

Article

The Contribution of Ecosystem Services in Developing Effective and Sustainable Management Practices in Marine Protected Areas. The Case Study of “Isola dell’Asinara”

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Abstract: Ecosystem Services (ESs) are assuming a constantly increasing importance in management practices due to their key role in ensuring a sustainable future to fauna and flora on Earth. In addition, ES degradation and quality loss jeopardize current human activities. For this reason, it is essential to develop methodologies and practices able to efficiently assess environmental and socio-economic impacts in terms of ES deterioration, especially within protected areas. Norms and regulations have to be able to identify habitat and species categories to be preserved, and to determine the cost of their destruction and decline, according to a holistic vision, which includes social and economic impacts, besides the environmental ones. The paper illustrates the case study of the “Isola dell’Asinara” Marine Protected Area (MPA) in Sardinia, where an experimental methodology was developed with the aim to draw new regulations that integrate conservation measures of Natura 2000 sites included in its territory, provisions determined by the integrated coastal zone management (ICZM) protocol and the Standardized Actions for Effective Management of MPAs (ISEA) project. Subsequently, in order to assess the status of ESs and impacts on ESs located within the MPA territory, an ecosystem-based approach was implemented and applied to the actions defined for the new regulation proposal. Results show that regulations are in this way valuably enriched by environmental aspects of the MPA that would otherwise be overlooked.

Keywords: ecosystem services; millennium ecosystem assessment; marine protected areas; Natura 2000 network; integrated coastal zone management; standardized actions for effective management of marine protected areas; sustainable management; agenda 2030

1. Introduction

Commitment to biodiversity preservation has been increasing dramatically since the Convention on Biological Diversity in 1992. Thanks to international cooperation and stronger awareness of the close relationship between human needs and ESs, attention to ES preservation has grown exponentially over the years. Indeed, a constantly increasing number of scientific studies underline the fundamental role of marine and coastal ecosystems in providing important social and economic advantages [1–4], including food provisioning, nutrient cycling, biodiversity, climate regulation, cultural values, recreation and amenities [5] and the growing human dependence on marine ecosystems and their services [6].

However, overexploitation and mismanagement of marine and coastal resources, habitat destruction and water pollution jeopardize the wealth of ecosystems [7] and, consequently, the services they provide [2], thus threatening the well-being of local communities and of the global community as a whole in developing and industrial countries [8]. Nowadays, many coastal areas have been shown to be vulnerable due to ocean warming, sea level rise, flooding, storm surges, beach erosion, changes in ocean freshwater balance [9], overfishing, tourism and pollution [10,11]. Therefore, appropriate marine and coastal area management and governance are essential to limit environmental and ecosystem damages caused by human activities, to protect biodiversity [12–15] and to improve ecosystem resilience [2] and ecosystem services supply [16]. Scientific research shows that Ecosystem Services (ESs) have to be included in planning discourses [17], but this is still little done in practice [18]. Therefore, following the suggestions of the Strategic Plan for Biodiversity 2011–2020 and the related Aichi Targets, it is necessary to add a new conservation paradigm that integrates ESs in protected areas' planning rules in addition to the existing sets of biodiversity conservation measures [19]. The Strategic Plan for Biodiversity 2011–2020 was adopted in 2010 by the parties to the Convention on Biological Diversity, which has been ratified by 196 countries. Since the contracting countries are committed to the achievement of a number of targets by 2020, in 2011 the EU adopted the EU Biodiversity Strategy, which sets out six targets and 20 actions to halt the loss of biodiversity and ecosystem services in the EU by 2020. Among the objectives set by the strategy, this study focuses on those related to the preservation and protection of habitat, species and ESs located in Marine Protected Areas (MPAs) and Natura 2000 sites. In particular, regulation and planning aspects related to ESs are examined in the light of EU recommendations and communications in order to define research objectives and actions.

Marine Protected Areas (MPA) are globally recognized tools for managing marine ecosystems, specifically designed to safeguard biodiversity, to preserve marine ecosystem health, to maintain the supply of ESs [20], to prevent habitat loss [21] and to sustainably regulate human activities that affect the marine environment [22]. The aim is to reverse ecosystem and biodiversity loss, while sustaining local economy relying on sea and coastal resources [23]. The International Union for Conservation of Nature (IUCN) underlines that deep knowledge of the area is necessary in order to define ecological boundaries of the MPA and to set its objectives. It also calls attention to the vital support of the public and to established techniques for surveillance and monitoring of compliance with the provisions of the regulations. It plays an essential role in advocating the expansion of the MPA network through reliable science and by engaging with local stakeholders. In Europe, the State of the Environment Report (SOER) identifies three types of MPAs: Marine Natura 2000 sites, marine protected areas designed in the framework of regional marine agreements and the single national marine protected areas [24]. These three typologies of protected areas can overlap, that is, a specific zone can be disciplined according to more than one regulatory regime [25]. In Italy, MPAs are established through a ministerial order under the laws no. 979/1982 and no. 394/1991 and normally include three zones characterized by different levels of protection; namely, zone A, the “integral reserve”, which is a no entry and no take zone; zone B, the “general reserve”, which surrounds zone A where human activities and resource exploitation are severely restricted; and zone C, the “partial reserve”, where human activities and resource exploitation are generally allowed but regulated [26]. It might occur that other regulatory regimes operate within the boundaries of an MPA, such as Natura 2000 network conservation measures for Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Sites of Community Importance (SCIs), the provisions determined by the integrated coastal zone management (ICZM) and by the Standardized Actions for Effective Management of MPAs (ISEA). SCIs, identified by European countries according to article 2 of European Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, subsequently labelled SACs, contribute towards ensuring bio-diversity through the conservation of natural habitats and of wild fauna and flora. SPAs, identified by European countries according to article 1 of European Directive 79/409/EEC on the conservation of wild birds, contribute to the conservation of all species of naturally occurring birds in the wild state in the European territory. In this way, fragmentation, spatial isolation and

functional independence of protected areas often prevent a coordinated and integrated management of local activities, which might even present conflicts and contrasts that need to be handled. For example, the coexistence of tourist, commercial and fishery activities need multidisciplinary and integrated public policies [27]. In addition, managing protected areas as isolated reserves—without integrating them into wider spatial strategies—exposes them to the consequences of habitat alteration and destruction, pollution and overfishing that might occur outside their boundaries [28]. For these reasons, an integrated management tool able to adequately harmonize sector-specific policies according to a holistic vision of the territory that goes beyond fragmentation and sectoral policies is clearly crucial [29,30]. Researchers agree that its objectives must be clearly defined and compatible with one another [31–38] so that they need to be researched empirically through negotiation with stakeholders, balancing ecological concerns, economic interests, social issues and political power [39].

With the aim of developing the growth potential of marine and maritime economic activities in a sustainable way, the European Commission identified nine ongoing initiatives in the European Union, including the one on maritime spatial planning and integrated coastal zone management introduced by Directive 2014/89/EU and the one on the ecosystem-based approach introduced by the Marine Strategy Framework Directive (2008/56/EC) [40].

On the one hand, Directive 2014/89/EU defines maritime spatial planning as a cross-cutting policy tool enabling the application of a coordinated, integrated and trans-boundary ecosystem-based approach, which promotes smart, sustainable and inclusive growth and ensures sustainable use of marine and coastal resources [41]. On the other hand, Directive 2008/56/EC recommends ecosystem-based approaches for marine strategies, so that pressure of human activities does not compromise the capacity of marine ecosystems to respond to human-induced changes and the sustainable use of marine goods and services is ensured to present and future generations [42]. In Italy, according to article 2 subsection 3 and article 3 subsection 4 of the Decree of the Ministry of Environment, Land and Sea Protection (in Italian: Ministero dell’Ambiente e della Tutela del Territorio e del Mare, MATTM) published on 17th October 2007, the management of Natura 2000 sites located within the boundaries of an MPA is in charge of the MPA managing authority. Therefore, the MATTM demanded the integration of Natura 2000 conservation measures into MPA regulations in order to efficiently manage the area.

2. The Case Study

Among the tools identified by the European Union to promote trans-boundary cooperation there is the Interreg Maritime Italy–France Programme, which financed 87 projects [43] including the GIREPAM project (Integrated Management of Ecological Networks through Parks and Marine Areas; in Italian: Gestione Integrata delle Reti Ecologiche attraverso i Parchi e le Aree Marine), which involves 16 partners located in five Italian and French regions (Sardinia, Corsica, Provence-Alps-Côte d’Azur, Liguria and Tuscany) and pursues the following three objectives:

1. To improve conservation and promotion of marine and coastal zones and to direct public accessibility to natural sites.
2. To improve the efficiency of planning and public governance of marine and coastal areas in the area of cooperation.
3. To raise awareness on the economic value of the natural capital and to promote green and blue growth [44].

The research group of the Department of Civil and Environmental Engineering and Architecture (DICAAR) of the University of Cagliari worked on the second objective by outlining an Experimental Procedure (in Italian: Protocollo Sperimentale, PS) aiming at formulating appropriate regulations for the management and control of the Marine Protected Areas (MPAs) named “Tavolara-Punta Coda Cavallo” and “Isola dell’Asinara” located in north-eastern and north-western Sardinia, respectively, as shown in Figures 1 and 2.

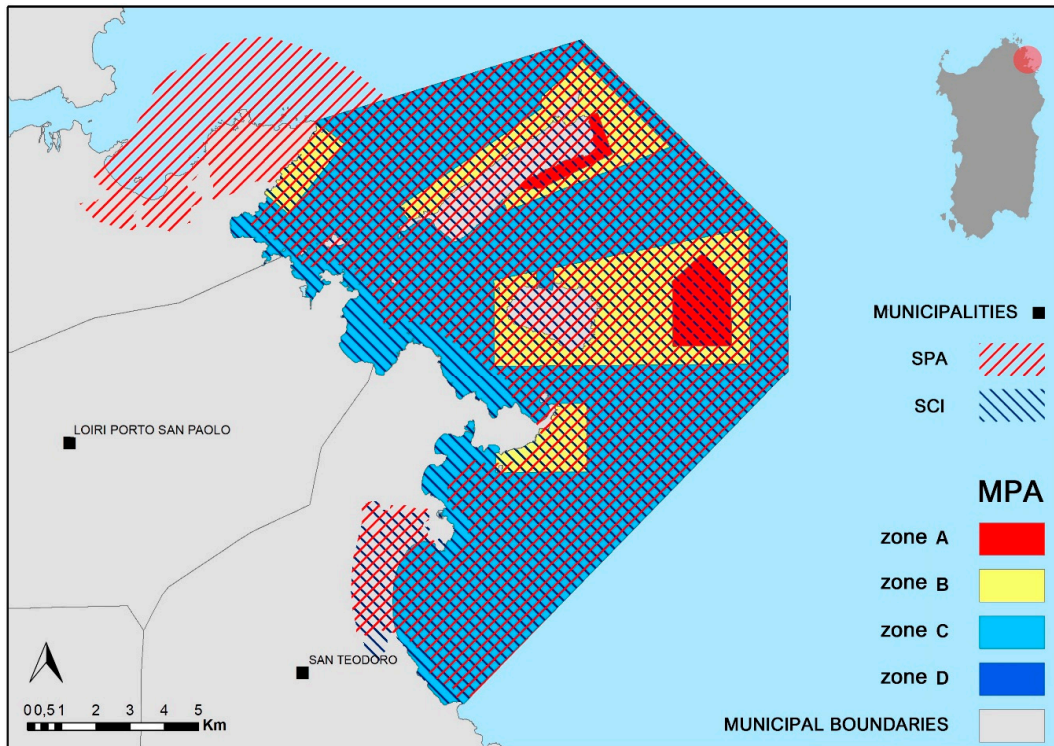


Figure 1. The territory of “Tavolara-Punta Coda Cavallo” Marine Protected Area (MPA) and of the Natura 2000 sites that overlap with it. Source: Authors’ elaboration.

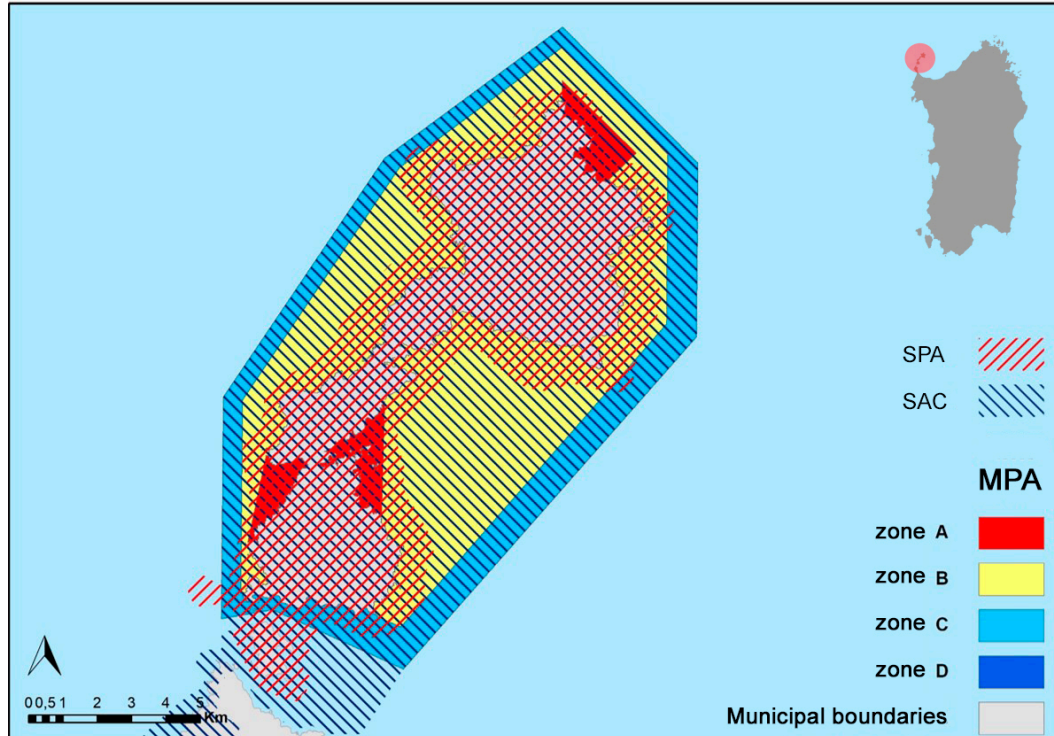


Figure 2. The territory of “Isola dell’Asinara” MPA and of the Natura 2000 sites that overlap with it. Source: Authors’ elaboration.

Figures 1 and 2 show that SPAs, SACs and SCIs are located within the boundaries of the MPAs of “Tavolara-Punta Coda Cavallo” and “Isola dell’Asinara”. Consequently, conservation measures

identified by the Natura 2000 network for SPAs, SACs and SCIs are in force in the MPAs. In addition, the ICZM protocol and the ISEA project are adopted by the MPAs; therefore, the provisions they determine are in force in the MPAs as well. The PS aims at integrating these legislative measures in a single document, coherently with a holistic territory vision able to ensure favorable conservation status of habitats, thus preserving biodiversity.

Within the framework of the study carried out by the DICAAR research group, following the provisions provided by the European Directives 2014/89/EU and 2008/56/EC mentioned above, this paper focuses on the definition of a pioneering methodology to define “ecosystemic objectives”, in accordance with the Sustainable Development Goals (SDGs) of Agenda 2030, to enrich the traditional assessment for sustainability provided by the Strategic Environmental Assessment (SEA). In this way, ecological and socio-economic disciplines are integrated to provide decision-makers with a synthesis of complex information to inform strategies definition. The aim is to provide a scientific framework, which integrates ecosystem services in environmental assessment procedures, in order to guide managers and legislators in making sound decisions.

For the purpose of this paper, only data concerning the MPA of “Isola dell’Asinara” are considered. The MPA was established in 2002 by a decree of the MATTM and its current regulations were approved by the MATTM through the decree of the 30th of July 2009 [45]. Its area covers approximately 108 km² in the sea and 79.64 km² in the mainland entirely comprised within the boundaries of the Municipality of Porto Torres, in the Province of Sassari [46]. The MPA territory overlaps with the following Natura 2000 sites: The SPA “ITB010001 Isola Asinara”, the SPA “ITB013011 Isola Piana di Porto Torres” and the SAC “ITB010082 Isola dell’Asinara”, as shown in Figure 2 [47]. It is characterized by an extensive coverage of various high-quality assets of natural capital as shown in Figure 3.

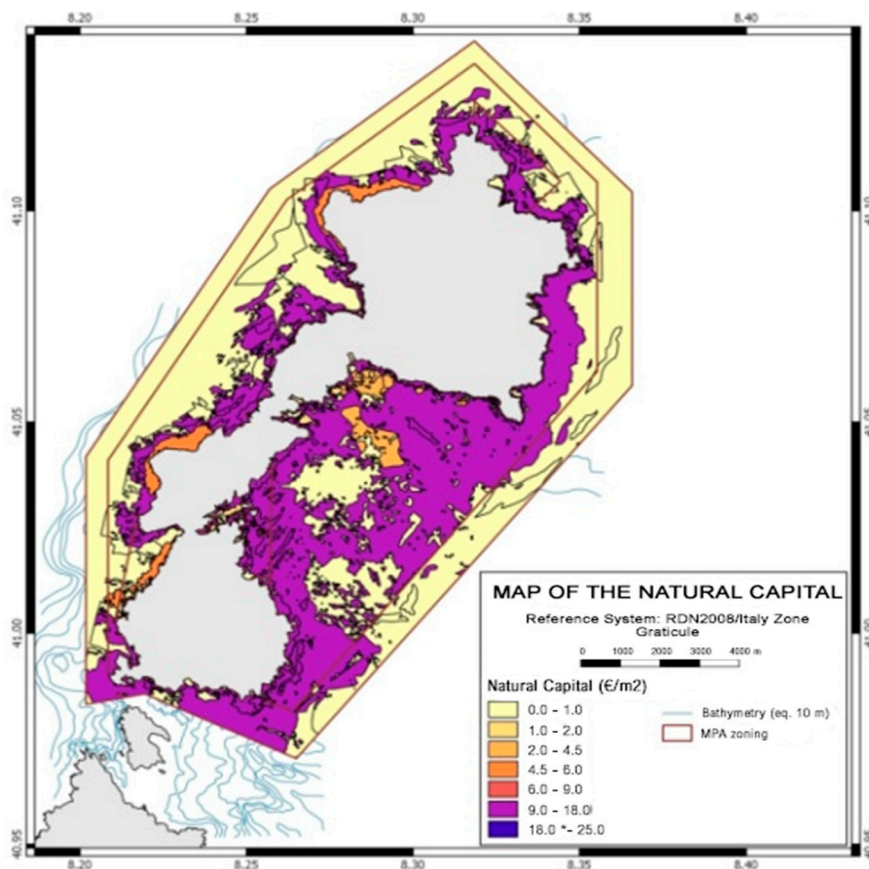


Figure 3. Map of the natural capital. Source: Povero et al., 2018 [48].

3. Methodology

The approach adopted for the definition of the new MPA regulation proposal is based on the outline of the PS. It draws inspiration from the Strategic Environmental Assessment (SEA), with particular reference to articles 1 and 6 of Directive 2001/42/CE, which concern decisional processes and public participation. In particular, the PS recalls the principle that the SEA is not a simple assessment of environmental impacts related to a decision, but it plays a strategic role in all the stages of the whole decisional process [49,50]. In this respect, the SEA is an effective political instrument for territorial governance, able to define strategical actions through the integration of diverse approaches and tools [49,51–55].

The PS applies these concepts with the aim of enhancing decisional processes and management practices. In particular, it promotes public participation in a holistic vision pointing at going beyond the fragmentation and sectorization that characterize the planning and management tools in force. It is structured into the sections illustrated in Figure 4.

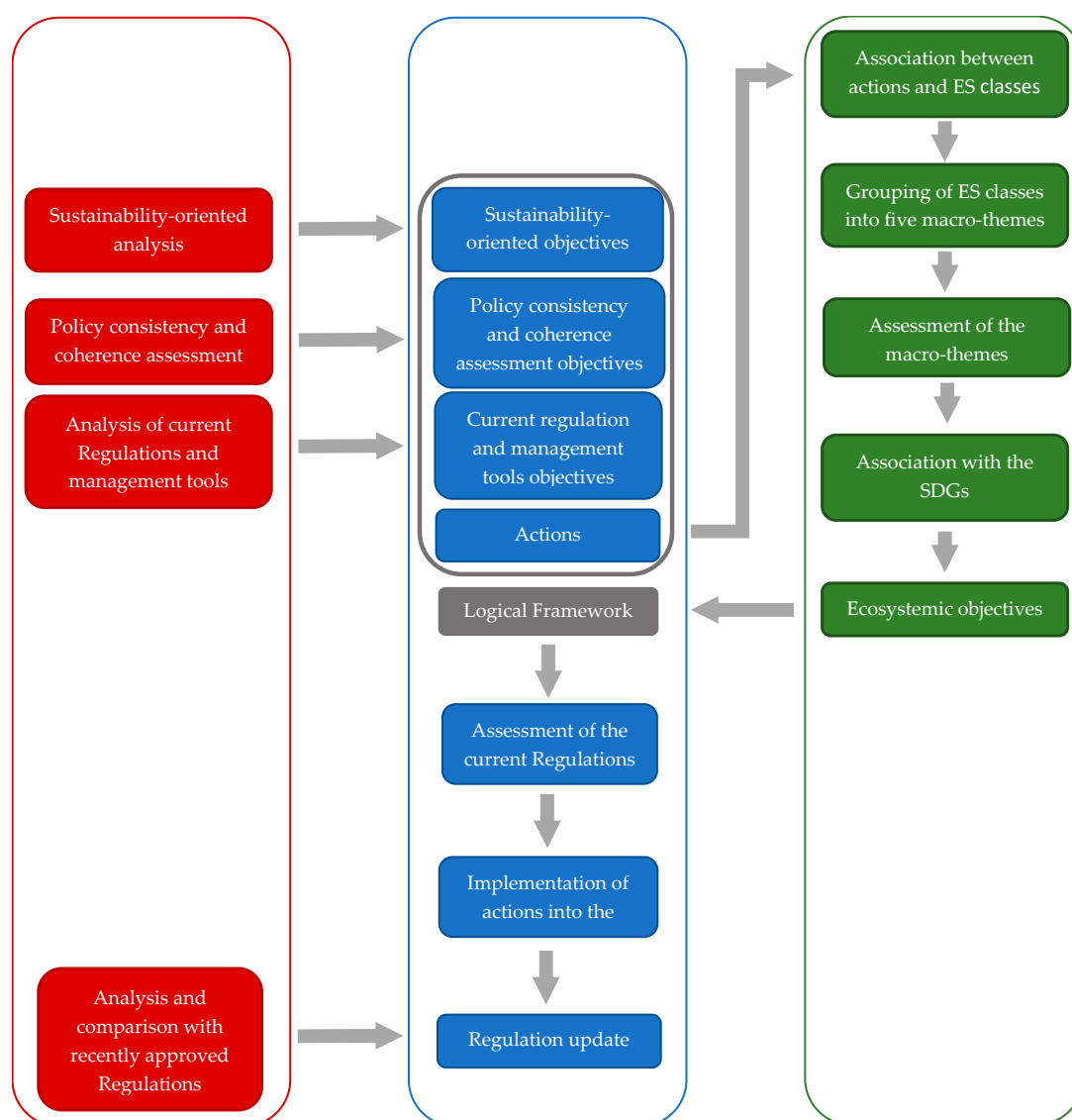


Figure 4. The Experimental Procedure (PS) scheme. Source: Authors’ elaboration.

The core of the PS is constituted by the Logical Framework (LF), since it organizes all the objectives and actions identified in the previous sections, and connects them in a cascade relationship. The LF

is organized according to a matrix structure, largely adopted in the programs promoted by the EU and other international entities. The LF is inspired to the so-called “programming by objectives”, according to which the definition of the activities strictly follows the objective identification [56–58]. The LF structure ensures the identification of “conceptual connections between sustainability-oriented objectives related to the spatial contexts at stake and the operational planning actions concerning the integration of conservation measures related to” Natura 2000 sites into the new regulation proposal [59]. It is organized into four levels, which express the relationships among the various objectives drawn from the diverse protection instruments analyzed during the process of regulation elaboration (see Figure 4) and the actions defined to pursue the objectives selected for the prospective regulations.

The first level lists the sustainability-oriented objectives—formulated on the basis of the SWOT analysis—which depict the environmental status of the area through the analysis of each environmental component that characterizes the area [60]. The second level encompasses the objectives derived from the policy consistency and coherence assessment, which analyzes plans and programs in force at the regional, provincial and local level. The aim of this analysis is to identify the potential effects of plans and programs within the MPA territory and their interaction with the regulations. The third level enumerates specific objectives. They represent the regulation aims, as their codification is based on the contents of normative and management tools in force within the MPA. This section is the core of the PS, due to its importance within the process of upgrading the regulations, and its subsequent implementation.

The last level of the LF is the operative one, since it identifies the actions that address regulation objectives. In order to draw an efficient new regulation proposal, actions are formulated considering the planning and management tools in force (specific objectives) and the results of the SWOT analysis. These actions are then compared with the legislative instruments in force, which are in this way integrated in the new regulation proposal.

The Construction of the Logical Framework

As illustrated in Figure 4, the first level of the LF is constituted by the sustainability-oriented objectives. These objectives result from the analysis of various environmental and socio-economic aspects that describe the analyzed area. The environmental components are identified on the basis of the list provided by the guidelines issued by the Sardinian Region adequately adapted to the MPA studied [61]. In particular, the following ten “environmental components” are examined:

1. Air;
2. Water;
3. Waste treatment;
4. Soil and marine geo-morphology;
5. Flora, fauna and biodiversity;
6. Landscape;
7. Settlement layout and functions;
8. Tourism, recreation and outreach activities;
9. Fishing and other production activities;
10. Mobility and marine and terrestrial accessibility.

Characteristics of each component are reported in a summary sheet, whose scheme is illustrated in Table 1. The sheet contains the essential information assessing the status of natural resources and the pressures of anthropic and economic factors, which can be relevant in the phase of implementation of the regulations. Contextually, a SWOT analysis is conducted to analyze each environmental component, considering data drawn from the context analysis, in order to finally define a set of sustainability-oriented objectives. Subsequently, these objectives are better focused thanks to the ten sustainability criteria identified by the EC [48].

Table 1. Summary sheet for the analysis of the environmental components.

<i>Environmental Component K</i>	
The introduction qualitatively describes the environmental component K in the analyzed territorial context (i.e., air).	
The description is organized according to themes (i.e., air quality, meteorological conditions), which are in turn articulated in specific aspects (i.e., source of pollution, temperature, annual precipitation, etc.). The latter provide a quantitative analysis based on appropriate indicators.	
<i>Theme n</i>	
This section provides a brief qualitative description of the theme n, which refers to the environmental component K.	
Specific aspect t	
Brief description of the aspect through its distinguishing elements such as legislative and management tools, operational tools, thematic maps, infrastructure, etc.	
Indicator 1 [unit]	Notes
...	
Indicator n [unit]	
Source: ... Year: ...	
<i>SWOT Analysis</i>	
Strengths	Weaknesses
...	...
Opportunities	Threats
...	...
<i>Sustainability-oriented Objectives</i>	<i>Environmental sustainability criteria</i>
Ps_Ob_SA_n

Table 2 shows the SWOT analysis conducted for the “air” component, in relation to the sustainability-oriented objective: “Increasing air quality by mitigating pollution impacts, in order to control negative effects caused by climate change”. It highlights strengths, weaknesses, opportunities and threats related to the component “air”. Subsequently the identified sustainability-oriented objective is compared to the appropriate environmental sustainability criteria, designated by the EC [42] (The ten sustainability criteria are the following: (i) Minimization of the use of non-renewable resources; (ii) use of renewable resources within limits of capacity for regeneration; (iii) environmentally sound use and management of hazardous/polluting substances and wastes; (iv) conservation and enhancement of the status of wildlife, habitats and landscapes; (v) maintenance and improvement of the quality of soils and water resources; (vi) maintenance and improvement of the quality of historic and cultural resources; (vii) maintenance and improvement of the local environmental quality; (viii) protection of the atmosphere (global warming); (ix) development of environmental awareness, education and training; (x) promotion of public participation in decisions involving sustainable development). In particular, the sustainability-oriented objective here identified is better focused by considering the environmental sustainability criteria numbers i, ii, iii, vii and viii.

Table 2. SWOT analysis.

SWOT Analysis	
Strengths	Weaknesses
— Absence of air pollution sources within the MPA.	<ul style="list-style-type: none"> — Absence of monitoring networks able to promptly provide information within the MPA territory. — Potential air pollution within the MPA boundaries, due to motor boats.
Opportunities	Threats
— Favorable meteorological conditions during the summer period, and mild weather during the winter.	— Presence of pollution sources near the MPA, namely the Porto Torres industrial area and Fiume Santo power station.
Sustainability-oriented Objective	Environmental sustainability criteria
— To enhance air quality by reducing the pollution consequences in order to mitigate negative effects caused by climate change.	i, ii, iii, vii, viii

The second level of the LF is represented by the policy consistency and coherence objectives.

The assessment of policy consistency and coherence considers all the plans and programs in force at any level in the Marine Protected Area by examining the economic, social and spatial aspects relevant to the analyzed context. All the objectives illustrated in each plan or program are analyzed, and those considered meaningful for the regulations are adopted, either identical to their original formulation or adequately rephrased in order to be specifically tailored to the context.

For example, the objectives identified in relation to the Regional Air Quality Plan are listed below:

- To pursue general environmental enhancement, in relation to other zones and types of polluting substances;
- to integrate environmental needs in sectorial policies (especially in the sectors of energy, industry and transportation) with the aim of ensuring sustainable socio-economic development;
- to increase citizen awareness in order to promote environmentally friendly behavior;
- to integrate authorizations and inspection and monitoring activities in order to best ensure the implementation of the planning and regulation actions.

The third level of the LF is constituted of the specific objectives drawn from the various regulatory regimes in force in the “Isola dell’Asinara” MPA, with the aim of grouping them into a single regulatory framework. In correspondence with each objective, one or more actions are identified in order to guarantee the implementation of the objectives of the new regulation proposal. Simultaneously, actions pursue the aim of eliminating—or at least reducing—pressures exerted on natural resources by anthropic factors. In Tables 3 and 4 excerpts of the LF referring to the “air” component are reported.

Table 3. LF excerpt referring to the “air” component.

Sustainability-Oriented Objectives	Policy Consistency and Coherence Objectives	Regulation Objectives (Specific Objectives)
Ps_Ob_SA_1 To enhance air quality by reducing pollution consequences, in order to mitigate the negative effects caused by climate change.	Ps_Ob_CE_4 To increase citizen awareness in order to promote environmentally friendly behaviors.	PS_Ob_REO_10 To organize information, promotional, awareness-raising and educational programs in order to guarantee sustainable fruition of the area and of its natural resources.
		PS_Ob_REO_11 To promote the development of economic, social, cultural and tourist activities, which are compatible with conservation needs.
		PS_Ob_REO_12 To promote programs and projects directed to the enhancement of marine ecosystems.
		PS_Ob_REO_16 To ensure efficiency in the integrated management of the MPAs.
	Ps_Ob_CE_5 To monitor natural phenomena and processes in order to support authorization and control procedures for a better implementation of the regulation actions.	PS_Ob_REO_18 To efficiently organize surveillance and assistance activities.
		PS_Ob_REO_19 To promote scientific investigation programs.
		PS_Ob_REO_20 To monitor the state of conservation of habitats and species.
	Ps_Ob_CE_11 To integrate sustainable development policies, in order to reduce and prevent climate change and desertification impacts, by reducing the emission of climate-changing gas.	PS_Ob_REO_8 To efficiently organize recreational boat activities, mooring and docking, in compliance with the rules in force in each zone of the MPA and with the related Code of Conduct.
		PS_Ob_REO_13 To reduce the main anthropic pressure factors.
		PS_Ob_REO_16 To ensure efficiency in the integrated management of the MPAs.
Ps_Ob_CE_13 To increase knowledge, applied research and experimentation.	PS_Ob_REO_19 To promote scientific investigation programs.	
	PS_Ob_REO_8 To efficiently organize recreational boat navigation, mooring and docking, in compliance with the rules in force in each zone of the MPA and with the related code of conduct.	
Ps_Ob_CE_16 To reduce energy consumption, pollutant emissions and their impacts on the MPA territory, landscape and environmental value.	PS_Ob_REO_13 To reduce the main anthropic pressure factors.	

Table 4. LF excerpt referring to the “air” component.

Sustainability-Oriented Objectives	Regulation Objectives (Specific Objectives)	Regulation Actions
Ps_Ob_SA_1 To enhance air quality by reducing pollution consequences, in order to mitigate the negative effects caused by climate change.	Ps_Ob_REO_11, Ps_Ob_REO_13	Act_REO_3 Positioning of landing stages and buoys for the mooring of recreational boats in proximity of the Asinara island, in order to preserve <i>Posidonia oceanica</i> habitats.
		Act_REO_4 Realization of artificial submerged barriers in order to constrict illegal trawling and to protect <i>Posidonia oceanica</i> meadows.
	Ps_Ob_REO_12	Act_REO_6 To elaborate strategies and programs for the sustainable use of the MPA territory.

Table 4. Cont.

Sustainability-Oriented Objectives	Regulation Objectives (Specific Objectives)	Regulation Actions
	Ps_Ob_REO_18	Act_REO_7 To adopt measures to facilitate the rescue of animals in distress or disoriented.
	Ps_Ob_REO_10	Act_REO_8 To regulate photo shoots, filming and TV recordings.
	Ps_Ob_REO_8, Ps_Ob_REO_10, Ps_Ob_REO_13	Act_REO_11 To regulate activities allowed in each MPA zone.
	Ps_Ob_REO_10, Ps_Ob_REO_13	Act_REO_12 To organize the tourism fruition system within the MPA.
	Ps_Ob_REO_8	Act_REO_13 To control and limit ship and boat speed, in order to reduce underwater noise pollution and the risk of collision with cetaceans and turtles.
	Ps_Ob_REO_20	Act_REO_14 To regulate monitoring activity.
	Ps_Ob_REO_10, Ps_Ob_REO_13	Act_REO_18 To design and create submarine paths.
	Ps_Ob_REO_12	Act_REO_19 To launch seabed cleaning campaigns.
	Ps_Ob_REO_19	Act_REO_20 To regulate technical and scientific research activity.
	Ps_Ob_REO_13	Act_REO_21 To regulate bathing and swimming.
	Ps_Ob_REO_8	Act_REO_24 To regulate recreational boat activities.
	Ps_Ob_REO_8	Act_REO_25 To regulate docking of recreational boats.
	Ps_Ob_REO_8	Act_REO_26 To regulate mooring of recreational boats.
	Ps_Ob_REO_11	Act_REO_31 To regulate chartering and leasing—even temporary—of recreational boats.
	Ps_Ob_REO_11, Ps_Ob_REO_13	Act_REO_33 To define a set of indicators to assess carrying capacity of the MPA during the summer.
	Ps_Ob_REO_11	Act_REO_34 To regulate authorizations for the development of socio-economic, tourist, social and cultural activities within the MPA.
	Ps_Ob_REO_11	Act_REO_35 To adopt measures to preserve and protect the archaeological, historic and cultural submarine heritage.
	Ps_Ob_REO_8	Act_REO_41 To systematize the mooring infrastructure.
	Ps_Ob_REO_20	Act_REO_42 To launch monitoring campaigns to collect data on air quality.

Once the LF is completely filled, actions are compared with the regulations in force in order to evaluate their mutual coherence. In the event that the regulations in force in the MPAs do not include—or only partially include—a particular action, the regulations are updated either by adding new articles and subsections, or by modifying the existing ones. In order to best pursue this upgrading, regulations in force are also compared with regulations recently approved in other Italian MPAs, which are considered as best practices from which inspiration is taken. Table 5 shows the methodological model adopted to revise the regulations in force and is based on a double level of assessment.

Table 5. Methodology adopted to revise the regulations in force.

Title						
Regulations in Force	First Assessment Level: Comparison between Actions and Articles of Regulations in Force			Second Assessment Level: Comparison with Recently Approved Regulations		Regulation Update
Article from Regulations in Force						Article of the Updated Regulations
Subsection	Action	Article/action assessment	Remarks about the article/action assessment	Recent approved regulations	Remarks about the comparison with recent approved regulations	New subsection proposal

As a result of this double comparison, the new regulation proposal includes the aspects that characterize the sectorial norms that coexist in the area and those drawn from the regulations recently approved in other Italian MPAs. This integration aims at reinforcing biodiversity and environmental conservation, while guaranteeing efficient management of all the socio-economic activities in the area.

4. Definition of the PS Actions

While the objectives constitute the structural dimension of the PS, the actions, in turn, embody the operational aspect, by providing detailed indications and restrictions for the organization and management of the MPA. Following the criteria adopted for the identification of the regulation objectives, actions are codified considering the current restrictions imposed by the legislation in force. These are the MPA establishment decree, the regulations, the management plans of the Natura 2000 sites, and the provisions of the ICZM protocol and of the ISEA project. In addition, the results of the environmental analysis—in particular, the SWOT analysis—for each environmental component have been considered. In this way, actions result strictly linked to the regulation objectives and well connected to the strategic themes raised during their definition.

Once defined, actions were grouped by the categories that characterize the regulations in force as illustrated below:

- Dispositions and regulatory norms;
- monitoring;
- promotional, awareness-raising, information and educational programs;
- security and surveillance;
- institutional coordination.

Attention has been focused on the dispositions and regulatory norms showing a strong link between the sustainable use of natural resources and the protection of marine habitats and species.

Table 6 reports the action set defined.

Table 6. Regulation actions. Source: PS of “Isola dell’Asinara” MPA.

Code	Action
Action category: DISPOSITIONS AND REGULATORY NORMS	
ACT_Reg_1	To adopt protection and conservation measures for habitats and species.
ACT_Reg_2	To regulate the management of stranded <i>Posidonia oceanica</i> .
ACT_Reg_3	Positioning of landing stages of buoys for the mooring of recreational boats in proximity of the Asinara island in order to preserve <i>Posidonia oceanica</i> habitats.
ACT_Reg_4	Realization of artificial submerged barriers in order to constrict illegal trawling and to protect <i>Posidonia oceanica</i> meadows.

Table 6. Cont.

Code	Action
ACT_Reg_5	To adopt measures to prevent coastal erosion.
ACT_Reg_6	To elaborate strategies and programs for the sustainable use of the MPA territory.
ACT_Reg_7	To adopt measures to facilitate the rescue of animals in distress or disoriented.
ACT_Reg_8	To regulate photo shoots, filming and TV recordings.
ACT_Reg_9	To launch recovery campaigns of abandoned waste and of the polluted areas of the MPA.
ACT_Reg_10	To launch eradication campaigns of all invasive or potential invasive alien plants.
ACT_Reg_11	To regulate activities allowed in each MPA zone.
ACT_Reg_12	To organize the tourism fruition system within the MPA.
ACT_Reg_13	To control and limit ship and boat speed, in order to reduce underwater noise pollution and the risk of collision with cetaceans and turtles.
ACT_Reg_14	To regulate monitoring activities.
ACT_Reg_15	To define identification criteria of fishing gear hallmarking.
ACT_Reg_16	To define a plan for the recovery of ghost fishing gear.
ACT_Reg_17	To adopt adequate measures to rehabilitate dunes and bars (protection, signage and maintenance).
ACT_Reg_18	To design and create submarine paths.
ACT_Reg_19	To launch seabed cleaning campaigns.
ACT_Reg_20	To regulate technical and scientific research activity.
ACT_Reg_21	To regulate bathing and swimming.
ACT_Reg_22	To regulate guided scuba diving tours.
ACT_Reg_23	To regulate sea-watching activities.
ACT_Reg_24	To regulate recreational boat activities.
ACT_Reg_25	To regulate docking of recreational boats.
ACT_Reg_26	To regulate mooring of recreational boats.
ACT_Reg_27	To regulate activities of public passenger transport services, sailboat charters and guided tours.
ACT_Reg_28	To regulate professional fishing activities.
ACT_Reg_29	To regulate activities of recreational fishing and ichthyic tourism.
ACT_Reg_30	To regulate whale-watching activities.
ACT_Reg_31	To regulate chartering and leasing, even temporary, of recreational boats.
ACT_Reg_32	To assess vulnerability and risk to accordingly adopt measures of prevention, mitigation and adaptation to face consequences of natural disasters and environmental emergencies.
ACT_Reg_33	To define a set of indicators to assess carrying capacity of the MPA during the summer.
ACT_Reg_34	To regulate authorizations for the development of socio-economic, tourist, social and cultural activities within the MPA.
ACT_Reg_35	To adopt measures to preserve and protect the archaeological, historic and cultural submarine heritage.

Table 6. Cont.

Code	Action
ACT_Reg_36	To adopt temporary protection measures in the areas and during the reproductive periods of vulnerable species that nest on cliffs or minor islands, such as ban on entry of boats, bathing prohibition and stop of recreational and commercial tourist activities.
ACT_Reg_37	To tighten controls on sea-water quality.
ACT_Reg_38	To establish rules and regulations concerning wastewater and hydrocarbons discharge into the sea.
ACT_Reg_39	To circumscribe areas at risk of landslide.
ACT_Reg_40	To define motor parameters of boats according to the Italian Legislative Decree No. 171/2005.
ACT_Reg_41	To systematize the mooring infrastructure.
Action category: MONITORING	
ACT_Reg_42	To launch monitoring campaigns to collect data on air quality.
ACT_Reg_43	To launch monitoring campaigns of habitats and species to guarantee biodiversity preservation.
ACT_Reg_44	To launch monitoring campaigns of marine and coastal invasive alien plants.
ACT_Reg_45	To launch monitoring campaigns of geomorphological dynamics of beach-dune systems and of sandy coastlines.
ACT_Reg_46	To launch census and monitoring campaigns of fish species.
ACT_Reg_47	To launch monitoring campaigns of tourist activity impacts.
ACT_Reg_48	To launch monitoring campaigns of the marine avifauna of conservation interest.
ACT_Reg_49	To launch monitoring campaigns of professional fishing and its impacts.
ACT_Reg_50	To launch census and monitoring campaigns for the protection of coralligenous biocenosis.
ACT_Reg_51	To launch census and monitoring campaigns for the protection of <i>Posidonia oceanica</i> meadows.
ACT_Reg_52	To launch monitoring campaigns of fishing and ichthyic tourism.
Action category: PROMOTION, SENSIBILIZATION, INFORMATION AND EDUCATION	
ACT_Reg_53	To launch awareness-raising campaigns to prevent alien species importation.
ACT_Reg_54	To launch awareness-raising campaigns for the installation of low-impact-lighting systems aimed at reducing animal disorientation.
ACT_Reg_55	To launch awareness-raising and information campaigns to protect the species of the marine and coastal environment.
ACT_Reg_56	To launch awareness-raising and information campaigns to reduce anthropic disturbance of the avifauna in the MPA.
ACT_Reg_57	To launch awareness-raising and information campaigns to reduce waste abandonment.
ACT_Reg_58	To launch environmental education programs and activities.
ACT_Reg_59	To promote the MPA territory.
ACT_Reg_60	To promote interdisciplinary scientific research projects.
ACT_Reg_61	To plan awareness-raising, education and training activities on integrated management of coastal areas.

Table 6. Cont.

Code	Action
ACT_Reg_62	To launch awareness-raising, education and control activities to prevent material removal from the coast and the sea, according to the Regional Law 16/2017.
ACT_Reg_63	To launch campaigns to promote environmental and landscape heritage.
ACT_Reg_64	To launch information and promotional campaigns on the economic activities of the MPA.
ACT_Reg_65	To launch information and promotional campaigns addressed to the economic actors who work in the MPA.
ACT_Reg_66	To launch awareness-raising campaigns addressed to the operators of the fishing sector against the abandonment of fishing equipment.
Action category: SURVEILLANCE	
ACT_Reg_67	To organize and intensify the surveillance in the most problematic zones, paying particular attention on marine and terrestrial areas with important tourism flows.
ACT_Reg_68	To implement the surveillance camera system.
ACT_Reg_69	To launch surveillance campaigns to protect habitats and species.
ACT_Reg_70	To organize and improve the surveillance of the fishing sector.
ACT_Reg_71	To promote poaching suppression.
Action category: INTERINSTITUTIONAL COOPERATION	
ACT_Reg_72	To encourage national, regional and local initiatives through coordinate actions of promotion, cooperation and partnership.
ACT_Reg_73	To adopt adequate measures to reinforce regional, national and international cooperation.
ACT_Reg_74	To coordinate institutional intersectoral activities promoted by administrative services and regional and local authorities in charge in the coastal zones.
ACT_Reg_75	To organize access and parking in the MPA according to the environmental carrying capacity.
ACT_Reg_76	To enhance and coordinate, in cooperation with the surrounding local entities, the public transportation system that connects the Asinara Island with the municipalities of Stintino and Porto Torres.
ACT_Reg_77	To coordinate the activities for cetacean and sea turtle rescue.

Selection of Ecosystem Services for MPAs

Given the need of guaranteeing coherency and compatibility among the diverse assessments, and the aim of properly integrating ES assessment into the PS in order to update the regulations in ecosystemic terms, this paper proposes a selection of ESs for the “Isola dell’Asinara” MPA based on the Common International Classification of Ecosystem Goods and Services (CICES). CICES consists of a hierarchical scheme for ES classification based on the three main categories of ecosystem services [62]:

1. Provisioning services: Provision of genuine goods, such as food, water, timber, fiber, fuel and other raw materials, but also genetic material and ornamental species;
2. regulation services: Regulation of climate, air quality and water, soil formation, pollination, waste assimilation, and mitigation of natural hazards such as erosion, weeds, etc.;
3. cultural services: Non-material benefits such as heritage and cultural identity, spiritual enrichment and intellectual, aesthetic and recreational values.

The work has been conducted on the basis of a study realized in the “Isola dell’Asinara” MPA, concerning environmental accounting in Italian marine protected areas (in Italian: “Contabilità ambientale nelle aree marine protette italiane”) [63], which assigns an ecological value to environmental heritage and subsequently identifies the ecological functions and the relative ESs that characterize it.

On the basis of data provided by the MPA, a set of ESs has been identified and classified according to the CICES scheme (Table 7). The criterion adopted for ES identification was the influence wielded over them by the protection regime in force within the MPA, and their suitability to MPA management.

Table 7. Proposal of a common Ecosystem Service (ES) classification [64].

CICES for Ecosystem Accounting			
Section	Division	Group	Class
This column lists the three main categories of ES.	This column divides section categories into the main types of output or process.	The group level splits division categories by biological, physical or cultural type or process.	The class level provides a further sub-division of group categories into biological or material outputs and bio-physical and cultural processes that can be linked back to concrete identifiable service sources.

The three sections identified by the CICES scheme are: Regulation and maintenance, provisioning and cultural. It must be noticed that these categories are not designed for a specific spatial scale nor for a unique governance level. Thus, the ES assessment needs to be tailored for MPAs and Natura 2000 sites by considering that:

- Terrestrial ES (cultivated crops, surface water for drinking, etc.) are out of the scope of this study;
- the MPA objectives focus more on biodiversity protection rather than on recreational functions and food productions (i.e., fishing).

Tables 8–10 illustrate the match between ES classes and PS actions related to the ES sections “regulation and maintenance”, “provisioning” and “cultural”, respectively.

Table 8. Association between ES classes and PS actions related to the ES section “provisioning”.

Section: Provisioning	
ES Class	PS Action
Cultivated crops	
Reared animals and their outputs	
Wild plants, algae and their outputs	
Wild animals and their outputs	
Plants and algae from <i>in-situ</i> aquaculture	
Animals from <i>in-situ</i> aquaculture	
Surface water for drinking	
Ground water for drinking	
Fibers and other materials from plants, algae and animals for direct use or processing	To adopt protection and conservation measures for habitats and species
	To regulate professional fishing activities
	To regulate activities of recreational fishing and ichthyic tourism
Materials from plants, algae and animals for agricultural use	
Genetic materials from all biota	
Surface water for non-drinking purposes	
Ground water for non-drinking purposes	
Plant-based resources	
Animal-based resources	

Table 9. Association between ES classes and PS actions related to the ES section “regulation and maintenance”.

Section: Regulation and Maintenance	
ES Class	PS Action
Bio-remediation by micro-organisms, algae, plants, and animals	To regulate the management of stranded <i>Posidonia oceanica</i>
Filtration/sequestration/storage/accumulation by ecosystems	Positioning of landing stages of buoys for the mooring of recreational boats in proximity of the Asinara island, in order to preserve <i>Posidonia oceanica</i> habitats
	Realization of artificial submerged barriers in order to constrict illegal trawling and to protect <i>Posidonia oceanica</i> meadows
Dilution by atmosphere, freshwater and marine ecosystems	
Mediation of smell/noise/visual impacts	
Mass stabilization and control of erosion rates	To circumscribe areas at risk of landslide
Buffering and attenuation of mass flows	
Hydrological cycle and water flow maintenance	
Flood protection	To regulate the management of stranded <i>Posidonia oceanica</i> .
	To adopt measures to prevent coastal erosion.
	To adopt adequate measures to rehabilitate dunes and bars (protection, signage and maintenance)
	To assess vulnerability and risk to accordingly adopt measures of prevention, mitigation and adaptation to face consequences of natural disasters and environmental emergencies
Storm protection	To launch monitoring campaigns of geomorphological dynamics of beach-dune systems and of sandy coastlines
	To regulate the management of stranded <i>Posidonia oceanica</i>
	To adopt measures to prevent coastal erosion.
	To adopt adequate measures to rehabilitate dunes and bars (protection, signage and maintenance)
	To assess vulnerability and risk to accordingly adopt measures of prevention, mitigation and adaptation to face consequences of natural disasters and environmental emergencies
Ventilation and transpiration	
Pollination and seed dispersal	
Maintaining nursery populations and habitats	To adopt protection and conservation measures for habitats and species
	To elaborate strategies and programs for the sustainable use of the MPA territory
	To adopt measures to facilitate the rescue of animals in distress or disoriented
	To regulate photo shoots, filming and TV recordings
	To launch eradication campaigns of all invasive or potential invasive alien plants
	To regulate activities allowed in each MPA zone
	To organize the tourism fruition system within the MPA
To control and limit ship and boat speed, in order to reduce underwater noise pollution and the risk of collision with cetaceans and turtles	

Table 9. Cont.

Section: Regulation and Maintenance	
ES Class	PS Action
	To regulate monitoring activities
	To design and create submarine paths
	To launch seabed cleaning campaigns
	To regulate technical and scientific research activity
	To regulate bathing and swimming
	To regulate guided scuba diving tours
	To regulate sea-watching activities
	To regulate recreational boat activities
	To regulate docking of recreational boats
	To regulate mooring of recreational boats
	To regulate activities of public passenger transport services, sailboat charters and guided tours
	To regulate professional fishing activities
	To regulate activities of recreational fishing and ichthyic tourism
	To regulate whale-watching activities
	To regulate chartering and leasing, even temporary, of recreational boats
	To define a set of indicators to asses carrying capacity of the MPA during the summer
	To regulate authorizations for the development of socio-economic, tourist, social and cultural activities within the MPA
	To adopt temporary protection measures in the areas and during the reproductive periods of vulnerable species that nest on cliffs or minor islands, such as ban on entry of boats, bathing prohibition and stop of recreational and commercial tourist activities
	To systematize the mooring infrastructure
	To launch monitoring campaigns of habitats and species to guarantee biodiversity preservation
	To launch monitoring campaigns of marine and coastal invasive alien plants
	To launch census and monitoring campaigns of fish species
	To launch monitoring campaigns of tourist activity impacts
	To launch monitoring campaigns of the marine avifauna of conservation interest.
	To launch monitoring campaigns of professional fishing and its impacts.
	To launch census and monitoring campaigns for the protection of coralligenous biocenosis
	To launch monitoring campaigns of fishing and ichthyic tourism
	To launch awareness-raising campaigns to prevent alien species importation

Table 9. Cont.

Section: Regulation and Maintenance	
ES Class	PS Action
	To launch awareness-raising campaigns for the installation of low-impact-lighting systems aimed at reducing animal disorientation
	To launch awareness-raising and information campaigns to protect the species of the marine and coastal environment
	To launch awareness-raising and information campaigns to reduce anthropic disturbance of the avifauna in the MPA
	To launch awareness-raising and information campaigns to reduce waste abandonment
	To plan awareness-raising, education and training activities on integrated management of coastal areas
	To launch awareness-raising, education and control activities to prevent material removal from the coast and the sea, according to the Regional Law 16/2017
	To launch awareness-raising, education and control activities to prevent material removal from the coast and the sea, according to the Regional Law 16/2017
	To launch campaigns to promote environmental and landscape heritage
	To launch information and promotional campaigns on the economic activities of the MPA
	To launch information and promotional campaigns addressed to the economic actors who work in the MPA
	To launch awareness-raising campaigns addressed to the operators of the fishing sector against the abandonment of fishing equipment
	To promote poaching suppression
Pest control	
Disease control	
Weathering processes	
Decomposition and fixing processes	
Chemical condition of freshwaters	
	To adopt protection and conservation measures for habitats and species
	Positioning of landing stages of buoys for the mooring of recreational boats in proximity of the Asinara island, in order to preserve <i>Posidonia oceanica</i> habitats
	Realization of artificial submerged barriers in order to constrict illegal trawling and to protect <i>Posidonia oceanica</i> meadows
Chemical condition of salt waters	To elaborate strategies and programs for the sustainable use of the MPA territory
	To launch recovery campaigns of abandoned waste and of the polluted areas of the MPA
	To launch eradication campaigns of all invasive or potential invasive alien plants
	To regulate activities allowed in each MPA zone
	To organize the tourism fruition system within the MPA
	To regulate monitoring activities
	To launch seabed cleaning campaigns
	To regulate bathing and swimming

Table 9. Cont.

Section: Regulation and Maintenance	
ES Class	PS Action
	To regulate recreational boat activities
	To regulate activities of public passenger transport services, sailboat charters and guided tours
	To regulate chartering and leasing, even temporary, of recreational boats
	To define a set of indicators to assess carrying capacity of the MPA during the summer
	To regulate authorizations for the development of socio-economic, tourist, social and cultural activities within the MPA
	To tighten controls on sea-water quality.
	To establish rules and regulations concerning wastewater and hydrocarbons discharge into the sea.
	To define motor parameters of boats according to the Italian Legislative Decree No. 171/2005
	To launch monitoring campaigns of tourist activity impacts
	To launch census and monitoring campaigns for the protection of <i>Posidonia oceanica</i> meadows
	To launch awareness-raising and information campaigns to reduce waste abandonment
	To plan awareness-raising, education and training activities on integrated management of coastal areas
	To launch campaigns to promote environmental and landscape heritage
	To launch information and promotional campaigns on the economic activities of the MPA
	To launch information and promotional campaigns addressed to the economic actors who work in the MPA
Global climate regulation by reduction of greenhouse gas concentrations	Positioning of landing stages of buoys for the mooring of recreational boats in proximity of the Asinara island, in order to preserve <i>Posidonia oceanica</i> habitats.
	Realization of artificial submerged barriers in order to constrict illegal trawling and to protect <i>Posidonia oceanica</i> meadows
	To launch census and monitoring campaigns for the protection of <i>Posidonia oceanica</i> meadows
Micro and regional climate regulation	Positioning of landing stages of buoys for the mooring of recreational boats in proximity of the Asinara island, in order to preserve <i>Posidonia oceanica</i> habitats
	Realization of artificial submerged barriers in order to constrict illegal trawling and to protect <i>Posidonia oceanica</i> meadows
	To launch monitoring campaigns to collect data on air quality
	To launch census and monitoring campaigns for the protection of <i>Posidonia oceanica</i> meadows

Table 10. Association between ES classes and PS actions related to the ES section “cultural”.

Section: Cultural	
ES Class	PS Action
Experiential use of plants, animals and land-/sea-scapes in different environmental settings	To adopt protection and conservation measures for habitats and species
	To adopt protection and conservation measures for habitats and species
Physical use of land-/sea-scapes in different environmental settings	To define identification criteria of fishing gear hallmarking.
	To define a plan for the recovery of ghost fishing gear
	To regulate bathing and swimming
	To regulate guided scuba diving tours
	To regulate sea-watching activities
	To regulate recreational boat activities
	To promote the MPA territory
	To launch campaigns to promote environmental and landscape heritage
	To launch awareness-raising campaigns addressed to the operators of the fishing sector against the abandonment of fishing equipment
	Scientific
Educational	To launch environmental education programs and activities
	To plan awareness-raising, education and training activities on integrated management of coastal areas
Heritage, cultural	To launch awareness-raising, education and control activities to prevent material removal from the coast and the sea, according to the Regional Law 16/2017
	To adopt measures to preserve and protect the archaeological, historic and cultural submarine heritage
Entertainment	To regulate bathing and swimming
	To regulate guided scuba diving tours
	To regulate sea-watching activities
	To regulate recreational boat activities
Aesthetic	To regulate whale-watching activities
	To launch awareness-raising, education and control activities to prevent material removal from the coast and the sea, according to the Regional Law 16/2017
Symbolic	
Sacred and/or religious	
Existence	
Bequest	

Tables 8–10 show that the previously defined actions of the PS match all the three ES sections and that the majority of the actions refer to the “regulation and maintenance” and “cultural” ES sections. In particular, the highest number of matches is observable in the classes “maintaining nursery populations and habitats” and “chemical condition of salt waters” in the section “regulation and maintenance” and in the class “physical use of land/sea-scapes in different environmental settings” in the section “cultural”. However, not all the ES classes are matched to PS actions. Nevertheless, some of them are relevant for defining an appropriate management of the MPA. For example, “wild animals

and their outputs”, “bio-remediation by micro-organisms, algae, plants and animals”, “dilution by atmosphere, freshwater and marine ecosystems”, “symbolic”, “existence” and “bequest”.

Subsequently to this classification, in order to assess the management of the MPA, ES classes have been grouped into five macro-themes according to the proposal of the Millennium Ecosystem Assessment proposal [62] for urban, coastal and marine areas as follows:

- Tourism fruition and eco-tourism;
- fish biomass supply for business or entertainment purposes;
- climate regulation;
- water quality regulation;
- landscape and cultural heritage.

These macro-themes have been assessed through a methodological approach similar to the one that guided the environmental assessment of the PS. Indeed, they have been described through a proper summary sheet with the aim of identifying a set of objectives in addition to those already defined in the PS. In this way, it is possible to update the regulations according to an “ecosystemic” perspective. Table 11 provides an example of a summary sheet for the ES “k”.

Table 11. Example of a summary sheet for the ES “k”.

ES k		
The introductory section qualitatively describes the ecosystem Service K in the analyzed territorial context. Moreover, the activities that best represent the analyzed ES are identified and articulated in specific aspects. These provide a quantitative analysis based on appropriate indicators.		
<u>Activity 1</u>		
This section provides a brief qualitative description of the activity and its characterizing aspects.		
<i>ES Class</i>	<i>Indicator</i>	<i>Measure unit</i>
<u>Activity n</u>		
This section provides a brief qualitative description of the activity and its characterizing aspects.		
<i>ES Class</i>	<i>indicator</i>	<i>Measure unit</i>
<u>Flow calculation</u>		

Among the previously identified “ecosystemic macro-themes”, for the purpose of this study, it is worth focusing on the following:

- Fish biomass supply for business or entertainment purposes;
- landscape fruition for recreational activities (bathing, diving and yachting) and scientific/educational purposes.

In the operational phase, after identifying and mapping where each ES fruition occurs in order to analyze each ES macro-theme, an interview sample was realized with the aim of monitoring anthropic pressures related to ES fruition. Data collection focused on bathing, scuba diving, professional and small-scale fishing and yachting and relied on fieldwork and interviews conducted in the MPA headquarters, especially through:

- Questionnaires to users (i.e., tourists and scuba divers);
- collection of information and documentation related to financial reports, studies and resource exploitation in the MPA headquarters. This part was conducted by the MPA staff in collaboration with the University of Genova;

- analysis of the documentation on the authorizations granted by the MPA in order to assess anthropic pressures and to gather information concerning the typology of the related operator or user;
- outline of a new authorization system for the simultaneous collection of information about the authorization-release procedure and of all the data needed for the application of the environmental accountability [63].

Human benefits have been assessed according to an anthropocentric approach. In particular, those that derive from ES fruition by operators, tourists and visitors of the MPA were considered as “environmental benefits” and thus evaluated in monetary terms. Differently, biophysical benefits (i.e., those related to the environment and not to humans) were assessed according to an eco-centric approach, which is currently being developed by the Department of Earth Sciences of Environment and Life of the University of Genova within a number of projects, such as GIREPAM. Environmental benefits deriving from the use of the MPA natural heritage have been re-classified on the base of the ES from which they originate [63].

Tables 12 and 13 show the summary sheets related to “tourism fruition” and “fish biomass supply for business or entertainment purposes”, elaborated as an example of the previously illustrated analysis.

Table 12. Summary sheet related to “tourism fruition”.

ES “tourism fruition and eco-tourism”
The “Isola dell’Asinara” MPA allows the following tourism activities:
Bathing. According to article 11, bathing is forbidden in zone A, and allowed in zones B and C, according to the ordinances of the of the competent maritime authority.
Diving. According to articles 12 and 13 of the regulations, non-organized scuba diving is forbidden. Scuba diving tours are allowed exclusively in zones B and C during the day and at night, prior authorization and according to the procedures provided in the same regulations.
Recreational boats. According to article 14 of the regulations, navigation is allowed to recreational boats with inboard engine exclusively in zone C and in the entry corridors to the mooring of “La Reale” and “Cala d’Oliva”, prior authorization and according to the procedure provided in the same regulations.
Bathing
Since in the “Isola dell’Asinara” seaside facilities are absent, users mainly bath in “Cala Sabina”, “Cala d’Oliva” and “dell’Ossario” beaches, which are also included in guided tours. These beaches accommodate the majority of bathers, because access to other sites is more complicated.
The yearly number of bathers, obtained through monitoring activity, is estimated to be approximately 44,450. During the summer of 2016, a survey was conducted on a sample of 343 bathers. They were all tourists, since the island has only one resident.
77% of the respondents were long-stay tourists, the average of their stay in Sardinia was 11 days, of which only one was spent in the MPA. Among them, 15% spent their holidays in a second home, 31% rented a house and 44% chose other options (i.e., hotel, bed and breakfast, etc.). The remaining 23% of the interviewees were one-day tourists.
Figure 5 shows tourist distribution according to the following categories of tourists: (i) Usual stay; (ii) occasional stay; (iii) usual one-day stay; (iv) occasional one-day stay.
Thus, among the visitors of the “Isola dell’Asinara” MPA every year, 76% are occasional tourists. With respect to the origin, 95% of bathers are residents in Italy (of them, 25% are from Sardinia and 38% from the north of Italy). All the interviewees consider the MPA important or even a priority.

Table 12. Cont.

<i>Class type</i>	<i>Indicator</i>	<i>Measure unit</i>
Landscape fruition for recreational and scientific activities.	No. of visits.	Average annual attendances (2014–2016 period).
Scuba Diving		
Diving centers must be authorized by the MPA managing entity. Authorization is subject to verification of a number of specific requirements for diving centers.		
In order to protect the seabed, the managing entity monitors underwater activities, identifies dive sites and mooring points, and establishes the maximum number of dives per day and of the marine vessels daily employable by each diving center.		
The number of dives per day is fixed at 24 (intended as single plunges), for each of the 25 sites identified by the managing entity. The maximum number of diving centers authorized every year is 5, and the maximum number of marine vessels for each center is 2.		
During the three-year-period 2014–2016, the annual average of dives was 2223.		
With the aim of deeply analyzing habits of scuba divers, and how they perceive the MPA, a sample of 61 scuba divers were interviewed; 67% of them were men, and 55% were aged between 30 and 50. The majority of divers (92%) were from Italy, and 87% were tourists who were staying in Sardinia; 62% of divers considered the institution of the MPA a priority, whereas the remaining 38% considered it important but not a priority.		
<i>Class type</i>	<i>Indicator</i>	<i>Measure unit</i>
Landscape fruition for recreational and scientific activities.	No. of visits.	Average annual attendances (2014–2016 period).
Flow calculation		
The flow of the “tourist fruition” ES is calculated through the numbers of users of each fruition category.		

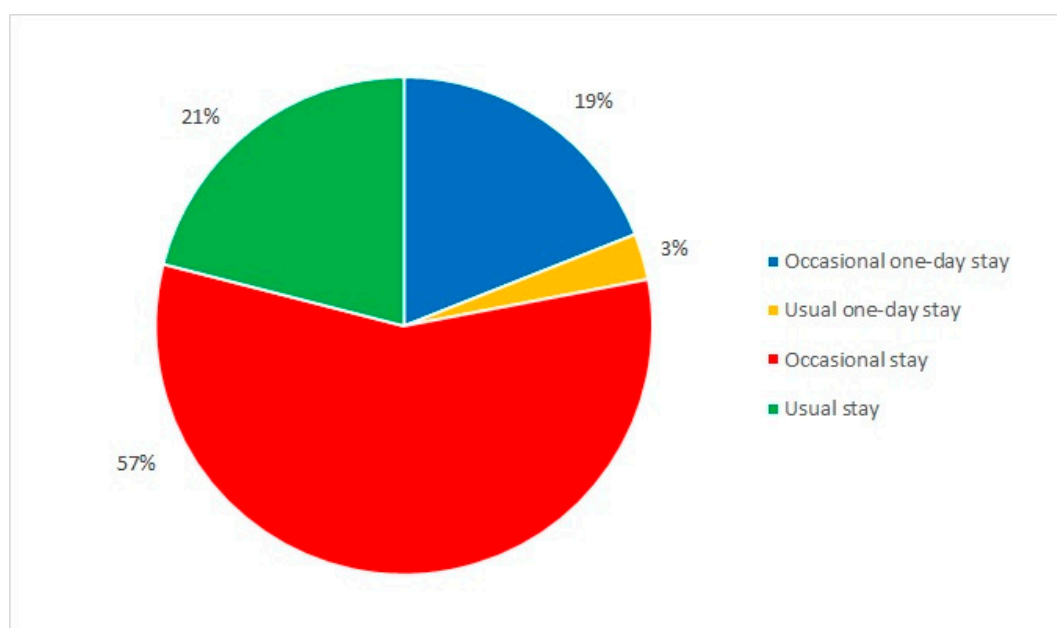


Figure 5. Tourists' stay distribution. Source: Authors' elaboration.

Table 13. Summary sheet related to “fish biomass supply for business or entertainment purposes”.

ES: “Fish Biomass Supply for Business or Entertainment Purposes”		
Professional Small-Scale Fishing Related to the ES		
The number of fishing boats that work in the MPA is 26, of which 73% are wooden vessels and the remaining 27% are made of fiberglass. The average length is 8.76 m, and the propellant is diesel.		
The regulations of the “Isola dell’Asinara” MPA establishes that:		
<ul style="list-style-type: none"> — Professional small-scale fishing is forbidden in zone A; — trawling, purse-seine and fishing with light sources is forbidden; — aquaculture and active repopulation are forbidden; — professional small-scale fishing is allowed in zones B and C only to the fisheries registered in the municipality lists of the MPA, according to the procedures established by the regulations. 		
With regard to the calculation of fish biomass, data are obtained through visual census campaigns (conducted by the MPA). In particular, the MPA signed an agreement with the Environmental Office of Corsica (OEC, Managing Entity of the Natural Reservation of the Strait of Bonifacio, France), to monitor the fish fauna of the SAC ITB010082 “Isola dell’Asinara” and the SPA ITB010001 “Isola Asinara”.		
The methodology adopted was the direct count via the “visual census” technique, choosing fixed circular points and areas of 100 m ² , with a depth between 10 and 20 m. Each fixed point was determined by using a rope of 11.3 m length, corresponding to the diameter of a circle whose area is 100 m ² . The biomass was calculated on the basis of density data, conferring to each individual of each species an average weight according to its size class.		
By multiplying the biomass value (calculated for area units) by the areas, the total amount of fish biomass was obtained: 943 tons of carbon, corresponding to 3.63% of the benthonic biomass stored in the MPA.		
This amount is distributed mainly on the biocoenosis of <i>Posidonia oceanica</i> , on infralittoral algae and on coastal detrital.		
Calculation of the fish stock underestimates the real value, because the “visual census” technique cannot detect some species, as the pelagic ones. Thus, the species captured by professional, small-scale and leisure fishers should be added to the results obtained with this methodology. However, even in this case, the sum would underestimate the real stock, because these catches would not represent the entirety of the individuals that compose the stock.		
<i>Class type</i>	<i>Indicator</i>	<i>Measure unit</i>
Wild animals and their outputs	Quantity of fish caught	Kg/year
Flow calculation		
The flow of the “wild animals and their outputs” ES was calculated by previous studies conducted by the AMP (Vargiu, 2012, 2014, 2015), considering data on small-scale professional fishing in the three-year period between 2014 and 2016. The estimated quantity of fish caught was of 61,562 kg/year.		

Definition of “Ecosystemic objectives” was realized on the basis of the strategy of Agenda 2030 towards sustainable development (Agenda 2030 is an action program joined by 193 ONU countries in September 2015. Agenda 2030 strongly highlights the unsustainability of current economic, environmental and social development models. This vision shifts away from the common idea that sustainable development is just an environmental issue by simultaneously integrating the diverse development dimensions into one coherent vision. The agenda gathers 17 Sustainable Development Goals (SDGs) into an action program articulated in 169 “targets” or “goals”. The objectives were launched in 2016, and the subscribing countries committed themselves to achieve them by 2030). In particular, with the aim of defining the “ecosystemic objectives” referring to the studied MPA, the Sustainable Development Goals of Agenda 2030 refer to the themes on which the case study focuses. They have been selected and linked to the macro-themes previously defined. The selected goals are the following:

- Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all;
- Goal 13: Take urgent action to combat climate change and its impacts;
- Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Subsequently, each SDG has been matched with the previously identified macro-themes. Table 14 shows the definition of the ecosystem objectives in relation to the ES chosen for the case study and in correspondence with the selected SDG. These objectives are drawn from the SDGs, but are carefully rephrased in order to be adapted to the context.

Table 14. Ecosystemic objectives.

ES macro-themes	SDG	Ecosystemic Objective
Touristic fruition	Goal 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development	<ul style="list-style-type: none"> — Significantly prevent and reduce marine pollution; — Efficiently regulate fishing activities; — Improve the economic benefits deriving from activities like fishing, aquaculture and tourism through the sustainable use of marine resources.
Fish biomass supply for business or entertainment purposes	Goal 14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development	<ul style="list-style-type: none"> — Efficiently regulate fishing activities; — Significantly prevent and reduce marine pollution; — Ensure access to natural resources and marine markets to small-scale fishermen.
Climate regulation	Goal 13 Take urgent action to combat climate change and its impacts	<ul style="list-style-type: none"> — Integrate the regulations with measures to contrast climate change.
Energy production from renewable resources	Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all	<ul style="list-style-type: none"> — Promote the use of renewable energy in the regulations

5. Discussion

In this section, results previously obtained and presented are discussed, highlighting the main issues that characterized the two phases of the research. The results offer a way to cope with the critical issues related to the definition of MPA regulations, identified in the previous sections.

The research was articulated into two phases: In the first phase, the methodological approach to update the regulation in the light of Natura 2000 conservation measures was defined; in the second phase, the analysis of the constitutive elements of the PS and their assessment in light of the ESs was conducted.

Concerning the first phase of the research, it is worth noting the following two significant results:

- The integration of the conservation measures provided in Natura 2000 management plans, and in the ICZM protocol and ISEA project into the regulations;
- the involvement and active participation of competent authorities, public bodies, stakeholders and experienced actors—who contributed to regulation improvement by virtue of their diverse needs and visions—which reflect the contrast between environmental protection and socio-economic development. It is important to underline that this moment is not for actors to passively approve decisions already taken according to a top-down approach, but it constitutes a valuable opportunity to share knowledge among stakeholders characterized by diverse backgrounds. It is during this phase that the PS process swings into action, by actually designing the new regulation proposal. Participation is essential to effectively integrate conservation measures and sectoral policies because norms are, in this way, assessed from a legislative point of view and interpreted in the light of their impacts on MPA users' daily life. For this reason, participation is strongly encouraged from the very first steps of the PS definition process. Therefore, sharing is not limited only to results, but it also includes the working methodology.

The two results reported above allow the overcoming of some critical issues that arose during the construction of the PS:

- The overlapping of local, regional and national competencies. In particular, while the draft of the Natura 2000 management plans is produced by municipalities, their approval is entitled to regional administrations. Similarly, MPA regulations are proposed by the MPA authority, but they are approved by the MATTM. Interaction of diverse authorities complicates the process and entails numerous difficulties, such as the fragmentation and sectorization that characterize the planning and management tools in force;
- lack of operational objectives and actions in the regulations in force, which are able to adequately address a number of territorial problems and issues related to the allowed activities in the MPA. Response to this criticism is currently offered by the annual procedural guidelines, which establish detailed norms and operational conditions for the activities allowed in the MPA. In this sense, the regulation updating responds to the territorial problems and issues related to the allowed activities in the MPA by integrating the indications of the annual procedural guidelines into the new regulations.

Concerning the second phase of the research, it is worth noting the following three significant results:

- Acquisition of knowledge and awareness of ESs and of their potential contribution to human wellbeing. This is obtained through a set of objectives oriented to promote and protect the natural capital of the MPA by giving the regulation updating an ecosystem focus. In fact, it is fundamental to orient human actions to a sustainable use of ES in order to conserve their flows, especially considering that their economy relies on specific ESs (i.e., agriculture and fishing are strictly linked to provisioning ESs, tourism takes advantage of cultural ESs, etc.). With reference to this, “ecosystemic objectives” are defined on the basis of ES and are contextualized in the area of the case study coherently with the regulation actions defined in the PS. This represents the pivotal element for the regulation process to update coherently with the EU guidelines regarding ESs. In particular, with regard to the ES “climate regulation”, it was necessary to define a corresponding objective aiming at integrating measures to combat climate change into the regulations. This aspect was totally absent in the existing regulations; thus, it represents an innovation with respect to the “traditional” issues that arose during the implementation of the PS;
- the formulation of a set of ecosystemic objectives and actions in coherence with Agenda 2030 objectives. This connection allowed addressing the existing objectives to specific future challenges (as in the case of objectives related to fishing in light of Objective 14 of Agenda 2030 and the fish biomass supply for business or entertainment purposes).

6. Conclusions and Suggestions for Further Research

In light of the previously discussed results, the main obstacles to efficient MPA management are the high variety of objectives regarding protection and development of MPAs and the need to provide users with information about norms and rules concerning the sustainable fruition of these areas. The need to overcome these discrepancies and to simultaneously facilitate users’ fruition, by reducing information fragmentation, called for the construction of a dynamic and interdisciplinary instrument able to consider, in an integrated way, all the ecosystem fragilities, the coastal landscape and the human impacts on them.

The proposed conceptual approach represents the starting point for the definition of guidelines on the systematic application of the PS model to spatial planning and to the management of natural areas characterized by an overlapping of diverse normative levels.

Thus, governance and management of marine areas can be innovated according to a holistic territorial vision, able to efficiently contrast biodiversity loss and ecosystem degradation.

Possible further research projects can be developed according to this vision, as, for example:

- The definition of a monitoring system related to the regulation implementation, in order to assess the impacts of the coastal ecosystem management on ESs;
- ES measurement through adequate accountability and statistical methods to support the decisional process. Indeed, notwithstanding their fundamental role for socio-economic development, the importance of ecosystems for human wellbeing is currently not adequately evaluated, especially at planning and regulation levels [65]. Indeed, ecosystems provide vital support to life quality, and their functions and services can be assessed in monetary terms thus including the value of natural capital in resource management and spatial planning. ES assessment should take into account ecosystem mapping, anthropic pressures that threaten them and interactions between natural capital and its potential in terms of ES provision. This requires the definition of a set of adequate and representative indicators [66];
- ES monetary assessment. In this sense, it is necessary to re-consider the whole management process in order to identify and highlight ES value, and to understand the role of their safeguarding in influencing their quality and quantity in relation to an improvement of the natural capital [22], and also in economic terms;
- the introduction of an evaluation procedure for the MPA regulations. The proposed PS stresses the significant impacts of the regulations on the environment and formulates an innovative approach, inspired by SEA principles and methodology, which allows the inclusion of environmental objectives into the decisional process.

In conclusion, this study proposes an innovative ecosystem approach based on the interaction of diverse disciplines [67] that allows a draft of a new regulation proposal that is more effective with respect to the themes of environmental safeguards and biodiversity protection [68]. It demonstrates that it is possible to realize efficient ex-ante and ex-post assessment for public policies through the development of accounting systems, indicators and assessment methods related to the impact of these policies on the state of the natural capital [66]. This innovative approach can be replicated in other similar contexts for sustainable planning in coastal territories.

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