Social Learning for Facilitating Dialogue and Understanding of the Ecosystem Services Approach: Lessons from a Cross-Border Experience in the Alboran Marine Basin

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Abstract: Social learning (SL) appears to have considerable potential to enhance the impact of the ecosystem services approach (ESA) discourse on policy and society. However, empirical research to better understand the processes that support SL, the effects it generates, and the conditions that enable such learning is limited. This study assesses the ability of SL to enhance dialogue and understanding of the ESA to support transformative social change in governance practice in the Alboran Marine Basin. To do so, we conducted a specifically designed SL process oriented towards the ESA as a governance approach in this marine region. The SL process was developed through three interlinked workshops involving scientists, decision-makers and local users from Spain and Morocco, the two countries that share the governance of this social-ecological system. The results revealed that the SL process progressively facilitated (i) a more inclusive and constructive ecosystem services dialogue, (ii) a better understanding of the social-ecological system in which the actors were embedded, (iii) an enhanced recognition of science-policy-society complementarities to address sustainability issues, and (iv) a gradual social transformation towards more sustainable and equitable governance. Via the SL process, a variety of factors were identified as contributing to the creation of four relevant conditions that facilitated its successful operationalisation. These conditions included (i) the generation of trust and shared understanding, (ii) the facilitation of knowledge exchanges between actor groups across frontiers, (iii) the promotion of more democratic participation, and (iv) the co-production of practical outcomes. These contextual insights provided empirical evidence of the prominent role SL can play to enhance dialogue and understanding of the ESA for supporting its adoption as governance practice. On this basis, it is argued that operationalising SL in those processes focused on making the ESA relevant to policy and society is pivotal to its implementation in governance practice.

Keywords: social learning; communication; ecosystem services dialogue; knowledge co-production; social transformation; sustainable governance

1. Introduction

The ecosystem services approach (ESA) is a well-recognised principle with which to articulate policies for conservation and the sustainable use of ecosystems [1]. The scientific foundation of the ESA supports

governance models that encompass the complex interconnectedness and interdependence of social and ecological systems to be managed from an integral and sustainable perspective [2]. As a conceptual framework, the ESA stresses the benefits that people derive from the functions and processes of ecosystems, and emphasises the links between nature and human well-being [3]. This framework contrasts with the traditional governance approach that focused on managing isolated components of ecosystems but ignored their interactions with social systems [4]. Scientists consider that such piecemeal governance has a negative impact on safeguarding the Earth's ecosystems [3,5,6], and have encouraged the adoption of the ESA as a reference framework to re-orient policies towards ecosystem-based governance [1,7–9].

While a considerable amount of scientific knowledge has been generated over the last few decades to support the formulation of evidence-based policies from the ESA around the world [10], such knowledge has only slowly permeated to policy and society [11–13]. In order to catalyse the impact of scientific knowledge and translate it into action on the ground, an increasing number of academics have increased their efforts to strengthen the science-policy-society interface around the ESA. The publication of the Millennium Ecosystem Assessment [3], the constitution of the Ecosystem Services Partnership (ESP) network, in 2008 and the creation of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) in 2012 are examples of efforts to mainstream ecosystem service science to the global community. Concurrently, significant progress in this direction has been made through recent research focused on participatory approaches to raise awareness and elicit more direct public engagement [14]. These efforts have already delivered early results to guide policies around the world [15]. Despite its importance, various challenges have continued to prevent the adoption of the ESA as standard governance practice [13]. Such challenges have led to the development of new research directions to understand specifically what factors may be limiting the incorporation of the ESA into decision-making processes.

Within this context, a major constraint to increasing the impact of ecosystem service research is the limited knowledge and understanding of scientific discourse on the ESA by policymakers and the general public [16], particularly, on how ESA concepts can inspire dialogue and cooperation across social groups [17–19]. This may be attributed to the different meanings and interpretations that ES concepts elicit amongst people with a plurality of perspectives, knowledge and values [15]. These different understandings are largely derived from the market-oriented connotation attached to ecosystem services concepts [20], the complex scientific terminology of the ESA [11] and the general lack of a standardised ecosystem services lexicon [21]. It is recognised that unless there is an effective communication process for ESA, it will be difficult to catalyse its inclusion in decisions and policies. For this reason, the ecosystem service community has called for suitable approaches to strengthen dialogue and understanding amongst scientists, decision-makers and the general public across contexts [19].

Social learning (SL, also referred to as sustainability or transdisciplinary learning) is a tool to facilitate constructive dialogue between scientists and non-scientists [22–25], with the potential to enhance the ESA discourse in society. Among the multiple interpretations of SL in the scientific literature [26], SL can be understood as the collective learning dynamics around the ESA, which are built upon shared reflection and a common understanding of the principles of sustainability and its consequences [22,23]. One of the most relevant aspects of this type of SL is that the individuals involved can interact in terms of "communicative action" [27]. Communicative action implies that actors establish a communication pattern based on a common understanding of the principles of sustainability, and jointly define action-relevant situations [23]. This type of communication is recognised as pivotal to raise awareness of ecosystem services, taking responsibility, and making changes in individual behaviours and institutional practices [23,25,28]. Therefore, based on communicative action, SL can contribute by strengthening the links amongst the scientific community and other parts of society, thus generating transformative social change to re-orientate existing governance practice towards the ESA. Although significant progress has been made in the theoretical conceptualisation of SL over recent decades [26,29], empirical research to better understand the processes that support SL, the effects

it generates, and the conditions that enable such learning under specific contexts is limited [30], especially in the ESA field (see, e.g., [31,32]).

ESA implementation can be especially challenging in socio-ecological systems that cross geo-political boundaries given the significant cultural and socio-economic differences amongst populations, and competing interests and trade-offs between uses of ecosystem services by the bordering countries [33,34]. In this context, we developed a study focused on assessing the applicability of SL to enhance dialogue and understanding of the ESA to support transformative social change in governance practice in the Alboran Marine Basin (a marine ecosystem with high biodiversity values and geopolitical importance, the governance of which is shared by Spain and Morocco). To develop the study, we conducted a specifically designed SL process oriented towards the ESA as a governance approach in this marine region to (1) analyse the societal effects that such a process generates in individuals involved and (2) identify key factors that facilitate SL in this governance context. The SL process was developed through three interlinked workshops involving scientists, decision-makers and local users from Spain and Morocco. As a result of this process, we observed changes in interaction patterns and understanding and different social aspects that emerged progressively amongst the individuals involved. We identified key operative conditions that positively influenced the SL process, and reported the evaluation of the SL process by the participants themselves. Practical lessons and limitations are described and discussed. We believe that these insights provide a contextual orientation for both scholars and non-scholars interested in designing learning strategies for making the ESA relevant to policy and society.

2. Materials and Methods

2.1. Study Area

The Alboran Marine Basin (AMB) is located at the westernmost side of the Mediterranean Basin in the interface between Europe and Africa (Figure 1a,b). Specifically, the study focused on the marine area basin bounded by the coastline of Spain and Morocco (571 and 540 km, respectively). From an ecological point of view, the AMB is characterised by conspicuous hydrodynamic effects driven by the inflow of Atlantic Ocean water through the Strait of Gibraltar [35] (Figure 1c). These ecological conditions determine its high biodiversity, which accounts for 28% of the world's endemic species, 7.5% of the world's fauna species, and 18% of the world's marine flora species [36]. In recent decades, the increased intensification of human impacts in the Mediterranean region (e.g., overfishing, habitat loss and pollution) has led to a decline in biodiversity [37], which threatens the maintenance of ecosystem services provided to inhabitants from the north and south shores. The AMB is an area of importance and concern at the social, geopolitical, and strategic levels. It is characterised by the contrasting cultural and living standards between Spain (EU) and Morocco (non-EU member) [36]. Governance of the AMB is shared by these bordering countries and largely managed by different government institutions (from local to national scale) in both countries (Figure 1d). This complex socio-cultural, economic and political mosaic hinders the articulation of conservation policies that ensure equitable and sustainable governance of the region.
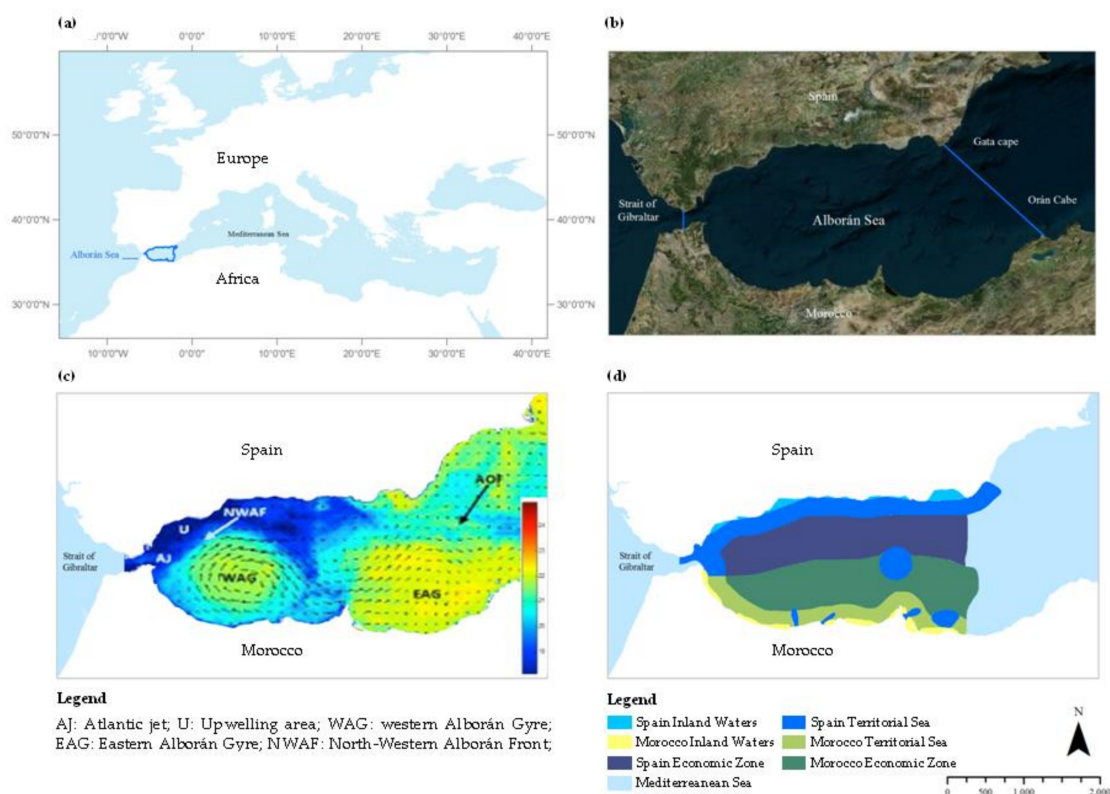
Figure 1. (**a**) Location of the study area: the Alboran Marine Basin (AMB); (**b**) External borders of the AMB; (**c**) Main hydrodynamic structures (simplified from [35]); and (**d**) Marine jurisdictional boundaries by country [38].

2.2. Methodological Approach

2.2.1. Social-Ecological System Overview and Participants

We initiated the study by exploring the AMB to provide a general overview of the social-ecological system context. In doing so, we interviewed fifteen key informants (April 2013) from academic entities (e.g., the University of Malaga and Tetuan), governmental institutions (e.g., the Andalusian Regional Ministry of Agriculture, Nature and Food Quality and the National Ministry of Agriculture and Fisheries on behalf of Spain and Morocco, respectively) and NGOs (e.g., the International Union for Conservation Nature Centre for Mediterranean Cooperation) (Table S1). Through the interviews, we identified several contextual factors that laid the foundation for designing a practical SL exercise related to the ESA in the study area. Such factors included the existence of (1) previous experience in theoretical meetings focused on the sustainability of the AMB; (2) limited culture of collaboration amongst science, policy and society; (3) limited perception of the AMB as a socio-ecological system; (4) limited knowledge of ESA concepts (especially outside the scientific community); and (5) legal requirements from Spain and Morocco for the implementation of marine conservation policies grounded in an ecosystem-based approach (see, e.g., [39,40]).

Following the interviews, we mapped the stakeholders for the SL process using the snowball technique in which each key informant was also asked what other people considered as key in the scientific, political and societal context of the AMB [41]. More specifically, each participant was invited to propose up to fifteen (1) scientists with experience in the AMB; (2) decision-makers from governmental institutions with regulatory competencies in the study area at the local, regional, national and international levels; and (3) local users who had lived and worked on both shores of the marine basin. In addition, we analysed the actors and institutions who had been involved in cooperation projects, studies and activities focused on sustainable governance in the AMB. By comparing both

information sources, we were able to derive a final list of potential stakeholders to be involved in the SL process.

Based on this list, we established a cross-border community of practice based on the integration of scientific, policy and societal dialogue. This type of community is defined as groups of actors who share common interests in a particular area through exchanging knowledge and experiences to enable members to learn from one another and to strengthen trust and mutual understanding [42]. To organise the community of practice, a formal invitation to participate in the exercise was extended to those stakeholders—representatives from universities, governmental institutions, and society—who had been identified in the previous phase. With the intention of involving a balanced representation of actors in the learning exercise, an equal number of participants from each stakeholder group from both countries were invited to participate (225 people in total, 75 from each group). The invitation was initially open to those whose participation did not require economic support, and the final participation list was determined by the available budget and logistics considerations. Ultimately, 28 scientists, 50 decision-makers, and 25 local users from Spain, Morocco and international entities participated in the exercise (Table S1).

2.2.2. Structure and Operation

We created a specifically designed SL process oriented towards an understanding of the ESA as a governance approach in the AMB, based on reflexivity and collective deliberation about sustainability issues by the community of practice [23]. To guide the SL process, we used the ESA developed by the Millennium Ecosystem Assessment (MEA) as a conceptual framework [3] (Figure 2). The selection of this framework was based on its recognition as an organising model to frame conservation policies between bordering countries that share governance over a unique ecosystem [33,34]. The rationale for this selection is that it provides a means for linking multiple services and assessing trade-offs between uses of services. Conceptually, this framework is based on the identification of multiple cause-and-effect relationships amongst drivers of global change, ecosystem conditions and functions, ecosystem services, human well-being and action management. Although the ESA inspired the entire SL process, only some portions of this framework were established for comprehensive analysis, collective deliberation, and outcome co-production by the participants: drivers of global change and ecosystem services. These elements provided the basis upon which participants could propose indicators for monitoring each component and supporting the alignment of conservation policies between Spain and Morocco through the geoportal located at http://www.iucn-geoportalboran.org/es/. The indicators were established as practical outcomes that could be applied to progress towards ESA implementation in the AMB.

The SL process involved a sequence of three three-day workshops from June 2013 to June 2014 aimed at the community of practice who would experiment with SL in the ESA. All workshops were built upon co-learning and knowledge co-production approaches aimed to generate outcomes based on a balance of trade-offs amongst individuals involved in the SL process [43]. In taking this approach, we created SL processes that established a neutral space based on open dialogue and oriented towards building participants' capacity to (1) learn and express their interests and (2) build outcomes by consensus to avoid bias in the generated outcomes [44]. To address unbalanced perspectives, power relations and asymmetries derived from unequal involvement of the participants from stakeholder groups and countries, all participants agreed to reach a consensus on workshop outcomes as a rule for the workshop activities. To promote information flow and mutual learning amongst participants, we used a knowledge brokering approach [45] coordinated by two knowledge brokers, one from Spain and another from Morocco. Both have social skills and experience in facilitating participative processes in the AMB.
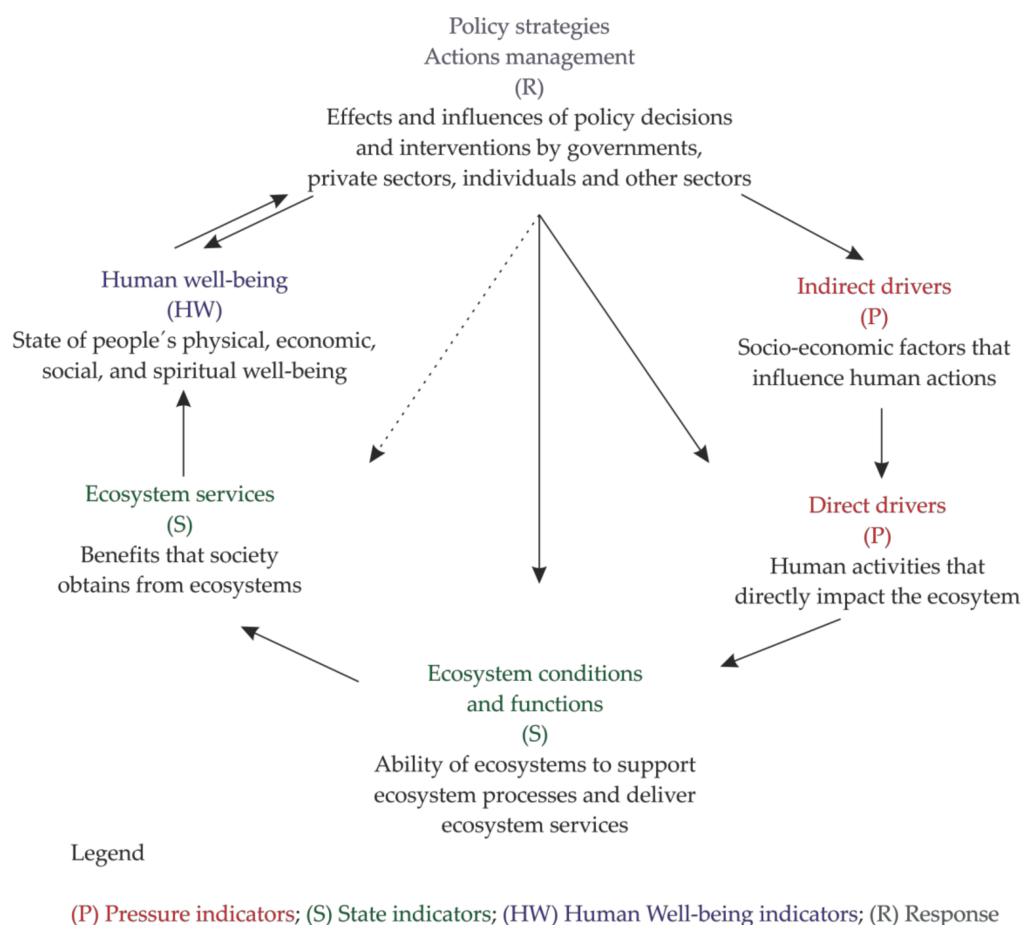
Figure 2. Conceptual framework adopted to guide the social learning (SL) experience. Adapted from the Millennium Ecosystem Assessment MEA [3].

Operationally, all workshops shared the same structure. Before each workshop, the individuals involved were provided with a synopsis of the conceptual framework of the process, the specific workshop goals and the work scheme. Each workshop started with knowledge brokers introducing the rationale of the SL experience and the mode of workshop operation, describing their neutral role in the process, and defining the learning exercise as a voluntary, equitable and collaborative social experience oriented towards sustainable governance of the AMB. The workshops continued with two experts in socio-ecological system science providing training lectures to build capacity in the ESA. Then, knowledge brokers guided sessions to simultaneously develop workgroup activities through the creation of four groups. Each workgroup included individuals with heterogeneous profiles, specialisations and nationalities to promote a view of the study area from multiple perspectives. The groups were separated into worktables with a translator to render comprehensive simultaneous interpretation between participants and an observer in charge of monitoring the SL process (more details in Section 2.2.3). The members of each group designated a moderator to take minutes on the topics discussed and to explain the outcomes to the other groups. After each group activity, a plenary session was then conducted to promote the exchange of feedback and synergies amongst work groups. During the workshops, coffee breaks and common lunches were organised to promote participants' informal networking and exchange of impressions. Once each workshop concluded, knowledge brokers compiled the outcomes and drafted a report that was sent to participants for corrections or suggestions to ensure consensus building. A final conference was held to present the outcomes of the workshops.

Workshop 1 was designed to collectively define priority direct drivers of global change [3] for the study area. To accomplish this goal, the four work groups were invited to identify five main

direct drivers of ecosystem change in the AMB. The selected drivers were grouped in MEA categories and ranked according to the number of times regional drivers were identified by work groups (absolute frequency). A score of 1 was assigned for each identified driver. Twenty-one scientists, 20 decision-makers, and 12 local users from Spain (75%), Morocco (21%) and international entities (4%) participated in the workshop (Table S1).

Workshop 2 was focused on characterising the marine ecosystem services negatively impacted by the regional drivers identified in workshop 1. To guide this workshop, we used a modified list of 19 ecosystem services from the MEA [3], which was provided as supporting material to the participants (Figure S1). This list included the definition of each ecosystem service, with examples and related pictures [46]. Each work group elaborated on a list of the ecosystem services affected by the previously selected regional drivers of change. A score of 1 was assigned for each identified ecosystem service. The data were then resampled via the bootstrapping method (10,000 replicates) to estimate the parameters of the probability distribution and to rank ecosystem services according to the number of times ecosystem services were identified by work groups (absolute frequency). After the workshop, the results were illustrated through a network model using the CMAP Tools version 5.05.01 software programme based on the workshop meeting minutes (Figure S2). Ten scientists, 12 decision-makers, and 10 local users from Spain (72%) and Morocco (28%) participated in this workshop (Table S1).

Workshop 3, aimed at the community of practice, proposed potential indicators (both pressure and state indicators) for monitoring both the regional drivers and the highest-ranked ecosystem services that had been previously identified. As criteria, we established that the co-produced indicators were scientifically valid, useful for decision-making and socially robust [47]. A list of example indicators was provided to the participants as supporting material (Table S2). This workshop included 14 scientists, 32 decision-makers, and 10 local users from Spain (52%) and Morocco (48%) (Table S1).

2.2.3. Monitoring and Assessment

The monitoring of the SL experience was based on a qualitative research perspective [48] using data from participatory observation techniques and informal interviews with individuals involved and during workshops. This type of qualitative research approach enabled an understanding of social changes that occurred as a result of a specific social processes through analysing the social constructs, beliefs and behaviours that operate in that context [22,25,48]. The qualitative data were collected through a standard template with the following variables: (1) changes in dominant patterns of interaction and communication amongst actors, (2) main social aspects that began to emerge amongst stakeholder groups through the workshops, and (3) key operative factors that enabled the SL process [23,25,49]. After each workshop, we (the research team) held sequenced group discussions between the knowledge brokers, observers, experts in building ESA capacity, and translators to analyse and systematise the collected data. All of the research team were involved in designing, coordinating, integrating, and disseminating the outcomes of the SL process, and thus, we were not active participants in the SL process. This separation helped us avoid potential bias in data collection, pre-empted possible obstacles and conflicts that may arise from social interactions and increased in-depth knowledge about the experience [23,50].

To assess the SL, we used an online questionnaire that was completed by the participants. This questionnaire allowed us to obtain an external evaluation from each individual involved in the SL process. The questionnaire was piloted prior to its use in the field with a researcher, decision-maker and local user from entities involved in the study to ensure that the questions were formulated as clearly as possible and relevant to all stakeholder groups [51]. The questionnaire included twelve generic questions inspired by normative, cognitive and relational dimensions [52] to capture whether the SL process had supported social change for re-orienting governance practices towards the ESA in the study area. The questions included: (*1) Are you in favour of holistic and sustainable management of the AMB? (2) Do you think that the current governance system could be improved in the AMB? (3) In your*

opinion, should governance in the AMB be based on ecological rather than socio-political boundaries? (4) Do you believe that coordinated management between bordering countries could help to the sustainability of the AMB? (5) Should sustainability issues be addressed through transboundary and science-policy-society interface approaches in the AMB? (6) Would you like to continue participating in transboundary platforms formed amongst science-policy-society entities to address sustainability issues in this marine region? (7) Do you consider that the social learning process helped you to acquire new knowledge about ESA as a governance practice? (8) Is the ESA a suitable framework for transboundary conservation? (9) Do you think that capacity building is needed when working with the ESA? (10) Do you believe that monitoring of drivers of global change and ecosystem services is useful for conservation policies? (11) Should a common set of drivers and ecosystem services indicators be harmonised across boundaries for aligning marine conservation policies? and *(12) Do you believe that a harmonised system of drivers and ecosystem services could promote sustainable and equitable governance in the AMB?* Each question included four standard replies that participants could choose (i.e., yes, no, do not know/no answer, and other). Apart from the professional profile and nationality information, the questionnaire was made anonymous to generate an impartial environment for collecting opinions from those surveyed. Given that a period of time is required for people to reflect on and form their opinions about such a process [50], participants were invited to complete the questionnaire through the online application "Google Forms" up to one month after the final conference. Subsequently, the participants' responses were evaluated by quantitative analysis and expressed as a percentage of the total sample, distinguishing professional profile and nationality.

3. Results

3.1. Workshop Outcomes

As part of the SL process the community of practice produced the following outcomes:

3.1.1. Main Regional Drivers of Marine Ecosystem Change in the AMB and Indicators for Its Monitoring

The community of practice identified six direct drivers of ecosystem change as major human pressures on the AMB (Table 1). The overexploitation of fishing resources, marine coastal pollution, intensive coastal urbanisation, and the intensification of maritime traffic were found to be the most relevant issues, followed by the invasive of alien species and climate change. In accordance with these findings, the community of practice proposed six pressure indicators for monitoring each regional driver (Table 1).

3.1.2. Marine Ecosystem Services Impacted by the Regional Drivers and Indicators for Its Monitoring

The community of practice characterised eight ecosystem services as the most heavily affected by regional drivers, based on an absolute frequency over the cut-off value (15.52) determined through bootstrap resampling (Table 2). These services included provisioning and cultural services: (1) food (fish), (2) recreational activities, (3) environmental education, (4) scientific knowledge, (5) aesthetic enjoyment of landscapes, (6) biotic materials, (7) sense of place or cultural identity, and (8) natural medicine and biotechnology. To monitor these ecosystem services, the community of practice proposed eight state indicators (Table 2). Indicators were not defined for the remainder of the ecosystem services, which had frequencies below the cut-off value (9–19) (Table S3).

Table 1. Main regional drivers of marine ecosystem change in the AMB. Each regional driver is ranked based on the number of times that each was mentioned by work groups, and is complemented with the indicators assigned and examples of measurements for their monitoring as proposed by the workshop participants (workshop 1 and 3).

Regional Drivers of Global Change (Workshop 1)	Number of Times Regional Drivers were Identified by Work Groups (Absolute Frequency) (Workshop 1)	Indicators Proposed for Monitoring Regional Drivers of Global Change (Workshop 3)	Measuring Examples for Its Monitoring (Workshop 3)
Overfishing	4	Fish capture	Biomass of fish species landed
Marine coastal pollution from land resources	4	Wastewater treatment in coastal cities with more than 10,000 inhabitants	Number of coastal cities with more than 10,000 inhabitants without wastewater treatments
Intensive coastal urbanisation	4	Urban settlement in coastal municipalities	Km^2 of urban settlement in coastal municipalities/Km^2 of total area of coastal municipalities
Intensification of maritime traffic	4	Transit for transporting merchandise (e.g., oil tanker, goods platform) sailing in the marine basin	Number of merchant ships sailing in the marine basin
Invasive alien species	2	Areas identified with presence of invasive alien species	Number of areas identified with presence of invasive alien species
Climate change	2	Regional contributions (Andalusia and Rif) of total CO_2 emissions	Tonnes of total CO_2 emissions

Table 2. Marine ecosystem services impacted by the regional drivers. Each marine ecosystem is ranked based on the number of times that each was considered negatively impacted by regional drivers and is complemented with the indicators assigned and examples of measurements for their monitoring as proposed by the workshop participants (workshop 2 and 3). The ranking of ecosystem services was based on an absolute frequency over the cut-off value determined through bootstrap resampling (more details in Table S3).

Main Ecosystem Services Negatively Impacted by the Regional Drivers (Workshop 2)	Number of Times Ecosystem Services were Considered Negatively Impacted by the Regional Drivers by Work Groups (Absolute Frequency over the Cut-Off Value) (Workshop 2)	Indicators Proposed for Monitoring Ecosystem Services (Workshop 3)	Measuring Examples for Its Monitoring (Workshop 3)
Food (fish)	20	Fish capture	Biomass of fish species landed
Recreational activities and nature tourism	20	Ecotourism businesses with recreational activities in the marine and coastal environment.	Number of ecotourism businesses with recreational activities in the marine and coastal environment.
Environmental education	19	Active participation in environmental education programs on the coast.	Number of people involved in environmental education programs related to coastal environment.
Scientific knowledge	18	Cross-border cooperation research project in the marine basin.	Number of cross-border cooperation research projects in the coastal and marine basin.
Aesthetic enjoyment of seascapes and landscapes	17	Tourism in coastal protected natural areas.	Number of visitors in coastal protected natural areas.
Biotic materials	17	Phytomass production for aquaculture, industry, and food.	Number of factories of phytomass production for aquaculture, industry, and food.
Natural medicine and biotechnology	16	Phytomass production for research and biotechnology.	Number of factories of phytomass production for research and biotechnology.
Sense of place or cultural identity	16	Historical and cultural patrimony on the coast.	Number of interests in historical and cultural goods on the coast.
Legend			
Provisioning ecosystem service			
Cultural ecosystem service			

3.2. Evolution of Key Variables Monitored throughout the SL Process

The monitoring of the SL process revealed that the patterns of interaction and communication amongst the participants changed gradually and different social aspects emerged as the process evolved (Table 3). The initial position of the participants involved was based on a certain level of scepticism and distrust towards interaction with one another. This moved to (1) more proactive

and trusting interaction across social groups and frontiers, and (2) a constructive dialogue on the basis of a communicative action pattern to address sustainability issues from the ESA (Table 3). In addition, a total of 10 operative factors that positively influenced the SL process were identified. Table 3 describes the evolution of the patterns of interaction and communication during the workshops, the main social aspects that emerged through the SL process, and the key operative factors that positively influenced the social learning experience.

3.3. Assessment of the SL Experience by the Participants

Forty-three questionnaires were completed by the participants once the SL process concluded (30% scientists, 48% decision-makers and 22% local users, of which 52% were from Spain and 48% were from Morocco) (Table 4). Most respondents perceived that they had acquired new capacities in ecosystem services concepts and the ESA as a suitable framework for cross-boundary conservation. Accordingly, they expressed their willingness to continue to participate in transboundary platforms formed amongst science-policy-society entities to address sustainability issues in this marine region. Participants also stated that capacity building is needed when working with the ESA. There was a high level of similarity in the replies from stakeholder groups and countries.

Table 3. Evolution of key variables monitored throughout the SL process: patterns of interaction and communication, social aspects that emerged amongst the actors throughout the SL process and enabling factors that contributed to operationalise such processes. Changes in interaction and communication patterns are described based on the initial social pattern and its evolution in each workshop, including the main social aspects, derived from each social pattern, that began to emerge amongst the actors. The key operative factors that positively influenced the SL process are presented transversally through the three workshops.

Workshop	Social Changes in Interaction and Communication Patterns amongst the Actors throughout the SL Process		Main Social Aspects that Emerged amongst the Actors throughout the SL Process	Key Operative Factors that Positively Influenced the SL Process [1]
	Initial Social Pattern	**Evolution of the Social Pattern**		
W1	Actors from both countries initially showed a sceptical attitude towards the planned SL experience and a certain level of distrust of interacting with each other. More intense interaction was observed amongst actors of the same nationality than amongst actors belonging to the same stakeholder group (e.g., science, policy, and society). In the communication process, the actors showed a reserved attitude towards opining about the topics discussed. Asymmetries in education and training could have influenced this initial communication process. Several actors publicly expressed their concern about expressing their points of views without sufficient foundation in ESA (this was especially argued by the decision makers and local users). They manifested a feeling of insecurity and inequality.	Progressively greater interaction started to emerge amongst the actors. They started to positively value the efforts undertaken by the research team to (1) increase capacity building in ESA, and (2) create a space based on inclusiveness, collective learning, consensus, and transparency. The participants began to show a more confident attitude towards expressing their opinion. They established a respectful dialogue marked by the exchange of ideas from their own perspective. This helped actors to progressively increase their understanding of the AMB from different standpoints (e.g., ecological, governance, social, cultural, economic) and formulate a wider and integrated image of the AMB. The initial atmosphere of distrust between actors from both countries shifted, and the interaction and communication patterns became more recurrent.	Recognising a limited and varying degree of knowledge of ESA concepts. Beginning to feel more comfortable by personally experiencing participation in a process based on horizontal equality and inclusiveness. Starting to envision the AMB as a social-ecological system. Developing a more positive attitude towards cross-boundary interaction. Generating an incipient climate of mutual confidence between actors from both countries.	Shared leadership between knowledge brokers from Spain and Morocco. Clear communication of goals and outcomes of the study and researchers' intended roles in the exercise. Statement of a flexible, transparent, inclusive, adaptive and consultative transdisciplinary learning process. Training activities on ESA to build capacity in previous workshops' activities.
W2	More positive attitude towards the learning process and better interaction amongst actors' groups. Several participants expressed satisfaction with the structure and functioning of the previous workshop and the procedure to obtain consensus outcomes. It was identified that scientists initially dominated the dialogue marked by the inherent complexity of ecosystem services concepts (especially with regulating ecosystem services). Decision-makers and local users showed more reserved conduct in expressing their opinion due to their perceptions about limitations of their own knowledge.	The intensive training activities and the mutual learning process guided by the knowledge brokers helped to increase familiarity and knowledge on ecosystem services concepts. As actors increased their capacity in ESA, decision makers and local users became part of the interaction with researchers in a less hierarchical way. They began to express their values, worldviews and knowledge. Stakeholders' groups started to recognise the enrichment of individual perspectives and co-produced context-based knowledge based on science, policy and society support. As a consequence, more intense interaction and efficient dialogue began to dominate the workshop.	Elucidating the contributions from different types of knowledge and values to co-produce context-based knowledge. Recognising complementarities amongst science, policy, and society. Connecting actors through a culture of collective action for sustainability. Improving trust and mutual understanding across stakeholder groups.	Presence of translators to offer the possibility of actors expressing themselves in their native tongue. Informal meetings between and after workshop activities to build personal relationships. Workshops based on a horizontal structure to avoid power imbalances and hierarchical structures. Information and communication technologies outside meetings to facilitate constant communication.
W3	The interaction and communication patterns were more fluent and trusting amongst stakeholder groups. The participants became to realise that it was a process in which all opinions were taken into account to address sustainability issues through mutual learning and consensus. During the workshop activities actors established an open and constructive dialogue beyond the exchange of individual opinions.	The proposition of common indicators throughout the workshop helped actors clearly articulate actions in both countries that could generate adverse effects on the other. They understood that sustainability of the AMB and, hence, their well-being, could be driven in terms of mutual interest for diverse stakeholders from both countries (rather than the interest of each individually) and by coordinated management actions. This showed that (1) an environment of confidence and mutual understanding had begun to consolidate across knowledge domains and countries, and (2) a culture of collective construction for sustainability emerged gradually. Proactive interaction moving towards a communicative action pattern amongst the actors developed by the close of the workshop. Such constructive dialogue resulted in identifying win-win strategies amongst the institutions involved in order to obtain funding for their implementation in the medium-term.	Consolidating trust and understanding amongst actors. Elucidating the benefits of collaboration and synergies across knowledge domains and frontiers. Transforming attitudes towards collective action for a more sustainable and equitable governance. Emergence of a positive willingness to be involved in further processes focused on sustainability with policy implications.	Consensus over ground rules to ensure inclusive environment and co-produce consensus outcomes. Generation of practical outcomes that could be transferred to policy as a starting point to begin aligning conservation policies.

[1] The operative factors were identified throughout the three workshops.

Table 4. Number and percentage of questionnaire replies classified by respondent profile (scientist, decision maker and social actor), country (Spain and Morocco) and the type of reply (yes, no, do not know/do not answer and other).

Question	Respondent Profile	Questionnaire Replies by Respondent Profile (No./%)							
		Yes		No		Do Not Know/ Do Not Answer		Other	
		Spain	Morocco	Spain	Morocco	Spain	Morocco	Spain	Morocco
1. Are you in favour of holistic and sustainable management of the AMB?	Scientist	1/2	5/12	1/2	0/0	0/0	0/0	0/0	0/0
	Decision maker	8/19	4/9	0/0	0/0	0/0	0/0	0/0	0/0
	Social actor	20/46	2/5	1/2	0/0	1/2	0/0	0/0	0/0
	Total	40/93		2/5		1/2		0/0	
2. Do you think that the current governance system could be improved in the AMB?	Scientist	2/5	3/7	0/0	0/0	0/0	0/0	0/0	2/5
	Decision maker	8/19	4/9	0/0	0/0	0/0	0/0	0/0	0/0
	Social actor	21/48	2/5	0/0	0/0	1/2	0/0	0/0	0/0
	Total	40/93		0/0		1/2		2/5	
3. In your opinion, should governance in the AMB be based on ecological rather than socio-political boundaries?	Scientist	1/2	5/12	1/2.5	0/0	0/0	0/0	0/0	0/0
	Decision maker	8/19	2/5	0/0	0/0	0/0	0/0	0/0	2/5
	Social actor	20/45	2/5	1/2.5	0/0	0/0	0/0	1/2	0/0
	Total	38/88		2/5		0/0		3/7	
4. Do you believe that coordinated management between bordering countries could help to the sustainability of the AMB?	Scientist	1/2	4/9	1/2.5	0/0	0/0	0/0	0/0	1/2.025
	Decision maker	7/16	3/7	0/0	0/0	0/0	0/0	1/2.025	1/2.025
	Social actor	20/47	2/5	1/2.5	0/0	0/0	0/0	1/2.025	0/0
	Total	37/86		2/5		0/0		4/9	
5. Should sustainability issues be addressed through transboundary and science-policy-society interface approaches in the AMB?	Scientist	1/2	4/9	1/2.5	0/0	0/0	0/0	0/0	1/2
	Decision maker	6/14	3/7	0/0	0/0	0/0	0/0	2/6	1/2
	Social actor	20/47	2/5	1/2.5	0/0	0/0	0/0	1/2	0/0
	Total	36/84		2/5		0/0		5/12	
6. Would you like to continue participating in transboundary platforms formed amongst science-policy-society entities to address sustainability issues in this marine region?	Scientist	2/5	4/9	0/0	0/0	0/0	0/0	0/0	1/2.03
	Decision maker	7/16	3/7	0/0	0/0	1/2.5	0/0	0/0	1/2.03
	Social actor	21/49	1/2	0/0	0/0	1/2.5	0/0	0/0	1/2.03
	Total	38/88		0/0		2/5		3/7	
7. Do you consider that the social learning process helped you to acquire new knowledge about ESA as a governance practice?	Scientist	2/5	2/5	0/0	0/0	0/0	0/0	0/0	3/7
	Decision maker	8/19	2/5	0/0	0/0	0/0	0/0	0/0	2/5
	Social actor	21/49	1/2	0/0	0/0	0/0	0/0	1/2	1/2
	Total	36/84		0/0		0/0		7/16	
8. Is the ESA a suitable framework for transboundary conservation?	Scientist	1/2	3/7	1/2	0/0	0/0	1/2	0/0	1/2
	Decision maker	6/14	4/9	0/0	0/0	0/0	0/0	2/5	0/0
	Social actor	20/47	2/5	1/2	0/0	0/0	0/0	1/2	0/0
	Total	36/84		2/5		1/2		4/9	
9. Do you think that capacity building is needed when working with the ESA?	Scientist	1/2	4/9	1/2	0/0	0/0	0/0	0/0	1/2
	Decision maker	5/12	3/7	1/2	1/2	0/0	0/0	2/5	0/0
	Social actor	18/42	2/5	2/5	0/0	0/0	0/0	2/5	0/0
	Total	33/77		5/12		0/0		5/12	

Table 4. *Cont.*

Question	Respondent Profile	Questionnaire Replies by Respondent Profile (No./%)							
		Yes		No		Do Not Know/ Do Not Answer		Other	
		Spain	Morocco	Spain	Morocco	Spain	Morocco	Spain	Morocco
10. Do you believe that monitoring of drivers of global change and ecosystem services is useful for conservation policies?	Scientist	2/5	4/9	0/0	0/0	0/0	0/0	0/0	1/2
	Decision maker	6/13	3/7	1/2.5	0/0	0/0	0/0	1/2	1/2
	Social actor	17/40	2/5	1/2.5	0/0	2/5	0/0	2/5	0/0
	Total	34/79		2/5		2/5		5/11	
11. Should a common set of drivers and ecosystem services indicators be harmonised across boundaries for aligning marine conservation policies?	Scientist	2/5	4/9	0/0	0/0	0/0	0/0	0/0	1/2
	Decision maker	7/16	3/7	0/0	0/0	0/0	0/0	1/2	1/2
	Social actor	18/42	2/5	2/5	0/0	0/0	0/0	2/5	0/0
	Total	36/84		2/5		0/0		5/11	
12. Do you believe that a harmonised system of drivers and ecosystem services could promote sustainable and equitable governance in the AMB?	Scientist	2/5	4/9	0/0	0/0	0/0	0/0	0/0	1/2
	Decision maker	6/13	3/7	1/2	0/0	0/0	0/0	2/5	1/2
	Social actor	17/40	2/5	1/2	0/0	0/0	0/0	3/7	0/0
	Total	34/79		2/5		0/0		7/16	

4. Discussion

The study provided empirical evidence that the specifically designed SL process successfully facilitated dialogue and understanding of the ESA, thereby supporting its adoption as a governance practice for a marine ecosystem that is managed by two different countries with significant cultural and socio-economic differences. By and through the SL process, the individuals involved moved from a limited perception of the AMB as a socio-ecological system and a poor understanding of ecosystem services concepts (Table 3) to perceiving the ESA as a suitable framework for aligning conservation policies in this marine region (Table 4). These findings are in accordance with other contextual studies that have shown evidence of SL as a means to create the conditions for establishing a constructive and effective dialogue that contributes to generating transformative social change for sustainability (see, e.g., [22–25]). However, unlike these contextual studies, we were able to empirically show that this transformation of traditional attitudes of communication emerged through a specifically designed SL process in the ESA field (Table 3) that could support the re-orientation of policies towards ecosystem-based governance in the study area (Table 4).

As the research was exploratory in nature, the study contributed to a better understanding of the learning outcomes in the ESA field and the contextual conditions that facilitate such learning in this marine region [23]. Specifically, the main social effects on the individuals involved that were generated by the SL process, the key factors that enabled such a process under these specific cross-border circumstances, and the prominent role that SL can play in facilitating dialogue and understanding of the ESA for supporting its adoption as a governance practice, are described and discussed below.

An inherent limitation of the study is that its replicability may be limited depending on different socio-economic, cultural and political contexts. While this study provides insights arising from the particular case of the AMB, such insights provide a useful contextual orientation to other SL experiences [24,26,44]. The relevance of these empirical studies lies in the recognition that there are no standard SL processes for sustainability due to its dependence on context [53]. SL practices require participatory processes that are carefully structured, sequenced and oriented towards common goals through social research methods adapted to the context and actors involved [54]. Therefore, identifying context-specific needs and practices for SL is crucial to producing experience-based guidelines in other contexts [55]. Although much has been discussed about the challenges of the application of this type of insight in other cases, recent research suggests that replicability is possible by analogy, i.e., assessing whether the cases in question are sufficiently similar in relevant aspects [56]. Further research identifying similarities and dissimilarities across cases and contexts for assessing the applicability of SL processes will assist in applying such insights beyond generalisability and enter into the collective process of knowledge accumulation to support learning and social transformation towards sustainability [57].

4.1. Societal Effects of the SL Process in the Individuals Involved

The assessment of the societal effects of SL is considered to be an under-researched field of study [26,52], and this is particularly evident in the ESA field, where few empirical studies have addressed such topics (see, e.g., [31,32]). In this study, we identified the following main effects that the SL process in the ESA generated for the individuals involved. As described in previous studies [22,25], these effects did not appear simultaneously. On the contrary, they emerged progressively as the SL process evolved.

1. *A more inclusive and constructive dialogue on the ESA.* Patterns of communication amongst the members of the community of practice changed gradually throughout the SL process and moved towards a more inclusive and constructive dialogue on the ESA (Table 3). At the beginning, we observed that the communication process was constrained by the asymmetries in education and misunderstanding of ESA concepts amongst individuals (Table 3). These limitations are likely influenced by a variety of factors that scientific literature suggests can hinder the communication process when the ESA is employed as a common language [19]. Amongst these factors are the market-oriented connotation

attached to the ecosystem services concept [20] and the complex scientific terminology of the ESA [11]. Throughout the SL process, we observed that the intensified collective debates about drivers of change and ecosystem services helped the actors to acquire cognitive and practical competencies that facilitated dialogue about the ESA and a common understanding of its importance to support the governance model (Table 3). This allowed individuals to gradually become better informed and acquire more fluency in the language of the ESA to address the sustainability issues at stake (Table 3) [58]. The generation of this effective dialogue amongst individuals with a plurality of perspectives and values facilitated the effective statement of their positions and promoted more equal participation in the sustainability debate [59,60].

2. *A better understanding of the interconnectedness and interdependence of the social-ecological system in which actors are embedded*. This effect became apparent through the co-produced inventory of regional drivers of global change and ecosystem services by the community of practice (Table 1). One such example was when the actors addressed the relationship between fishing (corresponding to the 'food' category of the provisioning ecosystem services) (Table 2) and overfishing (corresponding to the 'overexploitation' category of the regional drivers) (Table 1). The monitoring of both issues was considered a priority for the AMB (Table 1; Table 2) for two main reasons: (1) the Spanish and Moroccan fishing sectors make up just over 1% and 2.5% of each country's annual GDP (Gross Domestic Product), respectively, and (2) historical conflicts exist between Spain and Morocco related to the overexploitation of fish stocks in Moroccan waters by Spanish fishing fleets [61]. Although this was a sensitive topic initially, a social shift occurred once the community of practice understood the current status of small pelagic species, such as Sardina pilchardus and Engraulis encrasicolus which are declining in number and suffer from overexploitation [62]. Following discussion, participants acknowledged that the adverse effects of human activities from both sides on the marine ecosystem's ecological integrity can result in disparate consequences across socio-political borders [33]. This acknowledgement led to a demonstrable shift in the participants' general perceptions of a governance system based on ecological rather than socio-political boundaries, and they acquired progressively wider notions of the importance of cross-border collaboration between the countries to progress towards sustainability in the AMB (Table 4).

3. *Enhanced recognition of science-policy-society complementarities to address sustainability issues*. This argument was endorsed by the results of the questionnaire administered after the completion of the SL process, in which the participants showed willingness to continue to participate in transboundary platforms formed by science-policy-society representatives to address sustainability issues in this marine region (Table 4). The recognition of complementarities resulted from a slow and progressive change in pre-defined perceptions across science, policy and society throughout the process. Initially, we observed general uncertainty regarding the roles that the researchers, decision-makers and local users would play in the SL process, which was shaped by the need to reconcile different knowledge, interests and values [43]. The co-production of context-based knowledge to generate outcomes from the integration of multiple disciplines and backgrounds such as ecology, governance and socio-economic sectors (Table S1) led to the diverse actors gradually recognising the enrichment of their individual perspectives (Table 3). As mutual understanding increased amongst the participants, they began to clarify their respective roles in the sustainability debate and recognise science-policy-society complementarities to address issues at stake. For instance, the role of scientists became prominent when the community deliberated on regulating ecosystem services. Most actors had shown a limited understanding of these types of ecosystem services (Table 3), which led to the prioritisation of provisioning and cultural services (Table S3). These findings showed that the existence of knowledge gaps could be related to the global assumption that people tend to identify tangible ecosystem services more easily than intangibles [63]. This discrepancy could be one of the reasons why fishing resources (provisioning services) and recreation values (cultural services) are usually the most easily perceived ecosystem services provided by marine ecosystems [64]. To address these

knowledge gaps, the community of practice called for researchers to build more capacity in ecological processes and ecosystem functions in this marine region.

4. *A gradual social transformation towards more sustainable and equitable governance.* The results confirmed that the SL process through the ESA progressively generated a shift in social perception towards more sustainable and equitable governance of the AMB. Such social change was initially conditioned by the participant's different value systems and mental models associated with the traditional models of governance. This starting position gradually shifted throughout the SL process, as evidenced by the ESA indicators co-produced by the community of practice. As indicators represent a simplified picture of factors crucial to understanding and managing complex social-ecological systems [65], these tools helped individuals to easily envision different and similar means of monitoring specific ecological processes across socio-political borders [33]. Most of the actors supported the implementation of a harmonised system of ESA indicators in the bordering countries, as reflected in the responses to the questionnaire. They perceived the common indicators dataset as a key tool for advancing towards equitable and sustainable governance of this marine region (Table 4). This statement was based on such indicators being scientifically adequate, robust, and useful for aligning conservation policies [47] to complement and align management strategies framed into conservation policies to protect and conserve the AMB in each country [39,40].

4.2. Factors that Facilitated the SL Process in the Governance Context of the AMB

Previous studies have demonstrated that SL cannot be imposed upon actors, but they can be positively influenced by the creation of the conditions that facilitate its emergence [23,25]. Identifying these conditions, and factors that act as driving forces for SL arise under specific situations is considered critical to assess if they can be transferred, adapted and applied in other cases [53]. We found that a variety of operative factors contributed to the creation of four relevant conditions that, in turn, facilitated a successful SL process.

1. *Generation of trust and shared understanding*. The creation of an atmosphere of trust and shared understanding is widely recognised as one of the most important factors to enable SL [25]. To attain this goal, we combined face-to-face interactions through the three workshops with the use of electronic communications (such as email and online platforms). This combination helped build proximity and ensure a constant flow of communication between the groups involved in the SL process [66]. In addition, we incorporated well-recognised factors that contributed to the generation of trust and common understanding from different dimensions. These included (1) the clarification of the goals and outcomes of the study from the beginning, which helped avoid unfounded expectations [43]; (2) the establishment of a validation procedure of the generated outcomes that promoted transparency, flexibility, and adaptive capacity in the exercise [67]; (3) the implementation of workgroup activities and plenary sessions that facilitated a sense of collective construction of outcomes [59]; and (4) the organisation of informal meetings, which allowed building personal interactions [25]. Acknowledging that the emergence of trust and shared understanding is crucial to establishing collaboration [68], the creation of such conditions became evident at the end of the SL process when win-win strategies were established amongst institutions from both countries to obtain funding for programme implementation in the medium term to continue to advance the sustainability of the AMB (Table 3).

2. *Facilitation of knowledge exchanges between actor groups across frontiers.* A major challenge for SL is to enhance knowledge exchange and knowledge co-production between diverse actor groups to jointly generate outcomes to achieve a common purpose [69]. Throughout the SL process, we identified two key factors, which were not mutually exclusive, that contributed to surmounting this challenge. First, a knowledge-brokering approach [45] based on shared leadership between Spain and Morocco was used. In addition to promoting knowledge transfer

amongst the participants, we observed that this shared leadership led to a balanced representation of both countries and strengthened relationships between the participants from the bordering countries. Considering that knowledge-brokering approaches can be adapted based on the context, actors and desired goals (see, e.g., [67,70]), our results suggested that a shared approach between brokers of different countries can be a key factor for facilitating knowledge exchange and building confidence in cross-border contexts. Second, the development of a clearly structured, systematised and timed learning process focused the collective deliberations on specific areas [71]. In our case, such areas encompassed some parts of the ESA: drivers and ecosystem services. This focus facilitated the progressive co-evolution of the participants' understanding of these social–ecological issues, helping them to accommodate diverse perspectives and gain in-depth knowledge to co-produce knowledge on these topics [69]. As a result, the community of practice generated an inventory of drivers that was coherent with the conceptual model of the MEA (2005), as well as other similar evaluations (see, e.g., [72]) (Table 1; Table 2).

3. *Promotion of more democratic participation*. An increasing number of scholars have drawn attention to the need to ensure symmetrical opportunities so that everyone can contribute to the sustainability debate [23,73]. We observed three key factors that positively influenced more democratic participation in the process by the individuals involved: (1) the training lectures on the ESA, (2) the presence of translators, and (3) the implementation of "consensus rules". First, we found that the training lectures by specialists in socio-ecological systems to build capacity for relative newcomers in the lexicon and ESA concepts, also helped the participants acquire new cognitive competences in these matters (Table 4). This competency led to the most of the participants perceiving that capacity building is needed when working with the ESA (Table 4). This recognition is in line with recent studies that underline that capacity building as part of a social process can help actors to better understand the complexity of the issue at stake and become familiar with it [74]. Second, we tested whether the integration of qualified translators with experience in the AMB would help the participants express their positions more precisely and effectively in their home language [58]. This process allowed everyone to participate fluently in the ongoing discussions throughout the SL process. Finally, we observed that the participants' approbation of formal rules in workshops that required that all results reach a consensus allowed the representation of everyone's perspectives and interests in the workshops' outcomes. This approach helped to avoid bias in the generated outcomes despite the unbalanced participation of stakeholder groups involved in the SL process due to resources and time constraints (Table S1).

4. *Co-production of practical outcomes*. The provision of results that are translatable to real outcomes is recognised as an incentive for SL processes [75]. The direct relationship between effort and time invested by actors in participating, and the usefulness of the generated outcomes resulting from their participation is usually the reason behind this incentive [68]. Under this assumption, we developed a SL process oriented towards the ESA as a governance approach in the AMB with the aim of co-producing indicators that could be used to align conservation policies between Spain and Morocco. To clarify the intention of generating practical outcomes, first, some of the training lectures were focused on increasing the normative capacities of the actors. The reason for this approach is that such capacities are recognised as a key element to link knowledge and policy action [76]. To ensure these capacities do so, the experts explained the legal frameworks that call for the implementation of marine conservation policies based on an ecosystem approach in Spain and Morocco. These frameworks are the Marine Strategy Framework Directive [39] and the Ecosystem Approach Strategy for all Mediterranean Countries [40]. Second, we presented a geoportal as an on-line repository to collect and promote information exchange for more sustainable governance of the AMB (http://www.iucn-geoportalboran.org/es/). We informed the participants that this repository included a specific section focused on indicators in which the co-produced outcomes could be applied as an input for aligning conservation policies between both countries. This ability was considered important to helping the actors envision

the practicability and usefulness of the outcomes generated from the SL process. As a result, questionnaires evidenced that most of respondents supported that a common set of drivers and ecosystem services indicators be harmonised across boundaries to align marine conservation policies (Table 4).

4.3. The Potential of SL in the ESA to Make It Relevant to Policy and Society

This case study demonstrated that the SL process offers a means to generate more productive and effective dialogue amongst the individuals involved, based on a communicative action pattern (Table 3). This insight is in accordance with previous studies that evidence SL as a means to create space for more communicative action [22,23,25]. This type of communication is the opposite of strategic action, which refers to a communication pattern based on negotiations amongst individual preferences and interests. This is usually the dominant pattern in participatory processes for natural resources governance [23]. In the area of sustainable governance, it is increasingly recognised that establishing communicative action between scientists and non-scientists is pivotal to awareness of the ESA, and taking responsibility and changing behaviours and institutions accordingly [23,24,53]. This social change is required to re-orient policies towards ecosystem-based governance for biodiversity conservation and the sustainable use of ecosystems [28,54].

In the ESA area, the establishment of a communicative action pattern between scientists and non-scientists by and through SL is particularly relevant for two main reasons. First, this type of communication contributes to informing and educating people on complex issues to ensure that everyone has equal opportunities to contribute to the sustainability debate and provide comprehensive and well-informed answers [22]. As a result, communicative action can play a crucial role in preparing actors to participate effectively in the decision-making process and, thus, facilitate more democratic participation in sustainable governance. Second, communicative action is required to produce three interdependent forms of knowledge to engage different stakeholder groups in the sustainability debate [23,60]. Such forms of knowledge refer to (i) *system knowledge* (focused on the analysis of complex sustainability issues from integrative perspectives), (ii) *target knowledge* (based on the determination of common goals for better addressing these sustainability challenges, and (iii) *transformation knowledge* (aimed at the identification of pragmatic pathways to solve them) [54,77]. These forms of knowledge lay the foundation for linking scientific advances, policy needs and societal concerns with the aim of developing a culture of shared responsibility and collective action for sustainability.

Hence, incorporating SL in the processes focused on making ESA relevant to policy and society can be a crucial step in progressing towards its implementation in governance practice. To attain such implementation, such processes must be integrated into transdisciplinary research work-schemes oriented towards sustainable transitions [78] through which scientists can adopt a more active role in the science, policy and social dialogue in the ESA. Such approaches should be conceived as iterative, open and ongoing processes embedded within institutional settings that evolve and change over time to enhance sustainable governance of social-ecological systems [79]. The operationalisation of SL can be especially suitable for the practice of assessing ecosystem services, in which transdisciplinary approaches based on reflection and learning are considered a prerequisite for promoting the recognition of a transformative vision of nature–human relationships by different actor groups [80].

5. Conclusions

A major constraint to the adoption of the ESA as a reference framework for ecosystem-based governance is attributed to the decision-makers' and general public's limited knowledge and understanding of scientific discourse on this approach. This study reveals the ability of an SL process to enhance dialogue and understanding of the ESA to support its adoption as a governance practice in a marine ecosystem managed by two different countries with significant cultural and socio-economic differences (Spain and Morocco). Specifically, the results showed that using the SL process, participants from bordering countries gradually acquired theoretical and practical competencies to (1) dialogue regarding

the ESA and (2) facilitate a shared understanding of the importance of progressing towards ecosystem-based governance. As a result of this process, the study revealed that the SL dynamic facilitated (i) a more inclusive and constructive ecosystem services dialogue, (ii) a better understanding of the social-ecological system in which the participants were embedded, (iii) an enhanced recognition of science-policy-society complementarities to address sustainability issues, and (iv) a gradual social transformation towards more sustainable and equitable governance. In addition, the results demonstrated that four relevant conditions to facilitate successful operationalisation of the SL process across borders. These conditions included (i) the generation of trust and shared understanding, (ii) the facilitation of knowledge exchanges between actor groups across frontiers, (iii) the promotion of more democratic participation, and (iv) the co-production of practical outcomes. These contextual insights provide empirical evidence for the prominent role SL can play in facilitating a shift in general perception to re-orientate existing governance practice towards the ESA. On this basis, it is argued that the operationalisation of SL in those processes focused on making the ESA relevant to policy and society is pivotal in order to progress towards its implementation in governance practice.

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