Technical Study

MSP as a tool to support Blue Growth

Roundtable discussion paper: Aquaculture, 11/12 October 2017

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Marine Aquaculture

1 Introduction

Overall size of the sector and industry structure

Mature ☐ Growing ☒ Emerging ☐

The marine aquaculture sector covers the farming of aquatic organisms (finfish, mollusks, crustaceans, algae (macro and micro), reed). EU aquaculture production is mainly concentrated in 5 countries: Spain, United Kingdom, France, Italy and Greece (making up 76% of total volumes/weight and 75% in value of EU28 totals Aquaculture value)[1;].90% of the businesses of the sector are considered micro-enterprises with less than 10 employees. The main species produced at sea are Atlantic salmon (UK as main producer), oysters (France as main producer), mussels (Spain and main producer) and seabream and seabass (Greece as main producer). Algae aquaculture activities are currently at a very low scale in Europe although some algae products are widely used in the food industry (i.e. agar, carrageenan and alginates)[2.]

The entire sector´s sales volume and value reached 1.3 million tonnes and 4.5 billion euros in 2014 (of which 0.988 million tonnes and 3.375 billion euros where for the marine sector)[3]

Marine Aquaculture Value Chain

(with * those steps with marine spatial implications. Note: Micro algae production takes place on land, in raceways, photo reactors or in fermenters. So does reed production. Thus, no marine spatial implications for those unless done in coastlands)

[1] Scientific, Technical and Economic Committee for Fisheries (STECF) – Economic Report of the EU Aquaculture Sector (EWG-16-12); Publications Office of the European Union, Luxembourg
[2] 2012 Blue Growth Study - Scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Subfunction 2.3. Marine aquatic products. Brest/Utrecht/Brussels. DG MARE. No. MARE/2010/01
[3] DCF- Data Collection Framework data 2014

Time horizons			Spatial characteristics		
Seasonal	Yes		Place based	Yes & No	Place based while production and non-place based while transport.
Planning horizon	2020		Linear	No	
Development time	Varies depending on production cycles of species (e.g. 9-18 months at sea for salmon; 2 months to 3 years at sea for oysters).		Distance to shore	Dependent on aquaculture technology type (i.e. coastal, fixed cages, floating cages, longlines, net pens, etc.) and produced specie´s biological and environmental characteristics.	
Lifetime of installation	5-30 years	Licensing typically for 10 years (can vary between 5 – 30 years).	Water depth	It varies depending on aquaculture technology type and location and produced specie´s biological and environmental characteristics.	
			Moving	Yes & No	See place based explanation.
			Land Sea interaction	Yes	

2 Relevance

Legend: ◆ = low presence ◆◆ = medium presence ◆◆◆ = high presence

➡ = none / limited potential ➡➡ = medium potential ➡➡➡ = high potential

Status in each Sea Basin (Table 1[4])

Sea Basin	Presence	Potential	Comments
Atlantic	◆◆◆	➡➡➡	Higher potential for development
Baltic Sea	◆◆	➡	Its development potential is limited due to the risk of the eutrophication in the Sea Basin.
Black Sea	◆	➡➡	Medium potential for development
East Med	◆◆◆	➡➡➡	Higher potential for development
North Sea	◆◆	➡➡	Medium potential for algae aquaculture. Some experimental seaweed farms and "Integrated Multi-Trophic Aquaculture (IMTA)" systems
West Med	◆◆◆	➡➡➡	Higher potential for development

Status in each EU Country (Table 2[5,6])

Sea Basin	Country	Presence	Potential	Comments
Atlantic	Ireland	◆◆	➡➡	Production of Blue mussel, Atlantic salmon and Pacific oyster. Modest recovery in overall volume and a greater increase in overall value as value added strategies kick in (marketing, high end or niche markets such as organic salmon- origin green

[4] Table based on expert judgment and assessment of the sources quoted throughout the document.

Legend: ◆ = low presence ◆◆ = medium presence ◆◆◆ = high presence

➡ = none / limited potential ➡➡ = medium potential ➡➡➡ = high potential

[5] Table based on expert judgment and assessment of the sources quoted throughout the document.

[6] Scientific, Technical and Economic Committee for Fisheries (STECF) – Economic Report of the EU Aquaculture Sector (EWG-16-12); Publications Office of the European Union, Luxembourg

				differentiated products). Production expansion is limited by a number of factors (availability of licensed ground, raw material cost, distance to market, diseases and harsh environments) [7]. Some seaweed farms also exists, although at the experimental phase.
Atlantic	Portugal	◆	➡➡➡	Production of fish, sea bass sea bream, sole, turbot oysters and clams in brackish and marine waters (93% of total). The market is not self-sufficient and there is a dependence of imports to market supplies. However, an increase in production is expected due to new production farms for mussels and oysters (shellfisheries) and the increasing turbot production. Until 2017, when a new aquaculture law was introduced, production expansion was limited by limited licenses and long administrative delays.
Atlantic / North Sea	United Kingdom	◆◆◆	➡➡	Production of salmon, finfish, trout, sea bass, mussels and other shellfish species. Certification, technological improvements (decreasing cost per unit effort and better biological conditions for survival, size, etc.) and the consolidation of a mature market will be main future development drivers.
Atlantic / West Med	France	◆◆◆	➡	Largely dominated by bivalve mollusks farming, being the main producer of oysters (covering 88% of the total EU28 production). However recent (2014) high mortality rates and poor growths of oysters in France could trigger the aquaculture sector in this country and production is not expected to increase significantly in the coming years. Some seaweed farms also exists, although at the experimental phase.
Atlantic / West Med	Spain	◆◆◆	➡➡➡	Due to natural conditions, one of the main features of the Spanish aquaculture is diversity, with marine products, fish, mollusk and algae. Furthermore, Spain is the main producer of Mediterranean mussels. It is a sector showing a positive tendency due to an increase in product´s prices, more efficient production and investments in renovation and improvements.

[7] https://www.ifa.ie/sectors/aquaculture/aqua-facts/

Baltic Sea	Estonia	-	-	For human consumption not existing / not planned for development in the near future. However there is reed mariculture which is very popular.
Baltic Sea	Finland			Slight increase in development. However the Finnish environmental policy has been preventing from intensifying the production, limiting its overexploitation and making some Finnish aquaculture producers to move their production to Sweden where the environmental regulation if more favorable for the aquaculture production. Offshore open sea production has been piloted recently.
Baltic Sea	Latvia	-	-	Not Existing / Not planned for development in the near future.
Baltic Sea	Lithuania	-	-	Not Existing / Not planned for development in the near future
Baltic Sea	Poland	-	-	Not Existing / It is planned to initiate marine fish and mollusk farming by 2020. Some experimental grounds for mussels in the Puck Bay.
Baltic Sea	Sweden			Sweden has higher sea food net imports than net exports, which implies a positive development for the Swedish aquaculture farmer. The aquaculture industry sees a positive future and there are several large applications for expanded and/or new permits for fish production. However, in 2017 the Swedish government decided not to grant more finfish licenses and ordered the reduction in volumes farmed at some locations. Thus, its potential for further development is low. Sweden is also researching on the potential of mariculture for protection of the environment.
Baltic Sea / North Sea	Denmark			Mostly production of Blue mussels on longlines. Mussel farming in Denmark is struggling and the future for this segment is very unpredictable. However, mussel and seaweed farming as a mean to reduce the environmental impact from the sea cage farms are expected to grow, if the farms are allowed to expand production.
Baltic Sea / North Sea	Germany			The marine sector consists mainly of blue mussel producers. There is no political will to establish new aquaculture facilities due to competition of offshore wind farms and tourism in marine areas. Some seaweed farms also exists, although at the experimental phase.

Black Sea	Bulgaria	◆	➡➡➡	Mostly by loglines mussels production. High development opportunities. However the Bulgarian market is still developing and work remains to be done regarding facilities development.
Black Sea	Romania	◆	➡➡	Limited development envisaged, but some potential for marine aquaculture (mussels).
East Med	Croatia	◆◆	➡➡➡	Marine production consists on finfish (sea bass and sea bream), Bluefin tuna and shellfish (oysters and mussels). The Croatian National Strategic plan for aquaculture 2014-2020 predicts a significant increase of aquaculture, especially for Bluefin tuna production as it is representing more than half of total Croatian production value.
East Med	Cyprus	◆	➡➡➡	The aquaculture industry in Cyprus is mainly based on marine fish production. For the next years marine aquaculture in Cyprus is expected to continue increasing its production due to the increase of the global demand and the new markets.
East Med	Greece	◆◆◆	➡➡➡	Greece is a significant world producers and it was the leading European producer before the beginning of the Greek crisis is in 2009. The aquaculture industry in Greece is dominated by marine finfish farming in off-shore cages, mainly sea bream and sea bass. This is followed by mussel cultivation. In the near future, rise of the production and rise of investment is expected for the Greek aquaculture. Further consolidation of the mussel sector is expected. A considerable rise of the production is not expected if key issues of the mussel aquaculture in Greece are not addressed (e.g. identification of new suitable areas, legislating unlicensed production and the establishment of early-warning systems related to climatic factors).
East Med	Slovenia	◆	➡➡	The aquaculture industry in Slovenia consists of production of sea bass, sea bream and mussels. Marine fish farming practice is normally intensive and takes place in floating platforms where the cages are submerged into the sea. Shellfish farming practice is extensive and takes place in lines of floating buoys linked together, where longlines with mussels are suspended. Future development of Slovenian

				mariculture is strongly conditioned by the small size of the Slovenian Sea. Thus production development will come in hand with new developments and increasing production capacity.
East Med / West Med	Italy	◆◆◆	➡➡➡	Marine aquaculture in Italy includes both shellfish (mussels and clams) and finfish. Sea bream and sea bass are the major finfish species. Italy is the main European producer of clams. The Italian Strategic National Plan for Aquaculture highlighted the need to identify new areas for the marine aquaculture farms.
North Sea	Belgium	-	-	Not Existing / Not planned for development in the near future
North Sea	Netherlands	◆◆	➡➡	Producing mussels and oysters mainly. Mussel sector shows a good performance along the years, however its high dependence on seeds and increasing problems with larvae and seed mortality due to the presence of viruses is expected to drop production in coming years. Some seaweed farms also exists, although at the experimental phase. Also some experiments dealing with "Integrated Multi-Trophic Aquaculture (IMTA)" systems.
West Med	Malta	◆	➡	The Maltese aquaculture industry is exclusively based on marine fish with the Atlantic Bluefin tuna as the main produced species (63%) followed by Gilthead sea bream (32%).

3 Status and evolution Analysis

Current Status

Production of sea food for human consumption is still dominated by fishing activities (75% of the share) and there is still high dependency on sea food products imports in EU (47.5% self-sufficient). In 2014 the aquaculture sector provided 22% of the fish and shellfish supply share in EU28[8].

The aquaculture sector, and especially that occurring in the marine areas and shellfisheries, is a sector which has had a weak development with respect to production growth (in volume) and production value (increasing unit value and quality of its products). However, in the current situation where future demand for fish is expected to increase due to increasing population and income and health benefits associated with fish consumption, this growing demand offers a unique opportunity to expand the aquaculture production in the EU. At the same time, algae aquaculture activities are less developed at the European level than fish and shellfish activities and are mostly at the development stage, focusing both on freshwater and marine algae, depending on the final product they are aiming for.

Drivers

- ✓ Consumption demand
- ✓ Higher sea food prices
- ✓ Marine aquaculture capacity and effort reduction
- ✓ Exports to Asia – The increasing demand of Asia could drive the future evolution of the sector
- ✓ Reduction of pressure on natural stocks

[8] Scientific, Technical and Economic Committee for Fisheries (STECF) – Economic Report of the EU Aquaculture Sector (EWG-16-12); Publications Office of the European Union, Luxembourg

✓ New job opportunities for coastal communities

Barriers & Bottlenecks

Note: *Direct spatial implications* would be those which already hold a spatial characteristic (i.e displacements, re-routings, etc.); *Indirect spatial implications* would be those which might occur or not depending if we solve the barrier/bottleneck or not (i.e. efficiency improvements might bring more efficient developments and less new developments might be needed in the future which would create less spatial implications in terms of less space required)

Barriers / Bottlenecks	Direct spatial implications	Indirect spatial implications	Comments
Society / Jobs			For the aquaculture sector, the number of full-time employments (FTEs) seems to decrease (at a rate of 5%) per year, which might indicate a tendency towards higher specialization and less part time employment in the sector. However, this decrease in FTEs might be seen also as negative from the social perspective as aquaculture might be seen as becoming less important for supporting activity in coastal communities. This might affect the possibility to secure space for existing /new developments.
Bad press			Aquaculture related fish diseases, other environmental issues related to substances discharge from aquaculture facilities and social conflicts that have occurred between new aquaculture location sites and previous local uses of the marine space (i.e. small-scale and recreational fisheries, tourism or agriculture) have created a "bad press" around the aquaculture sector which is thought to be unsustainable in some countries. This lack of public confidence could act as a potential development barrier[9] reducing the support for expanding the space for aquaculture.
New deep-water explorations			The aquaculture sector is gradually moving to more exposed offshore sites using larger and more robust systems. Transferring marine aquaculture production in big production units further offshore to the open sea has potential for increasing the production. This might affect

[9] The FAO workshop "Increasing Public Understanding and Acceptance of Aquaculture – the Role of Truth, Transparency and Transformation" was held in Vigo, Spain, in October 2015. The workshop covered a number of core topics related to the perceptions of aquaculture, including transparency and ethics, communication, collaboration, responsibilities and new approaches to better management of sector performance and perceptions (FAO, 2016a).

			existing /new developments and their spatial implications as new space will be required at offshore waters or more space would be available for inshore aquaculture growth.
Efficiency improvements			Industry's focus has turned towards delivering efficiency improvements, building mostly on cost reductions (increased production per unit of effort). Innovative projects to improve efficiency and sustainability are being promoted by the EU (through the EMFF funding). Regions are also encouraged to pursue the concept of "Smart specialisation"[10]. This might affect existing /new developments and their spatial implications as more efficient and less space-demanding aquaculture might be developed.
Inappropriate spatial arrangement and site selection			Inappropriate spatial site selection of aquaculture is a major constraint to sustainable development and expansion of the industry. A poor location of an aquaculture farm or zone will not only create environmental problems such as localized eutrophication, it may also have a broader impact on environmental, social and economic aspects, such as conflicts with other human activities over the use of inland and coastal zone resources, that can detract from the benefits of a sustainable aquaculture industry. This might affect existing /new developments and their spatial implications as the aquaculture sector might need to move to other more appropriate areas.
Low competitiveness			There is the need to enhance the competitiveness of EU aquaculture. Even though application fees are low, other costs such as an Environmental Impact Assessment, when required, might increase the cost of new developments and should also be considered. This is seen as a necessary development if the EU industry is to remain competitive. This might affect existing /new developments and their spatial implications as new developments might or might not be pursued.
Limited access to Investments and credit			Limited access to credits slows new developments. At the same time, when credit/ investment is available its primary objective seems to be to get the industry started, with none to few investments being made throughout the production, maintenance and decommissioning phases. This might affect existing /new developments and their spatial implications as new developments might or might not be pursued.

[10] https://ec.europa.eu/jrc/en/research-topic/smart-specialisation

Uncertainty in financing			National governments and financing institutions do not have a good knowledge of where the prospects for aquaculture development are the most promising before committing resources to development. They still see it as a high risk financing area and are reluctant to invest. This might affect existing /new developments and their spatial implications as new developments might or might not be pursued.
Fragmentation and disorganization in markets			Markets with large number of producers and dealers which are unorganized and act individually will not seek for low cost-per unit of effort prices and will become non-competitive in front of foreign suppliers. This might affect existing /new developments and their spatial implications as new developments might or might not be pursued.
Transition to low carbon economy			Objectives agreed in Paris at COP21 demanded that EU should remain under the 2°C scenario. In order to do so microalgae production might play a fundamental part of this transition to low carbon economy due to its biofuel production. This might affect existing /new developments and their spatial implications as new developments might or might not be pursued. At the same time, the low carbon footprint of mussels when compared with other (sea)food has been pointed out, thus suggesting that mussels could be promoted as low carbon food. In addition to that carbon sequestration in shellfish in general suggest these production can contribute to transition to low carbon economy
High intensities of exploitation			Excessive farming density might lead to production issues such as lower growth and biomass of filter feeders (e.g. oysters, mussels) due to a decrease in the common-pool oxygen and food supply (i.e. microalgae). At the same time, waste and nutrient loads coming from aquaculture may cause environmental issues such as eutrophication and biodiversity and ecosystem service losses (if there is too many farms in a given area or water body). Capture of wild stocks for aquaculture needs is also an issue. Detailed studies of the carrying capacity of the environment and appropriate siting where developments are planned are necessary as this might affect existing /new developments and their spatial implications as new developments might or might not be pursued.
Constrains imposed by safety and			Aquaculture facilities need to comply with existing EU legislation regarding environmental issues including, alien species, as well as biosecurity, human health and food safety. With regard to fish diseases, the lack of effective biosecurity protocols and legislation makes it hard

environmental protection measures			to prevent potential farm-level disease outbreaks. This might affect existing /new developments and their spatial implications as new developments might or might not be pursued.
Unsuitable environmental conditions			In aquaculture, parasites, such as lice need to be continuously controlled as well as jellyfish and algal blooms which can have an effect from reduced feeding and condition to mortality of the produces species. Poor growth conditions such as high energy fluctuating environments as well as low water movements can also curtail production by creating stressed conditions and increasing mortality. This might affect existing /new developments and their spatial implications as new developments might or might not be pursued.
Lack of resilience to climatic variability			The aquaculture sector is seen to have a lack of resilience to climatic variability, climate change, and other external threats and disasters (e.g. hurricanes, tsunamis, etc.). This increases the production uncertainty and detracts investors for financing new development areas. At the same time, the production of some mariculture products, such as reed, may help in the potential protection of shores and coastlines against climate change impacts and macroalgae and shellfish production has also been thought as a way to capture and sequester atmospheric carbon (blue carbon projects). This might affect existing /new developments and their spatial implications as new developments might or might not be pursued.
Need to supply wild seeds			For the production of some aquaculture products (such as mussels) the need to supply wild seeds might be an important barrier as this reliance might curtail production if these seeds do not occur every year in sufficient amounts. This might affect existing /new developments and their spatial implications as new developments might or might not be pursued.
Complicated administrative procedures			There is a need to simplify administrative procedures that cover licensing aspects. Application processing time and uncertainties are seen as the main administrative problem as well as the need to comply with varying national rules (implementing EU legislation on Environmental Impact Assessments, Ecological and water quality, farming alien species and animal health criteria) as well as regional and local aspects regarding planning/building permission and Land/sea use (ownership, lease, consent). However, when application procedures are done right, the reported application success rate appears to be more than 90% in most Member

			States[11].This might affect existing /new developments and their spatial implications as new developments might or might not be pursued.

Policy & Management

* *General*: Common Fisheries Policy (CFP) / Reformed 2014 CFP / Water Framework Directive (WFD) [12] / Marine Strategy Framework Directive (MSFD).
* *Environmental Management / Assessment*: EU (European Strategic Environmental Assessment (SEA) Directive (2001/42/EC)) / Council Regulation concerning use of alien and locally absent species[13] / Council Directive 82/471/EEC[14] / Council Directive 96/25/EC[15].
* *Licensing*: EU (Council Regulation (EC) 2371/2002)

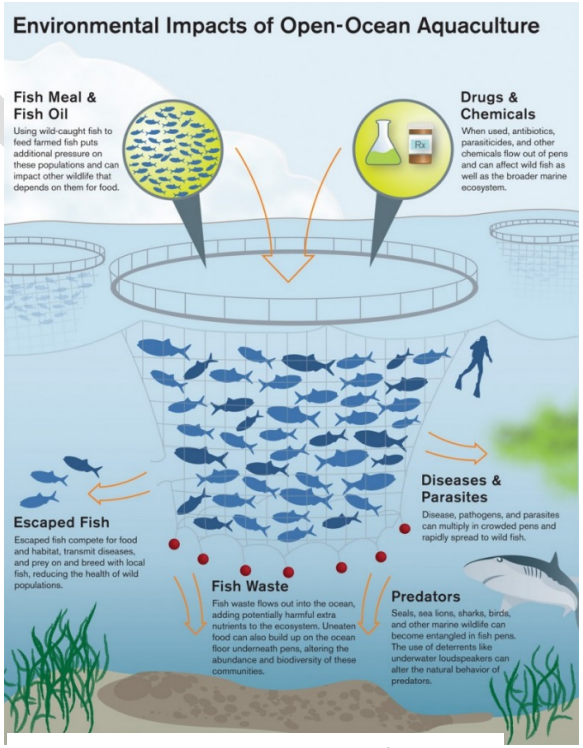

Figure 1: Environmental Impacts of Open-Ocean Aquaculture. Source: Pew Oceans

[11] https://ec.europa.eu/fisheries/sites/fisheries/files/docs/body/2016-aquaculture-in-the-eu_en.pdf
[12] European Parliament and Council Directive 2000/60/EC establishing a framework for Community action in the field of water policy.
[13] Council Regulation (EC) No 708/2007 of 11 June 2007 concerning use of alien and locally absent species in aquaculture.
[14] Council Directive of 30 June 1982 concerning certain products used in animal nutrition (82/471/EEC)
[15] Council Directive 96/25/EC of 29 April 1996 on the circulation of feed materials

Trends

- *Social aspects:* Shortage of local employees and no generational renewal both play a role in the aquaculture sector. Need for higher specialization for the aquaculture sector; at the same time, aquaculture´s "Bad press" implications are being addressed by encouraging transparency, consumer information and labelling, eco-certifications, local and niche marketing, communications and stakeholder consultations.
- *Technological aspects:* Some aquaculture activities are anticipated to moving further away from the coast into offshore waters. Transferring the aquaculture production to big production units further offshore could increase the sector´s production whilst minimizing conflicts with other coastal marine uses. One of the important issues for developments in aquaculture is the sustainability of the source of cultivated fish or shellfish: research on closing the life cycles of cultured species is essential to minimize the taking from wild stocks. For finfish aquaculture, research and innovation on nutritional aspect is still needed (e.g. protein and oil sources, fishmeal substitution, etc). At the same time, efficiency improvements in aquaculture have looked at cost reductions and to fuel-efficient techniques. At the same time, largest obstacle for up-scaling macro algae production is that large-scale production is hard to control in order to enable a constant high yield of productivity. Having said this, there is an increasing trend towards EU funds for innovation and development techniques that would allow to reduce the cost per unit of production whilst dealing with environmental legislation such as health and safety issues.

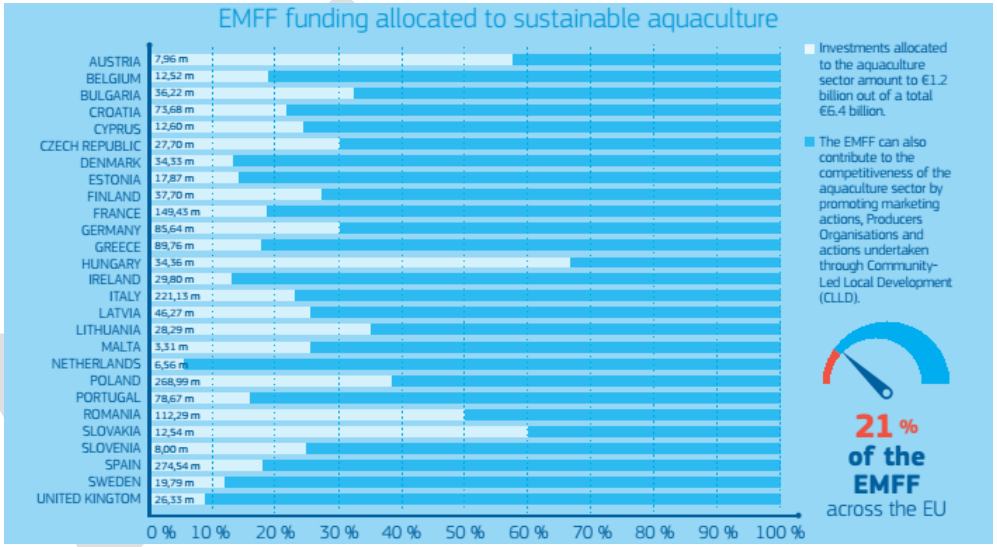

Figure 2: EMFF funding allocation to sustainable aquaculture per EU Country.

Source

- *Economic aspects:* Europe would have to deal with an increasing demand for fish and sea food proteins and macro algae production is expected to help fulfil this growing demand in proteins for human and animal consumption. At the same time, there is already an existing market for high value extracts from harvested macro and micro algae (cosmetics, nutrition, omega-3 fatty acids..), as well as a strong demand for biomass for energy, which could be targeted by the macro algae aquaculture sector. This is expected to benefit to the development of macro algae and micro algae aquaculture. However, some recent market uncertainties, commodity prices instability and the low or lack of investment for new vessel and facilities development

leads to creating a non-competitive enough sector against other marine uses. This needs to be urgently solved through new investments for explorations and licensing such as those already in-place for sustainable aquaculture through the EMFF (21% of EMFF in 2016, Figure 2) or the 2009 EU Commission Strategy for the sustainable development of aquaculture[16].

- *Environmental aspects:* For aquaculture the environmental challenge stays around ecosystem health and environmental protection against activity production elements such as waste, nutrient loads, escapees, invasive species, etc. At the same time, the sector´s production resilience against climatic variability remains a challenge and poses high uncertainty to production potential perspective´s analysis. Thus, trends in this sector call for new research with improvements in production (more resilient species) as well as an uptake of "Integrated Multi-Trophic Aquaculture (IMTA)" systems[17]. In these systems the sustainability and environmental damage is decreased because they mimic nature's cycle: Fish are fed but below them are feeders like lobsters, sea cucumbers, and urchins that obtain the excess fish food. Mussels and other shellfish are downstream from the fish to provide filtering and recycle the organic nutrients. Seaweed downstream from that absorbs and captures the inorganic waste and produce oxygen. Taking into consideration the current high nutrient content in the EU sea basins, there are opportunities under consideration to reduce nutrients with sustainable mussel farming and to support these approaches with compensation measures (pay for ecosystem services provided by aquaculture). Currently, there are legislative and funding gaps for sea-based measures. The MSFD explicitly sets the goal of no eutrophication in European waters by 2020. Hence, it is largely positive towards sustainable aquaculture as it improves water quality. On the same hand, the Commission Staff Working Document states that: "sustainable aquaculture contributes to delivering GES under MSFD". The natural filtration feeding of shellfish also leads to improvements in water clarity, as demonstrated by mussel farms in the Baltic"[18]. In addition, fish farms, appropriately sited (e.g. avoiding fragile environments such as seagrass meadows) have been demonstrated to be able to act as refuges for fish, supporting stock recruitment in adjacent areas).

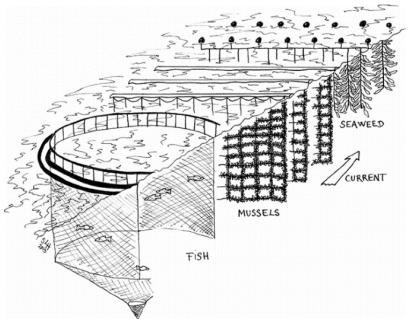

Figure 3: Integrated Multi-Trophic Aquaculture scheme (IMTA) © S.L. Holdt

- *Administrative aspects:* This is by far the most challenging factor for the aquaculture sector. At the same time administrative procedures for aquaculture licensing remain complicated and are seen as a major burden for the further development of the sector. Due to this, most Member States (15) have already began improving their licensing procedures, with review and streamlining, setting up of a one-stop-shop, online applications and longer

[16] COM (2009)162 final. Communication from the Commission to the European Parliament and the Council: Building a sustainable future for aquaculture: A new impetus for the Strategy for the Sustainable Development of European Aquaculture.
[17] http://www.preview2.aquacase.org/Seaweed/seaweed_production_algaplus/docs/Integrated%20multi-trophic%20aquaculture.pdf
[18] European Commission, Commission Staff Working Document, Brussels 2016 p 12, 13; ongoing study within the project BalticBlueGrowth

licence durations. The setting up of online portals have allowed to provide better support for applicants, allowing for their guidance and dialogue with public administrations.

4 Spatial Consequences of Future Trends

In terms of the aquaculture sector, MSP could also be a means to improve negative public perception about potential environmental impacts, especially those associated with marine fish farming, and on access to and use of coastal resources. Improving public perception by highlighting placement decisions in relation to possible environmental concerns such as migrating fish routes, currents circulation, degradation around aquaculture sites, eutrophication, and fisheries and other coastal uses displacement, etc. is encouraged. Public participations in decision-making, through consultations, could be a way to increase local stakeholder engagement to minimized conflicts and improve the perceptions on aquaculture. Also, in order to secure better possibilities of success for potential new licences, the possibility of earmarking suitable spaces for aquaculture activities (decided amongst all stakeholders) should be encouraged.

At the same time, MSP could help the aquaculture sector creating clusters of farms, each within a management area (Aquaculture Management Areas – AMAs; or Allocated Zones for Aquaculture - AZAs[19]), which will look at the specificities (social, economic and environmental) of their spatial area and will manage to reduce those risks that might happen whilst optimizing farm production. However, marine fish aquaculture is a very spatial demanding activity and, thus, its spatial co-existence with other marine uses should be enhanced. At the same time algae aquaculture can be developed in conjunction with other usage (wind farms, tidal farms...) and might have beneficial functions such as wave reduction (erosion reduction). Conflicts with other uses increase as marine aquaculture its developed closer to the coastline where other more economically attractive developments might also take or want to take place.

[19] Sanchez-Jerez, P et al., 2016

Relationship with other sectors

The matrix below indicates the potential Aquaculture Sector compatibility (synergies and conflicts) with other marine sectors. (Note: red = potential conflicts; green = potential synergies; grey = not applicable)

		Shipping and ports	Tourism & Recreation	Oil & Gas Extraction	Pipelines & Cables	Fishing	Aquaculture	Marine Renewables	Marine Aggregates	Conservation
Aquaculture	Synergies									
	Conflicts/Risks									

Recommendations in MSP

For the aquaculture sector, exploring new potential co-location opportunities amongst the various marine uses of the seas will definitively help the further development of the sector creating avenues for a more holistic and equitable approach of the aquaculture sector and MSP[20]. Furthermore, MSP offers a chance for greater recognition of the sector's interests. There is a need for siting criteria for the cultivation of different species and research on optimal sites is also needed[21]. In some EU areas it could be feasible to apply the idea of nutrient filtration and carbon reduction/fixation by sustainable aquaculture (providing ecosystem services) and to plan for spaces that combine production with compensation schemes as economic incentives (opportunities for carbon offsetting and opportunities for waste water treatment). In other areas, establishments of aquaculture areas as fish aggregation sites could also be explored, as well as the possibility to locate small scale aquaculture sites in proximity of marine protected areas in order to support minor local economies.

[20] 2012 Blue Growth Study - Scenarios and drivers for Sustainable Growth from the Oceans, Seas and Coasts. Subfunction 2.3. Marine aquatic products. Brest/Utrecht/Brussels. DG MARE. No. MARE/2010/01

[21] PartiSeaPate Single Sector Workshop Findings (2014), http://www.partiseapate.eu/dialogue/cross-sectoral-workshops/

5 Resources / Actors / References

Actors

Name of Actor	Type of Actor	LINK	Short explanation
EAS- European Aquaculture Society	Society	https://www.aquaeas.eu/	EAS has four principal objectives: To promote contacts between all involved or interested in marine and freshwater aquaculture; To facilitate the circulation of aquaculture related information; To promote the sponsorship of multi-disciplinary research concerning aquaculture; To enhance cooperation among governmental, scientific and commercial organizations and individuals on all matters dealing with aquaculture.
EAAP- European Association for Animal Production	Association	http://www.eaap.org/	Is an international non-governmental organization which aims to improve the knowledge and the dissemination of research of domestic animals farming.
AquaTT- The European Network for Training and Technology Transfer in Aquaculture	Training Network	http://www.aquatt.ie/	AquaTT is an SME, with a not-for-profit mandate. It was founded in 1992 under the EU COMETT programme as the University Enterprise Training Partnership (UETP) for the European aquaculture industry, to coordinate the training requirements of the industry through a single body.
SEA- Spanish Aquaculture Society / Sociedad Española de Acuicultura	Society	http://www.sea.org.es/	Its aim is to promote information sharing, contact and cooperations between all aquaculture actors currently involved or interested in developing aquaculture innitiatives in Spain. It serves as the main cooperation point for Spain with EU countries, South America and Mediterranean countries.

Projects

Name	Type of Project	Duration	LINK	Short explanation
TAPAS	Horizon2020	4 years	http://tapas-h2020.eu/	It aims to promote and consolidate the environmental sustainability of the European aquaculture.

AQUASPACE (Making Space for Aquaculture)	Horizon2020	4 years	http://www.aquaspace-h2020.eu/	It aims to provide increase space for aquaculture by identifying key constraints limiting development. It uses a case study approach in order to identify constraints to aquaculture in a wide range of contexts, scales and production types.
MedAID	Horizon 2020	4 years	http://www.medaid-h2020.eu/	The goal of MedAID is to increase the overall competitiveness and sustainability of the Mediterranean marine fish-farming sector, throughout the whole value chain. Its objectives will be achieved: - through a holistic assessment to identify the main technical, environmental, economic and social challenges which may condition the sustainability of the sector, - by addressing those technical, environmental, economic and social challenges that the sector currently faces, - by developing innovative knowledge and tools to improve the performance of the production systems, creating and fostering added-value products and socially acceptable business plans.
PERFORMFISH	Horizon 2020	4 years	http://performfish.eu/coming-soon.html	Performfish will focus on developing consumer driven aquaculture production by integrating innovative approaches that can help endure European sea bass and sea bream aquaculture business are sustainable and competitive.
SUBMARINER	Interreg Baltic Sea Region	2010-2013 3 years	http://www.submariner-project.eu/	Examining different types of maricultures and other uses of sea resources in the Baltic Sea region
Multi-Level Governance in MSP throughout the Baltic Sea Region - PartiSEApate	INTERREG IV B: Baltic Sea Region Programme 2007 - 2013	January 2012 – January 2014	http://www.partiseapate.eu/	The responsible bodies for MSP throughout the Baltic Sea Region joined forces within the project PartiSEApate in order to develop a pan-Baltic approach to those topics whose spatial dimension transcends national borders and to develop a concept for an MSP institutional framework and governance model which shall provide input to policy decisions. PartiSEApate tested and developed instruments and models for how such MSP multi-level governance mechanisms can be realized in the Baltic Sea Region.

Baltic Blue Growth	Interreg BSR	2016-2019	www.balticbluegrowth.eu	Examining siting criteria for mussel aquaculture
Zadar county integrated sea use and management plan	Zadar County, Croatian Government	2014	http://www.zadarska-zupanija.hr/images/stories/p.planovi/PPZ_2006_procisc_ni_tekst.pdf	The "Zadar county integrated sea use and management plan" is a legally binding plan focusing on mariculture, being this one of the most important maritime activity in the county. The plan has designated marine areas for specific types of mariculture (as for example fish cage farming of sea brass and sea bream), taking also in consideration potential conflicts with other maritime activities. The plan was harmonised with the Croatian national spatial development strategy and the spatial plans of adjacent counties.
Guidance of Better Integration of Aquaculture, Fisheries, and other Activities in the Coastal Zone - COEXIST	European Community's Seventh Framework Programme (FP7 2007-2013)	2013	http://www.coexistproject.eu/images/COEXIST/Guidance_Document/Best%20practices%20guidelines_FINAL.pdf http://www.msp-platform.eu/node/613	The purpose of this guidance document is to promote the better integration of aquaculture, fisheries and other activities in the coastal zone by the identification and application of appropriate spatial management tools. The conclusions drawn and the recommendations in this document are largely based on the experience of applying a set of methods and technical tools to address a number of key questions in spatial management in six COEXIST case studies (Hardangerford, NO; Atlantic Coast, IE; Atlantic Coast, FR; Algarve Coast, PT; Adriatic Sea Coast, IT; Coastal North Sea, DE, NL, DK; Baltic Sea, FI)
Making the European Fisheries Ecosystem Plan Operational - MEFEPO	EU 7th Framework Programme	August 2008	https://www.liverpool.ac.uk/mefepo/ http://www.msp-	The Atlas provides an overview of the North Western Waters ecosystem, covering issues including physcial and chemical features, habitat types, biological features, birds, mammals, Fishery and other human activities. This information is provided in non-technical language and intended to help policy makers, managers and stakeholders in decision making.

			platform.eu/node/144	
AQUAculture infrastructures for EXCELlence in European fish research towards 2020-AQUAEXCEL2020	Horizon 2020 research infrastructure project (INFRAIA-1-2014/2015)	October 2015 – September 2020	http://www.aquaexcel2020.eu/	Aims to further support the sustainable growth of the European aquaculture sector. AQUAEXCEL2020 will integrate a large group of leading European aquaculture research facilities and aims to advance aquaculture research and innovation in Europe. One of its key aspects will be to provide subsidized access to top-class aquaculture facilities, as well as numerous highly pertinent services for researchers from academia and industry.
Innovative practices and technologies for developing sustainable aquaculture in the Baltic Sea region - AQUABEST	Interreg 2007-2013 Baltic Sea Region	September 2011 – August 2013	http://www.aquabestproject.eu/	The project strived to demonstrate that the Baltic Sea region aquaculture has the potential to become a sustainable and responsible food production system, accepted by all stakeholders
Developing site selection and carrying capacity guidelines for Mediterranean aquaculture within aquaculture appropriate areas" (SHoCMed)	GFCM project with EU financial support.	2010 - 2015	http://www.fao.org/gfcm/activities/aquaculture/projects/shocmed/en/	The objectives of SHoCMed were to: i) produce site selection criteria in order to enhance the integration of aquaculture in coastal zone management through the use of allocated zones for aquaculture (AZA); and ii) to provide a basis for the harmonization of standards, aquaculture policies and legal frameworks across the Mediterranean region to ensure equal terms of competition and minimal environmental impact.
Guide for the Sustainable Development of Mediterranean Aquaculture - Interaction between	IUCN	2004-2005	https://www.iucn.org/content/guide-sustainable-development-mediterranean-aquaculture	Most of the potential environmental impacts of aquaculture can be managed and minimized through the understanding of the processes, responsible management and the effective siting of farms. Therefore, sustainable management guidelines are essential tools for policy makers, administrators, aquaculture producers and other stakeholders. The guide deals with

Aquaculture and the Environment				domestication, introduced marine species, capture of wild stocks, feed ingredients, pathogens, effects on local flora and fauna etc.

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- The FAO workshop "Increasing Public Understanding and Acceptance of Aquaculture – the Role of Truth, Transparency and Transformation" was held in Vigo, Spain, in October 2015. The workshop covered a number of core topics related to the perceptions of aquaculture, including transparency and

ethics, communication, collaboration, responsibilities and new approaches to better management of sector performance and perceptions (FAO, 2016a).

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