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Multi-uses in the Eastern Atlantic: Building bridges in maritime space

Helena Calado[a], Eva A. Papaioannou[b], Mario Caña-Varona[c], Vincent Onyango[b], Jacek Zaucha[d], Joanna Przedrzymirska[e], Timothy Roberts[f], Stephen J. Sangiuliano[g], Marta Vergílio[h,*]

[a] MARE – Marine and Environmental Sciences Centre, Faculty of Sciences and Technology, Department of Biology, University of the Azores, Rua da Mãe de Deus 13-A, 9501-801 Ponta Delgada, Portugal
[b] University of Dundee, Department of Architecture and Urban Planning, Matthew Building 13 Perth Road, DD1 4HT Dundee, United Kingdom
[c] University of the Azores, University of the Azores, Rua da Mãe de Deus 13-A, 9501-801 Ponta Delgada, Portugal
[d] The Maritime Institute in Gdansk, Długi Targ 41/42, 80-830 Gdańsk and University of Gdańsk Faculty of Economics 81-701 Sopot Armii Krajowej 119, Poland
[e] The Maritime Institute in Gdansk, Długi Targ 41/42, 80-830 Gdańsk, Poland
[f] Marine Scotland, Scottish Government, 375 Victoria Road, Aberdeen, AB11 9DB, Scotland, UK
[g] Marine Scotland, Scottish Government, Marine Planning & Policy Division, 375 Victoria Road, Aberdeen, AB11 9DB, Scotland, UK
[h] CIBIO – Research Center in Biodiversity and Genetic Resources/InBIO – Associate Laboratory, University of the Azores, Rua da Mãe de Deus 13-A, 9501-801 Ponta Delgada, Portugal

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ABSTRACT

Promoting co-existence and synergies amongst maritime uses is a key issue in maritime spatial management. Maritime economies are developing globally, leading to competition for marine resources and increasing environmental pressures. Multi-use (MU) is the joint use of marine resources in close geographic proximity. Focusing on the Eastern Atlantic sea basin, this article provides an overview of the MU context, existing and potential MUs, and the main drivers and barriers thereof. Based on desk research, literature review and stakeholder engagement, this study highlights differences between countries, regarding the implementation and advancement of sea strategies, and sector-specific and other Maritime Spatial Planning (MSP)-related policies. The legal, administrative and operational processes required to realise MUs are highly diverse and are related to the maturity of national maritime policies including MSP. A total of 25 MUs were identified and the three most relevant (Fisheries & Tourism & Environmental protection; Underwater cultural heritage & Tourism & Environmental protection, and; Offshore wind & Aquaculture) were analysed in-depth. The general conclusion refers to the need for multi-dimensional and multi-level policy actions overcoming technology constraints, and improving regulatory and policy frameworks. European strategies and actions might assist these efforts, however, the identified gaps are resolvable mainly at the national level within its specific context and through the engagement of innovative stakeholders. Recommendations for promoting MUs are presented. In summary, MUs are recognised as joint ventures, enabling synergy of interests and minimising conflicts. Findings suggest that early stakeholder engagement in the process of planning and implementing MU is necessary to achieve synergies, while respecting national planning cultures and existing MU experience leads to conflict solving solutions.

1. Introduction

Human use of the marine environment is expanding in volume, intensity and distance from shore (Collie et al., 2013). Maritime economies are developing across the globe, prompted by Sustainable Development Goals (SDGs) and the blue economy concept (United Nation Sustainable Development Knowledge Platform, 2018). SDG nº14 promotes the conservation and sustainable use of the oceans, seas and marine resources for sustainable development (United Nations, 2015). As recognised in the European Union's (EU) Blue Growth agenda, the ocean has great potential for economic growth, employment and innovation (COM, 2012), attracting new socio-economic demands and technological developments (Varjopuro et al., 2015). However, while new maritime activities appear and existing ones continue to expand, competition for space intensifies (Christie et al., 2014) and seas and oceans are under increasing pressures and threats, such as over-

* Corresponding author.
E-mail addresses: helena.mg.calado@uac.pt (H. Calado), e.papaioannou@dundee.ac.uk (E.A. Papaioannou), cmario1985@hotmail.com (M. Caña-Varona), v.onyango@dundee.ac.uk (V. Onyango), jzaucha@im.gda.pl (J. Zaucha), joaprz@im.gda.pl (J. Przedrzymirska), Timothy.Roberts@forestryandland.gov.scot (T. Roberts), Stephen.sangiuliano@arisaiginc.com (S.J. Sangiuliano), marta.hs.vergilio@uac.pt (M. Vergílio).

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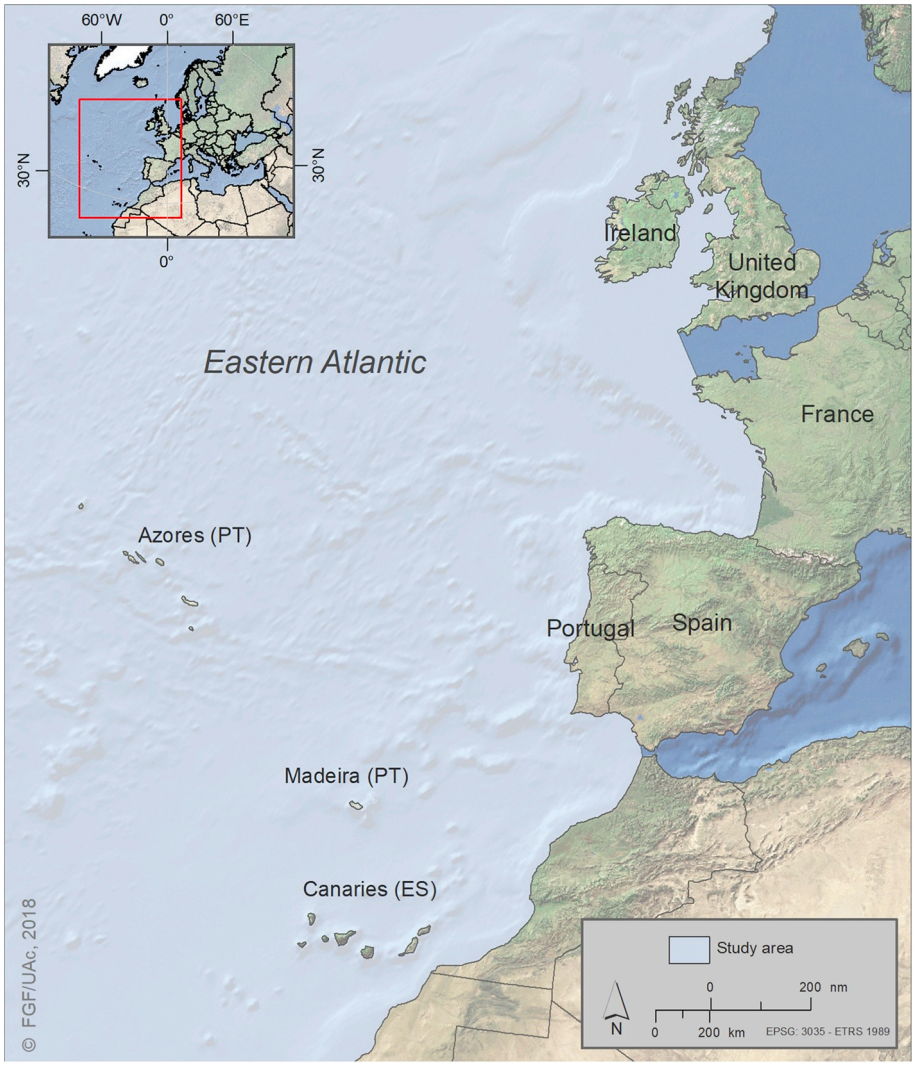

Fig. 1. Location of the study area.

exploitation, climate change, pollution and declining biodiversity (JOIN, 2016; Kyriazi et al., 2016). Proper functioning of many marine ecosystem services (Liquete et al., 2013; Lillebø et al., 2016) has been constrained (Dobson et al., 2006) and evolutionary resilience of land-sea interface regions are being compromised (Davoudi et al., 2016).

In this context, the relevance of the multi-use (MU) concept becomes evident. MU is understood as the joint use of marine resources in close geographic proximity, involving either a single user or multiple users performing multiple uses (Zaucha et al., 2016). This concept moves away from an exclusive single-use resource rights perspective to an inclusive sharing of resources. MU is an umbrella term that covers a multitude of combinations of maritime uses. The term is used in relevant research to include both “hard” and “soft” uses, namely combinations requiring technological and innovative solutions, typically involving the energy sector and the use of offshore structures (e.g. offshore wind and aquaculture); and combinations of maritime uses/sectors that do not include infrastructural integration, but the use of existing infrastructure or co-location (e.g. tourism and fishing) respectively (Lukic et al., 2018). Schupp et al. (2018) provide a comprehensive review of the current state and envisaged development of MU, categorising the concept of maritime MU. In short, MU is a policy innovation allowing a more rational and environmentally friendly pursuit of the Blue Growth agenda.

Combining uses reduces spatial pressures and can thus provide further socio-economic and environmental benefits. Some MU combinations require hard investments and long processes, while others emerge more readily through the sharing of space and resources (Przedrzymirska et al., 2018a). Nevertheless, for all MU combinations, policy frameworks strongly determine their existence and development due to their substantial transaction costs and high level of externalities. MU is in the interest of several policies, namely maritime, environmental and several sectoral policies. Maritime Spatial Planning (MSP) seems of particular relevance, being a public policy which encourages prudent and rational organisation of the use of limited maritime space and the interactions between its uses, protecting the environment, and to achieve social and economic objectives (Ntona and Morguera, 2018; Douvere, 2008). MSP enables integrated decision-making on the human uses of the sea (Pomeroy and Douvere, 2008; Janssen et al., 2015) through the effective implementation of Ecosystem-Based Management (EBM) (Ansong et al., 2017). As a key policy response to regulatory and ecological challenges in the marine environment (Richie and Ellis, 2010), MSP reduces conflict amongst competing uses and provides multiple benefits to existing activities (Ansong et al., 2017), reconciling economic and ecological concerns (Gee, 2018).

Promoting co-existence and synergies amongst maritime uses is a key issue in MSP. Synergies can refer to mutually beneficial use of ocean space and resources, but equally to shared infrastructure, technology or human resources (International Council for the Exploration of the Sea, 2018). The MSP Directive (Directive 2014/89/EU) also recognises the importance of co-existence of uses. The MSP approach to

synergies, co-existence and other related concepts, directly links to the concept of MU. But practical experiences of MU are limited (Przedrzymirska et al., 2018b). By bringing MU into discussions on Ocean Management and MSP, this paper seeks to investigate the linkages between MU drivers and barriers through an integrative lens. The addressed research question, therefore, has two components: (i) is there an integration of MU in existing governance, management, strategies and ocean policies in countries of the Eastern Atlantic (EA), and: (ii) is the integration of MU within MSP a prerequisite for MU development?

This article provides an overview of MU across the EA sea basin, assessing to what extent the development of MU is hampered by existing legal and management mechanisms and other barriers. The implementation and advancement of governance, sea strategies, sector policies and other MSP-related policies are largely distinct amongst the different countries. This, together with the different balances between traditional and emerging maritime sectors throughout the EA makes the case-study area particularly interesting for assessment. In this respect, this paper also analyses the policy framework integral for MU development, considering both existing and potential MU, and the main drivers and barriers thereof. Ultimately, key lessons to develop MU will be drawn from the experience of the EA.

2. Methodology

2.1. Study area

The study area focused on the Eastern Atlantic (Fig. 1). This sea basin comprises the Atlantic waters belonging to the five EU Member States with an Atlantic coastline (Table 1): France (FR), Ireland (IE), Portugal (PT), Spain (ES), and the United Kingdom (UK), including the Portuguese archipelagos of the Azores and Madeira, and the Spanish archipelago of the Canary Islands.

The EA is mainly dominated by deep oceanic basins (Johnsen et al., 2002), with three distinct seabed zones: a shallow continental shelf descending to 200 m in depth (along the European coast), an area of quickly increasing depth (continental slope), and the deep ocean basin (located in the Mid-Atlantic Ridge together with chains of seamounts). The abyssal plain is approximately 5000 m deep (OSPAR, 2010). Coastal geomorphology and dynamics are mainly shaped by highly energetic tides, waves and strong winds (Álvarez-Fernández et al., 2017).

The general ocean circulation is dominated by the Gulf Stream, also known as the North Atlantic Current, bringing relatively warm, nutrient and oxygen-rich water to European coasts (OSPAR, 2010).

The EA has rich biodiversity, especially in areas with particular topographic features, such as the Mid-Atlantic Ridge, seamounts, hydrothermal vents and submarine canyons. Vulnerable habitats, such as cold-water coral reefs and deep-sea sponge aggregations, host highly diverse biological communities with endemic species. Large submarine canyon systems provide pathways to the deep sea for sediments and nutrients and contain diverse biological communities, including several endemic species (OSPAR, 2010).

The EA maritime area provides the basis for a wide range of human uses and services including food, transport, energy and amenities for millions of people. Coastal areas in the EA are often highly populated, industrialised or used intensively for agriculture (OSPAR, 2010). This intense use, together with climate change, has resulted in considerable pressure on the marine environment, causing significant environmental problems and loss of marine life (Suárez de Vivero and Rodriguez Mateos, 2016; OSPAR, 2010).

Maritime-related industries and services contribute to roughly 1.9% of the employment in the EA (OSPAR, 2010), and the total average contribution to the Gross Domestic Product (GDP) in the five countries is 1.82% (Table 1). Tourism, fisheries and maritime shipping are the economic sectors with a greater interest in this area. Aquaculture, military activities, sand and gravel extraction, and oil and gas (O&G) are also important, while maritime renewables are increasing. Coastal tourism is of great value in the EA, with a large number of tourist destinations attracting millions of tourists annually, being the largest employer of the maritime industries in France, Portugal and Spain. Nature, biodiversity, cuisine and culture are assets that can be exploited further to attract non-seasonal tourism and help support quality jobs (COM, 2011). Fisheries have been a main pillar of the EA economy (COM, 2011), providing approximately one third of landings of the EU's fishing fleet by volume, however, many coastal communities have suffered from a decline in fisheries-related employment. The North East Atlantic Fisheries Commission (NEAFC) has banned bottom trawling to ensure the long-term sustainability of deep-sea fish stocks and to preserve vulnerable marine ecosystems (COM, 2011).

In terms of MU, these characteristics create favourable conditions

Table 1
Exclusive Economic Zones, claims of Extended Continental Shelf, and general aspects of the maritime economy in the Eastern Atlantic (sources: authors, based on and adapted from (Suárez de Vivero and Rodriguez Mateos, 2016; Service hydrographique et océanographique de la marine, 2017; Marinha Portuguesa, 2017; Suárez de Vivero JL, 2011; GRID Arendal, 2014; OSPAR, 2010; World Travel and Tourism Council, 2015)).

Country	Exclusive Economic Zone (sq. km)	Extended Continental Shelf (sq. km)	Persons employed (thousands)	Total contribution to GDP 2015 (%)	Tourism and recreation		Fisheries
					Direct contribution to employment 2015 (thousands)	Total contribution to GDP 2015 (%)	Capture production 2010 (t)
France	349,000[a]	–	322.8	1.25	1188.5	9.1	426.51
Ireland	409,929	425,400[c] 38.100 (Porcupine Abyssal Plain) 387,300 (Hatton-Rockall Area)	38.4	1.82	36.1	5.5	318.94
Portugal	1,656,181	2,115,100	171.2	3.33	357.2	16.3	222.94
Azores	926,149						
Madeira	442,316						
Mainland	287,715						
Spain	758,253[b]	350,800[c]	193.3	0.94	833.7	14.2	968.66
Galicia		52,000					
Canaries		298,800					
United Kingdom	756,639[a]	160,200[c] (Hatton Rockall)	634.4	2.19	1554.3	10.7	612.66

[a] Includes the North Sea basin.
[b] Includes part of the Mediterranean Sea basin.
[c] Includes part of the 81.700 sq.km of the joint submission by FR, IE, ES and UK on the Celtic Sea and Bay of Biscay.

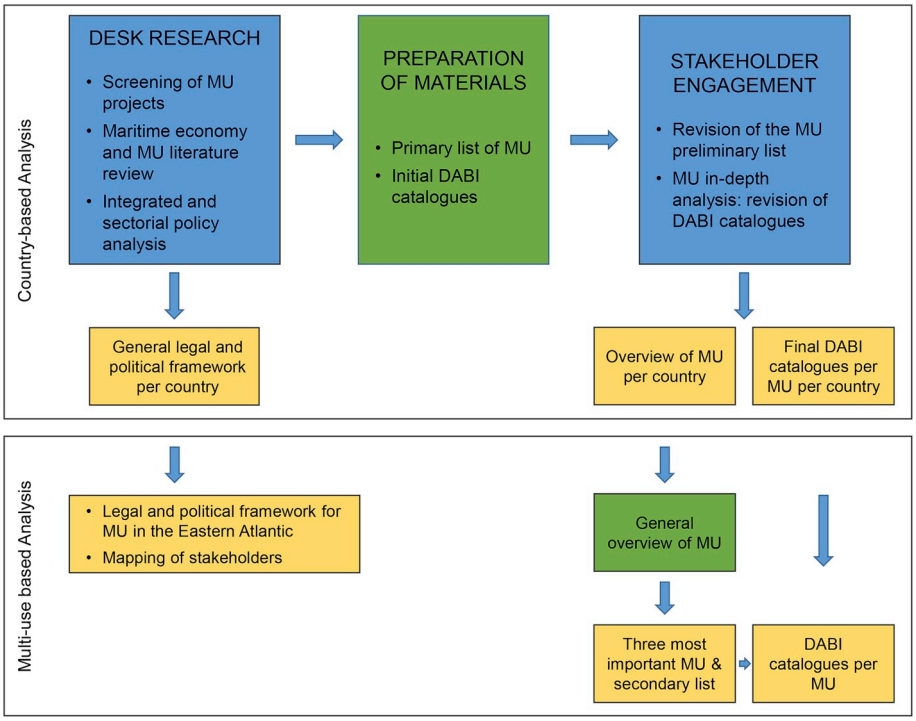

Fig. 2. Methodological steps used in the study (adapted from Zaucha et al. (2016)).

for hard integrated and innovative MU, typical for sea areas with significant depth and to both soft and hard MUs closer to shore.

2.2. Multi-use analysis in the Eastern Atlantic

The adopted methodology is based on the one developed during the MUSES project (funded by the EU's Horizon 2020 research and innovation programme, whose aim is to explore the opportunities for MU across the five EU sea basins (Zaucha et al., 2016)).

There are two main steps: (1) a country-based analysis, and; (2) MU-based analysis in the sea basin (Fig. 2). This methodology provides the necessary research tools to examine both the theoretical understanding and practical experience related to MU.

2.2.1. Country-based analysis

The first step consisted of desk research to analyse each country in the EA, including Ireland, Portugal, and the Atlantic coasts of France, Spain and the United Kingdom.

The desk research involved screening present and past MU projects, and reviewing available scientific literature of MU and relevant legal and political frameworks in each country. The latter included integrated maritime policy, MSP framework and plans, and sectorial policies. The analysis focused particularly on searching for evidence of MU promotion and development, including investigation of similar terms: co-location, synergies and co-existence, each of which have distinct legal and political contexts (national, sea basin and international/European). The international/European contexts are important in framing the general top-down approach to the management of maritime activities, and subsequently the implementation of MU. At the sea basin level, policy can promote or hinder the development of MU and can include sectoral strategies. However, the national level plays a pivotal role in policy implementation. Therefore, this initial analysis entails an overview of the legal and political contexts, and an in-depth analysis of the MU-specific context. This is performed for each of the five countries, and subsequently integrated to provide a synthesis for the EA sea basin.

Additionally, the analysis contributed to preparations for the stakeholder engagement process: a preliminary list of existing and potential MUs, as well as the most relevant stakeholders to engage with, and a preliminary identification of the Drivers, Added values, Barriers and Impacts (DABI) for the identified combinations. Drivers are factors promoting, supporting or strengthening the development of MU; Added values are the positive effects of establishing or strengthening MU; Barriers are factors hindering the implementation of MU, and; Impacts are the negative effects of establishing or strengthening MU. DABI are used as a means to qualitatively understand the potential and difficulties of MU development, as well as the effects of implementation, and were thematically categorised according to the nature of the issues for the development of MU (e.g. political, administrative, economic, social, environmental).

Stakeholder engagement facilitated information gathering on the implementation of MU in each country and DABI, especially where the concept of MU is not yet well-known or implemented. This process was developed through face-to-face and/or remote interviews, as well as through discussion groups in MUSES-organised workshops, including two EU-wide workshops and one local workshop in the UK. Key stakeholders were selected to engage with, from amongst those identified during the desk research, based on representativeness over key MU sectors, knowledge or responsibility across more than one maritime sector, and involvement in past MU-related projects. A total of 43 key stakeholders participated/collaborated in interviews. All participants signed a consent form, prepared and developed under the ethical requirements formed as part of the MUSES Grant Agreement to ensure that the EU ethics requirements under H2020 funded projects were met. The consent form, and the Informed Consents Procedures Manual that partners have followed during the course of the study, was approved by The Innovation and Networks Executive Agency (INEA), the funders for MUSES at the beginning of the project.

During interviews and workshops, stakeholders were asked to collaborate in two main exercises. The first aimed to identify current and potential MU in the given country, adding to and revising the list of MUs proposed by the research team. The second aimed to perform a more in-depth analysis of one or more MUs, according to stakeholders' expertise. Stakeholders were also asked to add to, and revise,

preliminary DABI catalogues. The integration of stakeholders' responses and contributions filled knowledge gaps from the desk research as to the status of MU development in each country, the results of which were subsequently aggregated to provide a general overview of MU development at the sea basin level.

2.2.2. Multi-use-based analysis

The second step of the methodology consists of an in-depth analysis into MUs identified during the desk research and stakeholder engagement, including DABI catalogues. Combinations considered include relatively common uses of the sea (fisheries, aquaculture and marine renewable energy) and other less common uses identified in the literature (environmental protection) defined as any area-based management solution for marine space, where measures are set up to achieve long-term conservation objectives, while other uses are managed within a clearly defined geographical scope. These include, amongst others, Marine Protected Areas (MPA), Natura 2000 sites, Biosphere Reserves, and Ecologically or Biologically Significant Marine Areas.

The selection criteria of the three most relevant MUs for the EA included: (i) a certain MU being present in several countries, following desk analysis and validation by stakeholders; (ii) the policy framework, notably provisions on the use of maritime space, and; (iii) accounting for the most prominent maritime activities, while ensuring both 'soft' and 'hard' uses were represented.

3. Results

3.1. Country-based analysis

During the desk research, literature and several projects were analysed and screened with relevance to the five countries addressed. Most projects do not refer directly to the joint development of maritime uses or to the MU concept, such as projects focused on information collection and production/organisation (e.g. MESH–Atlantic, AtlantOS and Atlas, covering France, Portugal and Spain). A few, however, address the concept or raise awareness to the need of creating synergies. The COEXIST project, in the same three countries, for example, provides opportunities for co-existence, such as between tourism and recreational fishing, ecological and oceanographic research and data obtained from tuna trap cultivation (joint-venture). The SEANERGY 2020 project, exploring renewable energy in the Portuguese case, suggests that opportunities should be sought for co-existence or MU, such as using the spaces between adjacent wind farms for other maritime uses (e.g. fishing or lower frequency shipping lanes). This has the knock-on benefit of reducing turbulence and regenerating wind resources. The AQUASPACE project, which explores ways of overcoming impediments to aquaculture expansion in all EA sea basin countries, analysed the limited level of planning for aquaculture implementation and other offshore activities as a barrier, and identifies the possibility of installing offshore concessions, which can be combined with other activities as an opportunity. Three major groups of projects were screened: (i) focus on marine renewables (e.g. WaveBoost and WETFEET in Portugal, and SpORRAn, NorthSEE and CEFOW in the UK with no MU integration); (ii) focus in aquaculture (e.g. OstraLusa in Portugal, also with no MU integration); (iii) focus on MSP integration (e.g. PISCES, Celtic Seas Partnership, and SIMCELT in the UK and IE; TPEA on transboundary MSP in the UK, Spain and Portugal, with no mention to MU but to space efficiency, H2Ocean dedicated to MU purposes platforms, and ENTROPI between France and Spain proposes the deployment of MU). As a final example, the MARIBE project, which aims to address the feasibility of MU platforms (i.e. trailing of MU concept), suggests that blue growth sectors should cooperate with other sectors via MU of space or MU platforms in order to foster new business partnerships.

3.1.1. International and European context

In order to understand the impact of international actions on MU deployment, several international and European initiatives have been screened, in particular those with relevance to maritime space and strategic blue framework. These ranged from: (i) a global planetary approach within the frame of the United Nations (e.g. Convention on the Law of the Sea (UNCLOS), Convention on Biological Diversity (CBD), UNESCO Convention on the Protection of the Underwater Cultural Heritage or the Espoo Convention), to; (ii) European Directives (e.g. Birds, Habitats, Water, O&G, Renewables, the Marine Strategy Framework and the MSP Directives), and; (iii) EU policies and strategies (e.g. Integrated Maritime Policy, Smart Sustainable and Inclusive Growth, Blue Growth, Fisheries, Aquaculture, Bioeconomy and Climate Change).

Beyond the MSP Directive (Directive 2014/89/EU), which defends MSP as a vehicle to promote the sustainable co-existence of uses and, where applicable, the appropriate apportionment of relevant uses in maritime space, the MU concept is generally absent and not explicitly promoted in the remaining initiatives and screened documents. Although documents screened in (i) and (ii) do not hamper MU development, only at the EU level (iii) is the pursuit of spatial efficiency and co-existence directly referenced.

3.1.2. Sea basin context

Ocean governance brings together intergovernmental organisations and economic, political and sectoral organisations (i.e. fisheries management bodies) that play a role in the EA regional context. Besides the EU, in the EA the most relevant regional organisations, mechanisms and instruments to maritime space management are common to each of the five countries. These instruments are adopted mainly on a voluntary basis (e.g. soft laws) and towards environmental concerns or advisory councils in specific sectors (e.g. fisheries).

The organisations and mechanisms covering the EA either directly promote environmental goals (OSPAR Convention) or Sustainable Fisheries (International Council for the Exploration of the Sea (ICES), North East Atlantic Fisheries Commission (NEAFC), International Commission for the Conservation of Atlantic Tunas (ICCAT), and North Atlantic Salmon Conservation Organisation (NASCO)). Being sectoral approaches, naturally, MU consideration is absent. The EU Atlantic Strategy, identifying key challenges and opportunities to create sustainable jobs and growth, covering the coasts, territorial and jurisdictional waters, aims to respond to the challenges of delivering growth, reducing carbon footprint, ensuring sustainable use of marine natural resources, setting up effective responses to threats and emergencies, and implementing an EBM approach (COM, 2011). However, it does not integrate MU in the Strategy. Similarly, the Action Plan for a Maritime Strategy in the Atlantic, that comprises a set of action areas for research and investment to tackle the challenges identified in the Atlantic Strategy (COM, 2013), does not reference MU. The Action Plan for the Atlantic Strategy, for example, could constitute an interesting instrument to promote MU in the EA by addressing the challenges and aiming to drive the "blue economy", and by promoting networks and research agendas.

3.1.3. National context

Analysis of policies, mechanisms and instruments, including national and/or sectoral plans, in the five countries allowed the identification of trends regarding their approaches to MSP and MU (Tables 2–4). The main difference amongst the five analysed countries in the EA is the level of maturity of maritime policies, especially of MSP. The UK has a high level of maturity and MU related policies in place; Ireland and Portugal are at a medium level of maturity with some instruments for MU in place; Spain and France have their action limited by the fact that the MSP Directive has only very recently been transposed.

In the UK, although no explicit reference to "multi-use" appears in relevant documents, the concept is directly addressed, with key policies

Table 2
Most relevant national/regional policies, mechanisms and instruments in the five countries identified in the EA sea basin (source: own elaboration based on data collected within the MUSES project). X – reference to co-existence of activities; XX – reference to MU; grey colour means existing in the country.

Policies, mechanisms and instruments	France	Ireland	Portugal	Spain	United Kingdom
National ocean strategies	X		X		
Transposition of the EU Marine Strategy Framework Directive			X		
Transposition of the EU Directive on Maritime Spatial Planning		X	X		
Policy of Planning and Management of the National Maritime Space			X		XX
Maritime spatial plans implemented					
Legal-administrative framework for maritime activities					
Fisheries				XX	XX
Aquaculture				XX	XX
Renewable energies		X			XX
Tourism					XX
UCH					
Marine environmental protection					
Shipping					XX
O&G					XX
National funding for the blue economy			X		

promoting the "co-existence" or "co-location" of activities: The UK Marine Policy Statement (UK-MPS) (HM Government, 2011) clearly states that the process of maritime planning should recognise that demand for ocean space will continue to increase and, as such, maritime planning should: (i) achieve integration between different objectives; (ii) manage competing demands taking an ecosystem-based approach; (iii) enable the co-existence of compatible activities, and; (iv) integrate with terrestrial planning. It also states that a key principle in maritime planning will be to "promote compatibility and reduce conflict" of activities (HM Government, 2011). Furthermore, the UK-MPS explicitly mentions that Marine Plans could "encourage co-existence of multiple uses". Co-existence of maritime activities is frequently mentioned in the UK-MPS as a concept to be promoted by decision makers, including key maritime sectors such as fisheries, and aquaculture.

In Portugal, Law 17/2014 (approving the basis for the Policy of Planning and Management of the National Maritime Space) and the Decree-Law 38/2015 (defining, amongst others, the legal regime of MSP instruments private use of maritime space, establishing the framework of the Planning and Management of the National Maritime Space) do not directly reference the development of MU, although the criteria to be applied in the case of conflicting uses are supporting the MU concept. The integration of the MU concept and vision in Portuguese politics is inherent in the interpretation of these criteria, where it is stated that priority should be given to uses or activities with higher social and economic advantages or to be given to those that present the maximum co-existence of uses or activities.

In other cases, despite national legislation and marine plans not addressing the MU concept, some sectoral strategic documents refer to the combination of activities or synergies amongst users. An example is the Irish Offshore Renewable Development Plan (Irish Government/Department of Communications Energy and Natural Resources, 2014), which sets forward a list of project-level mitigation measures addressing interactions with other maritime users, namely to "consider spacing of turbines at wide enough intervals to permit use of mobile fishing gear" (Irish Government/Department of Communications Energy and Natural Resources, 2014). Furthermore, the Plan's assessment suggests that no major impacts from turbines are expected on Natura 2000 sites, suggesting the activities could potentially co-exist.

3.2. Multi-use based analysis

Desk research and the stakeholder engagement process allowed the identification of several MUs with different potential. A total of 25 MUs were analysed for the EA (Table 5). MUs were classified as: past/existing and on-going (including pilot/test trials in the real environment); potential with at least one of the uses in place, and; potential with none of the uses yet in place.

Table 3
State of the MSP process in each country of the EA sea basin (source: own elaboration based on data collected within the MUSES project).

MSP status	France	Ireland	Portugal	Spain	United Kingdom
Legal framework	Yes	Yes	Yes	Yes	Yes
Agencies in charge	General Secretariat of the Sea (SGMer)/ Inter-regional Directorates for the Sea (DIRMs)	Department of Housing, Planning and Local Government	Ministry of the Sea, Maritime Resources General Directorate (DGRM)	Ministry of the Agriculture, Fisheries, Food and Environment (MAPAMA)	Marine Management Organisation (MMO); Marine Scotland; the Welsh Government; Department of Agriculture, Environment and Rural Affairs
Process	On going	On going	On going	Not started	Plan approved
Sectoral (strategic) spatial plans	Aquaculture Energy (not exclusively maritime)	Aquaculture Energy	Aquaculture	Aquaculture	Aquaculture Energy

Table 4
Overview of the existence of MU in national strategic and legal documents (e.g. sea strategies and MSP) in the five countries identified in the EA sea basin (source: own elaboration based on data collected within the MUSES project). FR – France; IE – Ireland; PT – Portugal; ES – Spain; UK – United Kingdom.

Reference to MU	Country
MU in national legislation	UK
MU at an individual administrative decision level	UK
Economic incentives for MU	IE[a], PT[a], ES[a], UK[a]
MU at the MSP level/National marine plans	IE[b], UK[b]
MU in strategic documents	FR[c], IE[d], PT[e], UK[b],

[a] Not directly to MU but available from general and sectoral policies.
[b] Not as MU but other terms and concepts (co-location/co-existence).
[c] National Strategy for Sea and Coast, Technical notes of the Ministry of Ecological and Solidarity Transition.
[d] Stated in sector and research policies.
[e] Specific sector regulation mention possibility of combination.

3.2.1. *Most relevant combinations*

The three most relevant MUs identified in the EA sea basin were Fisheries & Tourism & Environmental protection, Underwater cultural heritage (UCH) & Tourism & Environmental protection, and Offshore wind (OW) & Aquaculture. For these three MU, an in-depth overview and assessment of main DABI is provided below.

- Fisheries & Tourism & Environmental protection

Where fishing legally takes place within areas of environmental protection (even with some restrictions), it is considered MU. Conservation is a "use" in the sense that sufficient value is attributed to conserved resources resulting in restrictions on other possible uses. Tourism is a growing sector across the entire sea basin, with increased demand for new touristic experiences and the diversification of tourist products. Activities such as diving, swimming, surfing, and sailing take place in MPAs with some level of formal or informal organisation. With advancements in policy and market consolidation, as well as growth of organisations, new tourism opportunities emerge (e.g. tourists fishing alongside experienced fishers and being directly involved in the activity). Under certain conditions, tourists may be involved in a range of fisheries activities, such as on-board visits to open-sea fish catching. When these activities take place in protected areas (coastal or offshore), it is considered MU of Fisheries & Tourism & Environmental protection.

According to interviewees, this MU is very common along the French coast. Two locations were discussed in detail: Parc Naturel Marin d' Iroise and the coasts of Marennes and Oléron island. Analysis of DABI factors suggests that the main drivers promoting this MU are environmental (e.g. sustainable fisheries and eco-tourism development in MPAs) and drivers in relation to other uses (e.g. importance of fishing and tourism activities in the area) (see Table 1 in (Calado et al., 2019a)). Barriers are mainly due to legal (e.g. security of tourists in vessels), administrative (e.g. fragmentation of regulation) and social factors (e.g. resistance to changes in some fishing communities). Added values are mainly economic (e.g. local economic growth) but also relate to governance (e.g. promotion of development of local strategies) and society (e.g. preservation of identity). Negative impacts are mainly environmental (e.g. tourists' potential impact on the protected area) and related to other uses (e.g. increasing conflicts with other uses).

In Spain, this MU is the one most frequently mentioned by stakeholders, and is present in the country's Marine Sanctuaries, including Isla Graciosa, Isla de Tabarca, Isla de la Palma, and La Restinga in the Atlantic. Analysis of DABI factors suggests that the main drivers relate to single uses (e.g. tourism growth or reducing pressures from industrial fisheries) and economic factors (e.g. new income sources) (see Table 1 in (Calado et al., 2019a)). Management plans are the fundamental tool

Table 5
MU for the EA sea basin by country (source: own elaboration based on data collected within the MUSES project). Blue – past, existing (indicated with letter 'E') and ongoing MU, including pilot/test trials in the real environment; orange – potential MU with at least one of the uses already in place; yellow – potential MU with none of the uses yet in place.

MU	France	Ireland	Portugal	Spain	United Kingdom
OW & Aquaculture					
OW & Tourism					E
OW & Fisheries					
Aquaculture & Tourism			E		
Fisheries & Tourism & Environmental protection	E		E		
UCH & Tourism & Environmental protection			E	E	
Tidal & Wave					E
OW & Wave					
OW & Environmental protection					
OW & Shipping terminal					
Wave & Aquaculture					E
O&G & Tourism & Aquaculture					
Aquaculture & Environmental protection	E			E	
O&G & Aquaculture & Tourism/leisure activities					
Shipping terminal & Renewables & Aquaculture & Tourism					
Aquaculture & Renewables					
Scientific research & Environmental protection					
Military activities & Scientific research					
Scientific research & Underwater cultural heritage					
Tourism & Environmental protection					
Tidal (lagoon) & Tourism & Recreation & Aquaculture					
Tidal (stream) & Environmental protection					E
Tidal (stream) & Tourism					E
Shipping terminal & Environmental protection		E			
Aquaculture & Environmental protection & Fisheries		E			

with which maritime uses in MPAs are established. Despite imposing restrictions (barriers) at times, management plans are the most important driver for this combinations including MPAs. A secondary driver of importance identified by stakeholders is marine plans. Barriers mainly relate to administrative (e.g. licensing fragmentation) and social factors (e.g. limited expertise in MU). According to stakeholders, licensing for carrying tourists in fishing vessels, and the required security checks for this, are complicated procedures. Added values are diverse, highlighting environmental added values together with those related to technical, societal and governance aspects. Negative impacts are mainly economic (conflict between uses).

In Portugal, the fishing sector is a historically important sector of social and economic significance. Interviewees identified a number of locations in mainland Portugal where this MU is being developed, namely Vila Nova de Mil Fontes, Aveiro (regeneration of traditional fisheries), Sesimbra, Viana do Castelo and Peniche. Drivers with high importance for this combination are societal (namely, the current socio-economic crisis of the fishery sector whereby there is increasing demand for fish products, along with a need to diversify fishing activities while maintaining the identity of traditional fishing communities) and legal (the creation of legislation focusing on the combination of uses would favour the development of the MU) (see Table 1 in (Calado et al., 2019a)).

It is also worth noting that the creation of financial incentives and

new sources of income, as well as increasing awareness of the need for responsible tourism activities, are important drivers for this MU. There are several economic, technical and societal added values resulting from this MU. One of the most relevant is technical added values (the contribution of the MU to the recovery and conservation of artisanal activities); importantly, the development of new market opportunities for both traditional fisheries and tourism (e.g. integrative income for fishers) and the further development of eco-tourism are also positive impacts from this combination. For fishers, pesca-tourism is an opportunity to share and maintain their culture, while raising public awareness of the problems they are faced with. Although, these benefits exist only if the licensing rights are obtained by fishers and not tourist companies (Piasecki et al., 2016). Identified barriers are related to legal, administrative, economic, social, environmental and technical factors. The technical factors are the most relevant, indicating that limited expertise in tourism activities, especially the lack of soft skills of fishers, is a barrier to MU development. In the social category, the lack of ideas for organised economic business and limited expertise in MU are also significant barriers to this combination. Coordinated strategies to improve fishers' skills are important in overcoming these limitations. Only two negative factors were identified, one societal and one economic, related to possible conflicts with other maritime activities that might arise from this MU or discontent towards users developing alternative activities by colleagues.

- UCH & Tourism & Environmental protection

UCH includes all traces of human existence with cultural, historical or archaeological value which have been partially or totally submerged under water, periodically or continuously, for long (UNESCO, 2001) or shorter periods of time, usually designated as Historical Relevant Sites (Zaucha et al., 2016; Haponiuk, 2015). This definition includes sites, structures, buildings, artefacts and human remains, vessels, aircrafts, other vehicles, or any part thereof, their cargo or other contents, together with their archaeological and natural context, and objects of prehistoric character. Where tourism is practiced within areas of environmental protection and in presence of UCH, the UCH & Tourism & Environmental protection combination, all three activities benefit from each other in terms of protection and valorisation: for example, UCH is protected in MPAs, tourists benefit from visiting both UCH and marine natural values, and MPAs attract certain tourists.

In France, this combination was identified by interviewees within the marine park of Iroise. According to the DABI analysis, main drivers for this combination are environmental (e.g. diversity of marine environmental and UCH resources to be explored) and legal (e.g. UNESCO Convention on the Protection of UCH) (see Table 2 in (Calado et al., 2019a)). Only societal barriers are present (e.g. risk of looting and/or destruction of underwater archaeological sites). The most important added values are societal (e.g. prevent the destruction of submerged archaeological sites) while negative impacts are also societal (risk of looting and/or destruction of underwater archaeological sites).

The MU was also identified by interviewees to exist in Spain, specifically in Islas Cíes (Galicia) and Bahia de Santander (Cantabria). Certain stakeholders referred to Spain's current promotion of UCH and the inherent risks of publicising their exact location. According to stakeholders' opinion, policy, economic and societal aspects are the most important drivers in Spain for enhancing this combination, while administrative barriers and economic risks persist (see Table 2 in (Calado et al., 2019a)). Added values are numerous and relevant, such as the increase of local revenues related to tourist services, while social and environmental negative impacts are a legitimate threat due to the potential damage caused by tourists to the fragile environment or to UCH.

In Portugal, stakeholders identified a number of areas where this MU exists. The evolution of this MU is mostly driven by environmental and societal factors, due to the diversity of marine environmental and UCH resources to be explored, and the protection of the destruction of submerged archaeological sites (see Table 2 in (Calado et al., 2019a)). Societal factors were the most relevant added values, including the following: discovery, recovery and maintenance of cultural and natural heritage; preventing the destruction of submerged archaeological sites, and; increased tourist awareness towards environmental protection and UCH and provision of new jobs, due to new museums and information stands on land. Also very relevant is increased local revenues related to tourist services and improved control regarding UCH. The most relevant category, according to stakeholders' opinion, includes technical barriers because tourists need specialised skills (e.g. diving certification) or the design of new equipment (e.g. vessels to observe the sea floor) is required for the MU, as well as the possible increase of natural deterioration of archaeological material and the current lack of human resources and means in government. The main negative impacts of this combination are the risk of looting/stealing of the underwater archaeological sites and destruction of their contents, and the risk of congested diving sites that may decrease the level of tourist satisfaction. There is also a risk of damaging natural marine ecosystems.

- OW & Aquaculture

Growing needs for efficient use of maritime and ocean space, coupled with renewable energy targets and food quality and security concerns, contribute to the drive for combining aquaculture with existing or new OW developments. Combinations of the two uses vary and can include direct attachment of aquaculture installations (e.g. mussel longlines) to OW turbines; the sharing of maritime space with uses co-located side-by-side, or; the sharing of accommodating vessels and onshore infrastructure.

In the UK, trials to investigate the potential of shellfish aquaculture within an OW farm were performed within the North Hoyle OW farm (RWE) in the summer of 2010 by Deepdock Ltd., a mussel cultivator. The activity involved seabed ranching/cultivation, namely the growth and subsequent harvesting of mussel spats collected from the wild and placed in the OW farm (Shellfish Association of Great Britain, 2012; Syvret et al., 2013).

According to analysis of DABI factors, OW developers view the MU as an opportunity to gain public support and community approval for their development, as part of their Corporate Social Responsibility (CSR). Aquaculture developers, particularly shellfish farmers, view this MU favourably because of green credentials and spatial efficiency. Key barriers to the further development of the MU include financial risks to OW developers, especially in the case of a direct physical link between aquaculture installations and turbines. In the case of the North Hoyle trial, the main reasons for stalling further commercial MU development included: (i) staggered timing for MU, (ii) increased vessel traffic for aquaculture resulting in increased health and safety risks, and; (iii) the development being too small to support profitable aquaculture operations. With the gradual move of OW further offshore, access to the OW site and distribution of the final product could pose barriers in MU for shellfish farmers. Although offshore areas may be highly productive, it could be difficult to predict when to harvest, bring onshore and distribute (the live market usually has a 2-day window for distribution). Another major issue identified during stakeholder engagement was security of tenure for aquaculture developers. As a general rule, OW farms are licensed for 25 years, after which infrastructure has to be decommissioned. This could mean that the aquaculture operation also has to leave the site, even if it has been established as a profitable operation. Proof-of-concept is required from developers before engaging further and at a commercial scale with the MU. Funds for MU development could come from sources such as the European Fisheries Fund (EFF). However, the main tool to promote the MU was suggested to be MSP as it allows and incentivises MU, as well as frames the relationship between developers.

This potential MU has been identified in Basque Country, along the coast of Bizkaia province of Spain, by interviewed stakeholders. The

presence of the Biscay Marine Energy Platform (BIMEP), and the development of mussel aquaculture in close proximity, constitute a potential MU according to stakeholders. BIMEP is an infrastructure to demonstrate the technical and economic viability and safety of the energy converters for optimising the level of commercial development (Ente Vasco de Energia, 2017). Rather than OW farms being in place, they are projects on paper. According to stakeholders' opinion, economic, environmental and technical drivers are the most relevant for this combination (see Table 3 in (Calado et al., 2019a)). Administrative and environmental barriers are the most significant. Added values are numerous and diverse, meaning that this MU is perceived as having very positive effects across several aspects. Negative impacts are not considered relevant. OW is not currently present in Portugal or France, although the first installation in Dunkirk (FR) has started. Therefore, the MU is not expected to develop commercially in the near future. However, it can learn from the lessons from other sea basins and countries, as it has been identified by stakeholders as one of the most promising MUs to be further developed across the EA in the years to come.

4. Discussion

The comprehensive analysis of maritime activities and the MU context in each EA country allowed for reflections concerning identified main obstacles, key findings and lessons learned.

4.1. Is MSP a prerequisite for MU?

The UK demonstrates more a mature and consistent development of maritime management policies. However, it is not clearly related to the stage of the MSP process per se, as there are other sectoral policies in place in parallel, or even prior to MSP initiatives. What is consistent is that the UK leads in maritime economy sectors (with the exception of tourism) and this is driving the need for MSP and MU. Conversely, France has well-established planning traditions and strong sectoral policies but no maturity in integrated MSP processes. However, tourism-driven activities support MU, along with strong environmental management policies. Thus, the first key finding is that there is no deterministic logic between MSP and MU: MSP does not need to be in place for MU to exist. However, the existence of single uses, with explicit spatial sector policies and demands, increases the need for marine management and MSP (as is demonstrated in the combination of OW & Aquaculture).

4.2. What are key barriers for MU development?

When extending the analysis beyond a review of the integration of MU within MSP, with the objective of establishing other factors that shape MU development, it is important to summarise the main barriers (Table 6) to developing the three most important MUs across the sea basin. Despite the distinctive nature and drivers of each of the three MUs in question, they all share major common characteristics - barriers fall into the following general categories: legal framework, licensing procedures, capacity building, time constraints, and, engagement with other uses. This commonality highlights another key finding from our research, notably the added value of raising MU awareness, especially at supra-national levels. This could include teaching MU at relevant MSP and policy training courses (Calado et al., 2019b).

The main barriers for the MU Fisheries & Tourism & Environmental protection primarily include legal/regulation/administrative aspects (e.g. licensing, security of passengers and sectoral fragmented regulations), and the resistance to change of small fishing communities. As for UCH & Tourism & Environmental protection, concerns are similar, but here opposition stems from the competent regulatory agencies (impacts on the UCH sites-damage, destruction, robbery). A main barrier is the lack of expertise and technical skills of personnel/human resources in relevant positions and fields, including diving and UCH. For the combination of OW & Aquaculture, again, the main barriers relate to the absence of clearly defined administrative and legal processes, insufficient coordination between different administration levels and complex permitting procedures, as well as the absence of local skills and professionals (job creation is for non-locals) and the shortage of specific technologies.

4.3. How can key barriers be lifted?

For MU Fisheries & Tourism & Environmental protection, the integration of tourism and fisheries policies within limits set by environmental protection would be one of the enabling factors for further development. This will require new practices and processes as well as a change in the mind-set of actors in order to become multi-functional (fishers and tourist agents). Likewise, for MU UCH, tourism and environmental protection if synergies between comprising uses/activities were coordinated and integrated, the MU would certainly expand. In addition, the existence or the development of better norms/rules and underwater equipment for diving, signalising and protecting UCH sites would help overcome the resistance of governmental agencies and non-governmental organisations. The existence of maritime management plans for sites, or MSP, would enable rules to be more effectively set in place and thus engender confidence in MU practices. R&D knowledge and technological capital transference between countries appears to be the most efficient way to enable MU OW & Aquaculture. In addition, reasonable regulations which do not restrict but rather provide a clear perspective for investing in MU, along with CSR for OW required in sectoral plans, would likely promote social acceptance. There is a need for funds to be set aside for this MU along with systems of shared investments spreading development risks amongst partners.

To boost MU across the EA, it is necessary to overcome: (i) technological constraints, particularly relating to wave technology and combinations of different offshore energy infrastructures, and; (ii) the absence of concrete guidelines for regulators in the planning and licensing of maritime activities and/or licensing activities as MU, to

Table 6
Main barriers for the most important MUs in the EA.

Fisheries & Tourism & Environmental protection	UCH & Tourism & Environmental protection	Offshore wind & Aquaculture
• Legal aspects concerning the security of passengers on vessels; • Resistance to change in small fishing communities; • MU is not adequate for mass tourism due to environmental protection and limited capabilities of fishing fleets; • Limited expertise, lack of ideas for organised economic businesses of fishers	• Risk of looting, deterioration and destruction to UCH sites; • Permitting and competences fragmented in different administrations; • Risk of reduction in the budgets dedicated to the protection of heritage; • High specialisation and lack of human resources	• Delaying timing for co-location when OW developer is already in place; • Health and safety risks due to increased vessel traffic; • OW farm may have insufficient small size to allow for profitable aquaculture; • Inconsistent or uncoordinated policy making within countries (local/regional/federal levels); • Lack of clear, or complex administrative and legal procedures to implement offshore projects; • Resistance of civil society and fishers to OW farms

Table 7
General recommendations for overcoming obstacles to MU development in the EA.

Fisheries & Tourism & Environmental protection	UCH & Tourism & Environmental protection	Offshore wind & Aquaculture
• Disseminate evidences of responsible and quality food; • Attract new tourism segments based on learning about environmental and socio-economic aspects; • Demonstration projects (showing how MU reduces impacts in the environment); • Increase awareness for marine resources conservation providing grounds for acceptance; • Support new market opportunities for both traditional fisheries and tourism sectors; • Training of specialised professionals (fishers trained to work with tourists); • Assure integrative income for fishers	• Codes of Conduct and regulations on prevention of destruction of UCH sites; • Assure the provision of funding to UCH and environmental protection; • Account and demonstrate the increase of local revenues related to tourist services; • Promote programs of nautical equipment and vessels that enable appreciation; • Design a production chain that involves technology actors (vessels/equipment), heritage authorities and tourism; • Dissemination of unknown history; • Discovery, recovery and maintenance of cultural and natural heritage; • Promote education of tourists towards environmental protection and UCH; • Training of specialised professions – diving guides specialised in UCH; • Cooperation and integration of public agencies/programs in natural/cultural protection with tourism	• Early stakeholder engagement on MSP/ sectoral spatial plans/projects; • Campaign evidences of the efficient use of maritime space and resources; • Disseminate results on nutrient control, responsible farming and energy production; • Pilot projects for efficacy demonstration; • Account and demonstrate energy gains; • Social sharing of revenues (e.g. inputting energy into public services); • Mature and simple licensing procedures; • Adequate technical level of development of both uses; • Financial, licensing and fiscal incentives for MU

ensure stakeholder communication and engagement in relevant sectors, plans, and projects. These gaps and factors seem to be mainly resolvable at the national level and do not necessarily require international co-operation or EU intervention. The MU identified in this paper are more driven by local actions, within specific contexts and shaped by innovative stakeholders, even when coming from mature, traditional uses, such as fisheries and tourism. In summary, it is important for MU development that MUs are recognised as joint ventures enabling the synergy of interests and minimising conflicts. For this, early stakeholder engagement in the process of planning and implementing MU is necessary.

4.4. Key considerations for MU development

A fourth key finding relates to identifying those crucial aspects that condition MU development.

To that end, it is essential to assess the environmental impacts, but also positive environmental effects for the most relevant MUs in the EA (Calado et al., 2017). Combinations including Environmental protection are considered to have positive effects on the environment, since they intrinsically include conservation goals. This in turn results in positive effects with respect to public awareness. For renewable energy combinations, including OW & Aquaculture, although renewable energy sources have positive environmental effects, it is important to assess and mitigate potential negative impacts from MUs on fauna. Importantly, MU including OW are considered to have negative visual impacts, given the need for large infrastructure in the marine space (Calado et al., 2017). However, these impacts can be minimised with early stakeholder engagement within the decision-making process.

As for social aspects, Fisheries & Tourism & Environmental protection had a positive effect on fishers' capacity building, who gained new capacities with the combination. MUs involving renewable energy have positive effects regarding new scientific knowledge, given their relatively small presence in the EA, and limited technological readiness level. All combinations have largely positive effects on employment and revenues at local levels, although those requiring a more specialised labour force (MU involving the energy sector) may have lower impacts. Opposition from local communities are common in OW energy developments, given the visual impacts (Calado et al., 2017). MU integrating tourism activities are considered to contribute to the diversification of the tourism industry given the new options of tourism promoted, but may have negative impacts on congesting sites, due to the risks associated with mass-tourism or the intensification of tourism activities (Calado et al., 2017). Fisheries are traditional uses that may be regenerated mainly through tourism and environmental protection.

The main lessons learned from existing, successful MUs include: coordination and integration are frequently the most important factors; MU may scale-up positive impacts from single-uses, but this will depend on the context and has yet to be demonstrated; simple and efficient legal requirements are a key positive factor. Therefore, a fifth key finding is related to the need of combination of the MU enhancing legal framework with policy efforts conditioning administrative and management routines (e.g. spirit of cross-sectoral collaboration). National MU promoting outreach and demonstration activities might shape their importance.

5. Conclusions and final recommendations

The main characteristic of the EA sea basin is its heterogeneity. The EA is clear in its environmental and biophysical features which constrain or enable specific uses and MU (e.g. tidal-range) but it is also present in other important features for MU. For instance, the legal/administrative and operational processes required to set MU in place are highly diverse and related to the level of maturity of national maritime policies. The analysis of the combinations in the sea basin shows that MUs relate to the maturity and robustness that single uses currently have in place. In the case of "soft" MUs, when a specific sector is mature, along with sectoral (spatial) planning policies being in place, and growing perspectives, it can lead the way to other uses to combine with or be programmed together from start. That is the case for tourism-driven MUs (a mature, planned, growing sector across the EA). As for more technological MUs, the same assumptions can be made but it is also important to situate the technological, environmental and physical factors which support or constrain specific uses, such as renewables and aquaculture. Unsurprisingly, more "hard" technological uses appear in the UK while the Iberian countries have more "soft" MU combinations. Therefore, it seems understandable that the key actions for enhancement of MU in the EA should be of national character. MU may scale-up positive sector impacts but this perception is not homogeneous and it has to be demonstrated; simple, efficient and secure legal requirements are a key driving factor. While MSP is not necessary for MU development, it can play an important role in its promotion as a forum where maritime sectors may find synergies for integration.

Based on these conclusions, some general recommendations can be drawn for the development of the three most relevant MUs for the EA (Table 7).

At the sea basin or EU levels, MU can be supported by raising awareness, monitoring of MU deployment, experience sharing,

education and addressing technological gaps (joint research). Joint international projects can cover initial transaction costs of MU deployment. While existing EU sea basin strategies are not MU oriented, they may also support the establishment and maturity of single uses that in turn will drive others to jointly develop. If the MU concept gains a more prominent role in national policy agendas, it might lead to some types of integration attempts in-line with the open method of coordination related to MU development at the sea basin level. It is important that MU related collaboration will encompass both sea basin and cross-border levels, as it is a crucial condition for improving overall MSP and maritime governance. As argued by Hassler et al. (2018), transnational working groups or workshops focused on specific issues can be one way to identify and act upon potential synergies. MU represents an opportunity for co-existence, synergies and integration among maritime activities where multiple benefits from social, economic and environmental points of view would arise.

Declarations of interest

None.

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