and only for resident fishermen using selective artisanal gears. Fishing has a long and consolidated tradition in the area. In fact, there is a large small-scale coastal fishing fleet, consisting of 250 fishermen and 130 registered vessels. Commercial fishing plays a fundamental role in the local economy. In addition to being a source of employment and food supply, it is also crucial for the social and cultural role it plays in relation to the many activities that animate the coast. During the three-year period (2014–2016), the fleet authorized to fish within the MPA stabilized at 104 vessels for a total of 14,150 fishing days within the MPA. Fishermen are expected to inform the managing authority with regards to the catch within the MPA in terms of quantity and species. Based on these data, supplemented by interviews administered to fishermen to gather further information on the catch and market price per species; we estimated a catch of 93,500 kg per year. Five species alone accounted for 68% of the total number sampled (Scorpaenidae, *Mullus surmuletus*, *Diplodus annularis*, *Pagellus erythrinus*, *Sepia officinalis*). The annual benefit related to the ES was assessed by multiplying catches by the market price per species and was estimated at

1,013,771.94 €/y. The "control of erosion rate" and "mass flows" ESs were assessed based on capacity indicators (C) such as indices related to the extent of selected emerged, submerged and intertidal habitats, which summed to 16.654,10 ha. Within the MPA, *P. oceanica* meadows mainly colonize the substrates of the three SACs and form coastal habitats such as banquettes. In the winter and autumn periods, banquettes are widely distributed along the coast, creating deposits up to several meters high [64], which play a very important ecological role in containing erosive phenomena in the coast. The 32 km long coastline is characterized by a jagged coastline in which white beaches alternate with low cliffs, dunes that can reach several meters in height forming a characteristic dune ecosystem. Coastal erosion in the MPA is a generalized and historicized phenomenon. The fight against erosive processes can be achieved on the one hand through mitigation and blocking of erosive agents, and on the other hand through conservation and reconstruction of the natural environments of the beach system. In order to act in this direction in 2016 and within the framework of the European Charter for Sustainable Tourism, a Planning Document was drafted that envisages: closure of intersections between urban roads and the emerged beach; rehabilitation of the dune system and closure of dune crossings through naturalistic engineering techniques; beach nourishment; temporary sea wave contrast interventions; communication and awareness raising. Funding for the implementation of the above-mentioned interventions totals 946,991.44 €. Regarding the "regulation of chemical composition of atmosphere and oceans" ES, the flow indicator is the potential carbon fixation. Considering the habitats that can provide this service (Posidonia beds; facies of dead "matte" *P. oceanica* without much epiphora) which have an extent of 6992 ha, the stock corresponds to 8,740,471 tons of carbon and the sink to 3044 tons of carbon annually. Applying the SCC, the total annual benefit related to global climate regulation was estimated at 412.436,70 euros. The "characteristics of living systems that enable activities promoting health, recuperation or enjoyment through active or immersive interactions" ES assessed recreational activities (sunbathing, diving, boat renting, boating and recreational fishing activities). The capacity of the MPA to generate tourism value is given by the presence of resources of high naturalistic and historical-cultural value, including *P. oceanica* habitats, underwater and semi-dark caves, coralligenous, biocenosis of infralittoral algae, fish fauna, marine avifauna, beaches and coastal dunes. The flow indicator reported the tourist flow on the basis of official statistics and studies on the local tourism, which estimated at 1,460,530 tourist presences on the beaches, 10,784 presences of divers, 378,202 presences of recreational boaters and 82,866 days of sport and recreational fishing within the MPA. The benefit indicator was calculated by assessing the WTP through a survey conducted during the 2017 and 2018 bathing season. Questionnaires were submitted to 1314 tourists randomly selected on site and invited to participate in the survey. The questionnaires were administered to 523 bathers, 232 divers, 251 boaters and 308 recreational and sport fishermen. Data on the average daily catch per recreational fisherman (1.3 kg) and basket variety were derived from the questionnaires. This resulted in an annual catch of 107,726 kg to which the market price already used for professional fishing was applied. The commercial value of the catch has an equivalent monetary value of 671,869.86 €. Adding up the WTP and the market value, we estimated a benefit of approximately 1050 thousand euro (Table 3).

Table 3. Annual visitor flows and annual benefit

Activity	Tourist Presence	Sample	WTP	Benefit—WTP and Market Value
	(*n*)	**(*n*)**	**(€/y)**	**(€/y)**
Sunbathing	1,460,530	523	4.29	302,840.98
Diving	10,784	232	7.04	36,441.29
Boating	378,202	251	36.21	36,525.75

Recreational fishing	82,866	308	1.87	599.47
Recreational fishing—fish catches				671,869.86
Total	1,932,383	1314		1,048,277.34

Regarding the "characteristics of living systems that enable scientific investigation or the creation of traditional ecological knowledge" ES, during the three-year period, the MPA appeared in 10 scientific publications in which it was the subject of a study or was cited (average Impact Factor of 2.022), and was involved in ten projects with an average budget per year of 372,161.53€. Since the latter amount is already accounted for in the authority's revenues, only the economic evidence of the activity is provided in this section, but the amount is not accounted for in the flow account to avoid double counting. A total of 20 human resources were employed with fixed-term contracts, of which eleven were part-time and two full-time, while seven were external collaborators. Weighing the human resources by the time spent on activities in the MPA, it was estimated that they correspond to a total of 10.3 FTE. For the ES "characteristics of living systems that enable education and training" only data for the 2016 were available. The MPA managed eight educational projects, which involved 104 participants. Based on accounting data provided by the Managing authority, the educational activities produced revenues for 4740.00 €, of which 2240.00 for the economic operators and 2500.00 € for the Managing authority. As for the previous ES, of the latter amount already accounted for in the authority's revenue, only economic evidence is provided, but the amount is not accounted for in the flow account. The last ES ("characteristics of living systems that allow for activities that promote health, recovery or enjoyment through passive or observational interactions") assessed the impact generated by tourism and was listed separately in the MPA flow account. Along the 32 km of coastline, 27 bathhouses, eight diving centres, five dockyards equipped with 900 berths, two boatyards, six workshops for pleasure craft, four renting pleasure craft and six chartering pleasure craft are authorised to carry out their activity within the MPA. The benefit indicator is represented by the yearly total expenditures generated by tourists. Data were gathered through the survey. The direct tourism effect amounted to approximately 37 EUR million and, by applying the income activation multiplier of 1.89, the overall annual tourism impact within the MPA raised to 70 EUR million (Table 4).

Table 4. Annual tourism expenditure in 2016, indirect and induced effect.

Expenditure Category	**Tourism Expenditure (€/y)**
Main expenditure (accommodation, food, transport, parking)	21,510,434.63
Bathhouse	6,092,506.15
Diving guide and equipment	410,313.77
Mooring and general boat maintenance	3,245,853.21
Fishing license and general boat maintenance	3,352,383.47
Local products	3,058,459.29
Total tourism expenditure—direct effect	37,669,950.52
Total tourism impact—direct, indirect and induced effect	70,442,807.47

3.2. Costs Accounting: Income Statement Expenditures and Environmental Costs

As with revenue, expenses were derived from the reclassification of items in the MPA income statement. Over the three-year period, the current expenditure varied widely, with an extraordinary peak in 2015, so the average value of 580,652.44 € was used here as well. The environmental costs of institutional activities, professional fishing and tourism were calculated. Table 5 shows the environmental costs related to each activity calculated in terms of carbon footprint and the equivalent monetary value of 69,765.36 €/y which expresses the environmental costs.

Table 5. MPA annual environmental costs.

Activities	CO_2 Emission	Environmental Cost
	(kgCO_2eq/y)	(€/y)
MPA institutional activity	28,200	1041.14
Professional fishing (economic operators)	1,025,949	37,878.04
Bathing (economic operators and tourists)	4,569,640	168,711.11
Diving (economic operators and tourists)	103,763	3830.93
Boating (economic operators and tourists)	3,645,783	134,602.31
Recreational fishing (tourists)	664,595	24,536.85
Total environmental costs	10,037,930	370,600.38

3.3. Building the Annual Flow Account

The flow account summarized the environmental costs and benefits together with the expenses and revenues of the MPA. Table 6 shows that the local community receives from the MPA a total benefit of about EUR 3.26 million and a net benefit of about 2.31 EUR million. The annual benefit-cost ratio reached a value of 3.4. Furthermore, the ratio of net benefit to public funding was 3.7 considering current transfer funding. The two figures summarized the overall value for money of MPA (Table 7). It should be emphasized that these analyses did not yet include the tourism expenditure incurred within the MPA and thus the tourism impact, which represented an additional 70 EUR million generation on the local economy. The self-financing capacity of the authority, as is generally the case for other Italian MPAs [25,29], is rather low and slightly exceeds 2% of expenditure. Table 8 shows data on the human resources employed in the scientific and institutional activities of the MPA and the number of economic operators authorised to carry out their activities within the MPA, which amounted to 182. It should be emphasized that the number of people employed by each operator is not available and therefore the direct employment is greatly underestimated. Environmental indicators are shown in Table 9. Bathing and boating were the activities with the greatest impact in terms of carbon footprint, while the good condition and extent of seagrass meadows absorbed 30.3 per cent of the MPA CO_2eq emissions. Finally, as has already been noted in other Italian MPAs [25,29], recreational catch constitutes a significant part of the catch, even exceeding the catch of professional fishermen (107,726 kg vs. 93,500 kg).

Table 6. Porto Cesareo MPA annual flow account.

Costs	(€/y)	Benefits	(€/y)
Expenditures	580,652.44	Revenues	783,479.93
Current expenditures	453,103.21	Current transfers	627,091.50
Capital expenditures	91,820.10	Non-tax revenue	43,982.75
Third Party expenditures	35,729.13	Capital transfers	57,966.97
		Third party revenue	54,438.70
Environmental costs	370,600.38	Environmental benefits	2,476,725.98
MPA institutional activity	1041.14	Wild marine animals used for nutritional purposes	1,013,771.94
Professional fishing	37,878.04	Control of erosion rate and Mass flows	--
Bathing	168,711.11	Regulation of chemical composition	412,436.70
Diving	3830.93	Ch. that enables active or immersive interactions	1,048,277.34
Boating	134,602.31	Ch. that enables scientific investigation [1]	372,161.35
Recreational fishing	24,536.85	Ch. that enables education and training (MPA) [1]	2500.00
		Ch. that enables education and training (ec. operators)	2240.00

Total costs	951,252.82	Total benefits	3,260,205.91
		Net benefit	2,308,953.10
		Tourism impact	70,442,807.47
		Total	72,751,760.57

[1] Values were not summed up

Table 7. Porto Cesareo MPA annual flow account: economic indicators.

Economic Indicator	Unit of Measurement	Value
Benefits/Costs	(*n*)	3.4
Net benefits/public funding	(*n*)	3.7
Self-financing	(€/y)	12,880.00
Self-financing/Total expenditures	(%)	2.2

Table 8. Porto Cesareo MPA annual flow account: social indicators.

Social Indicator	Unit of Measurement	Human Resources	FTE
Scientific and institutional activity	(*n*)	20	10.3
Economic operators	(*n*)	162	n.a.

Table 9. Porto Cesareo MPA annual flow account: environmental indicators.

Environmental Indicator	Unit of Measurement	Value
CO_{2eq} emission (Carbon footprint)	(tCO_{2eq}/y)	10,037
of which bathing	(tCO_{2eq}/y)	4570
of which boating	(tCO_{2eq}/y)	3646
CO_{2eq} fixation	(tCO_2/y)	3044
CO_{2eq} fixation/CO_{2eq} emission	(%)	30.3
Catches (professional fishing)	(kg/y)	93,500
Catches (recreational fishing)	(kg/y)	107,726

4. Discussion

It is well established that healthy ecosystems and biodiversity are fundamental to sustaining our well-being, our communities and our economies [65]. Moreover, it is increasingly recognized that the degradation of nature is not a purely environmental problem requiring environmental policy responses; economic and social policy responses are also needed. As recently stated in the IPBES report [66], four leverage points can help shift decision-making towards the multiple values of nature: recognize the different values of nature, incorporate evaluation into decision-making, reform policies and regulations to internalize nature values, modify underlying social norms and objectives to align them with the overall goals of sustainability and justice. Therefore, decision-makers in all sectors need to consider their environmental context and the associated dependencies and impacts. Recording the contribution of ecosystems to production and the broader benefits to individuals and society encourages a broader understanding of the role of ecosystems and the effects that can result when the extent and condition of ecosystems change, such as the extension of protected status [6] pathway that is under discussion in the PC-MPA.

The integrated environmental accounting system can play a key role in systematically gathering information on the links between ecosystems and the socio-economic system. The eValue model illustrated in this research downscaled at the local level the well-known national accounting models by enriching the debate and adding a new key to existing tools. Those tools include voluntary environmental management systems such as the sustainability report published by organizations on the economic, environmental and social impacts of their daily activities; the Environmental Management and Audit Scheme Reg. (EC) 196/2006 and the Environmental Management System (ISO 14001: 2015) designed to help organizations assess, manage and continuously improve their environmental performance. The first describes the organization's positive and negative impacts in qualitative and quantitative terms. The second provides a comprehensive analysis of the organization's activities, products and services and their environmental impact and commits the organisation to improving its environmental performance. Again, impacts are described in qualitative and quantitative terms; eValue has gone a step further. Starting from the sustainability report and the environmental management assessment, benefits and costs were compared, not only in qualitative and quantitative terms, but also in monetary terms. Considering then the approach, voluntary tools analyse environmental management, while eValue, aligning with the ecosystem services approach [67], assesses both anthropogenic impacts and services provided by ecosystems. Assessing the environmental costs and benefits in monetary terms captures the so-called anthropocentric perspective including the dependency on nature and ESs. In these terms, the eValue model represents a local anthropocentric or socio-economic approach to natural capital accounting that complements the ecological approach or eMergy valuation [24], highlighting the flows of ESs provided by MPAs and assessing their value in monetary terms. With respect to the objectives set by the research, several results were achieved. In terms of communication, the eValue model has shown that the PC-MPA is not a limiting factor in terms of local economic development. In fact, the environmental benefit produced within the MPA amounted to approximately 2.5 million euro, most of which were economic activities related to professional fishing and tourism activities, plus a further 70 million euro of local economic impact strictly dependent on economic activities that enhanced ESs. In terms of environmental policy, management required public funding in terms of current and capital transfers to support nature conservation. The environmental accounting model demonstrated the sustainability of the investment: for one euro of public funding, the wealth produced by the PC-MPA is 3.7 euro. The annual benefit-cost ratio reached a value of 3.4, a significant result if one considers that if the value is less than 1, it can be assumed that the costs are too high to maintain the system. Read in these terms, the eValue model accounts for the economic impact of the MPA and helps demonstrate that nature conservation does not conflict with economic development and, on the contrary, generates wealth and job opportunities in the area. This result can enrich and support the ongoing debate on the expansion of the MPA of Porto Cesareo.

As pilot project, the study assessed a restricted list of ESs and environmental costs. Further research is needed to explore the potential of the eValue model by including in the assessment ecological indicators with the aim to create a direct link between ecosystems and the net benefit perceived by the community. As stated by the SEEA-EA [6], which identifies five main accounts (the ecosystem extent and the ecosystem condition accounts for biophysical information, the ESs flow account in physical terms and the ESs flow account in monetary terms, and the monetary ecosystem asset account) the eValue model should be integrated with the ecosystem accounts to provide biophysical information. This would highlight dependencies and impacts between ecosystems and socio-economic system.

Complementary methods have been developed since the 1990s. Two different approaches have emerged. The first has focused on estimating the value of natural capital and ESs using economic valuation methods [3,37,59,68,69]. These approaches have highlighted the importance of natural resources in sustaining the human economy, they have highlighted their limitation in the fact that money-based valuations reflect the values of the human society and their strength that as long as we are forced to make choices, we have to go through the valuation process [3]. The second employed non-anthropocentric value measures based on biophysical valuation methods and in this is complementary to economic valuation of natural resources [70–73]. In particular, Odum [73] introduced a measure of natural value called eMergy that has been used to assess the goods and services that sustain the biosphere, including the human economy. Applied to the environmental accounting of protected areas, the model articulates in three main steps (trophodynamic analysis, providing an estimate of the primary productivity used to support the benthic trophic web within the study area; biophysical accounting, providing an estimate of the biophysical value of natural capital; monetary conversion, expressing the biophysical value of natural capital into monetary units) [74,75].

In the 2021 the SEEA-EA [6] has achieved a perfect synthesis between the two approaches by setting up the five main accounts. Examples of the experimental implementation of SEEA on a national scale and for marine and coastal areas have been carried out in the United Kingdom [76,77], the Netherlands [78], Australia [79], Mauritius [80], and UN-ESCAP supported pilots projects in Asia and Pacific Countries. In addition, several countries produce statistics on the ocean economy, including the United States [81], Portugal [82], and China [83]. These first approaches encountered great difficulties due to gaps in biophysical data (cartographic images, data on the length and width of coastlines or the condition of protective ecosystems) as well as social and economic trends and their impact on marine and coastal environments. While this implies the need to invest in more ecological and economic research, it also highlighted the inherent difficulty of mapping coastal and marine ecosystems and quantifying ecosystem services and their value to the community [77].

5. Conclusions

This study presented a new eValue integrated environmental accounting model that measures the value produced by MPAs according to an anthropocentric approach. The case study of the Porto Cesareo MPA was implemented to test its applicability and potential usefulness as a support tool for managers and decision-makers in charge of developing nature conservation and enhancement strategies. These strategies are based on the assessment of environmental impacts and services provided by ecosystems that require synthetic indices and will need to include additional impact indices that can integrate the conservation status of marine ecosystems. Future applications of the eValue model will aim to improve its applicability, helping to establish a comparative assessment of MPAs at the local scale and within the groove already traced by the SEEA-EA.

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