AQUA-LIT

Learning Lab Report Mediterranean Sea

Deliverable 3.3 (D3.3)

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Vertidos Cero/MARNOBA	*Spain*	*c*
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Spanish Aquaculture Farmer's Association (APROMAR)	*Spain*	*a*
AZTI	*Spain*	*a*
Proyecto Bluenet	*Spain*	*a*
Ministry for the Ecological Transition and Demographic Challenge (MITECO)	*Spain*	*a*
Universitat Autónoma de Barcelona (UAB) – Departament de Biologia Animal, de Biologia Vegetal y d'Ecología	*Spain*	*c*
Instituto Tecnológico del Plástico (AIMPLAS)	*Spain*	*a*
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Protected Designation of Origin certification body (1)	*Spain*	*b*

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Other acknowledgements:

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Dissemination level		
PU	Public	x
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

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AQUA-LIT project

AQUA-LIT is an EASME-EMFF funded project that aims at providing the aquaculture sector with a sustainable **toolbox** of innovative ideas and methodologies to address the 3 main core aspects of marine littering: **prevention & reduction, monitoring & quantification, and removal & recycling.**

To fulfil this mission, we will be working face-to-face with aquaculture farmers in three **regional Learning Labs**: at the **Mediterranean basin, the North Sea and the Baltic Sea regions.** In parallel, we will identify and cluster existing, upcoming and already implemented tools on marine littering, and we will further **develop a platform and an app** for providing the **'Tide against marine litter toolbox'.**

Lastly, we will **'scale up the tide'** by developing the '**policy for less litter'** set of recommendations, by showcasing the **'funding a wave of solutions'** available for the sector and by coming up with a **transferability plan for outermost regions.**

Through this, we expect to help all stakeholders from the aquaculture chain to increase the understanding, awareness and availability of solutions, so a potential **transformation of the aquaculture sector towards a less polluting sector** can become possible.

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Project Consortium

Geonardo Environmental Technologies **(GEO)**

European Centre for Information on Marine Science and Technology **(EurOcean)**

Vlaams Instituut voor de Zee -Flanders Marine Institute **(VLIZ)**

Sustainable Projects GmbH **(s.Pro)**

Instituto Español de Oceanografía -Spanish Institute of Oceanography **(IEO)**

Société d'Exploitation du Centre National de la Mer - French National Sea Centre in Boulogne-sur-Mer **(Nausicaa)**

Fundo Regional para a Ciência e Tecnologia -Regional Fund for Science and Technology **(FRCT)**

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Definitions

Globally, the term 'marine litter' is put forward in research and communication strategies in the context of anthropogenic debris and plastic waste in and towards the sea. Actually, 'litter' has a strong connotation pointing at carelessly discarded items. Items that have been discarded incorrectly and/or deliberately at an unsuitable location.

The AQUA-LIT project cooperates with stakeholders from the aquaculture sector. This sector deals with exceptional offshore conditions, storm events, etc. and consequently has unintentional losses of materials or equipment. To better represent the context, the word 'debris' is used instead of 'litter' for those exceptional cases, if the distinction can be made correctly. Otherwise the authors stick to the term "litter" also due to the projects' name AquaLIT.

Litter: consists of (anthropogenic, manufactured, or processed solid) items that have been deliberately discarded, unintentionally lost or abandoned, or transported by winds and rivers, into the environment. The term 'litter' has the connotation of been discarded incorrectly and/or deliberately at an unsuitable location. The verb 'to litter' means to drop and leave fabricated objects in the environment.

Waste: any substance or material which is eliminated or discarded after primary use, or is worthless, defective and of no longer useful.

Debris: rubble, wreckage, scattered remains of something that has been destroyed, pieces of rubbish or unwanted materials.

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AQUA-LIT Mediterranean Learning Lab report (D3.3)

Summary

The AQUA-LIT project has conducted three regional and one virtual **Learning Labs** to engage with stakeholders and to identify the existing knowledge, expertise, tools, and best practices to help the aquaculture sector tackle the problem of marine littering. The aim of this report is to provide an overview of the stakeholders' needs in **the Mediterranean Sea region** in preventing, reducing, monitoring, quantifying, removing and recycling aquaculture installations, gear or equipment that are lost or carried away by the sea.

This report combines the outcome of two types of stakeholder engagement: an **interactive workshop** held on February 4th, 2020 in València, Spain, and 16 **targeted stakeholder interviews** from companies and organizations working and/or located in different countries in the Mediterranean Sea region (Spain, Italy and Greece). The stakeholders represented all stages involved in the life-cycle of an aquaculture farm: aquaculture farmers, researchers, start-ups, professional platform representatives, NGOs, national authorities, plastic manufacturers, consultancies etc.

Most aquaculture stakeholders are slightly aware of the potential impact of plastic and other unsustainable gear and items in the marine environment, and show genuine interest in mitigating it. However, there is still a clear need for more attention regarding this issue. Therefore, these stakeholders were involved in the search for solutions and providing more specific information. In this context, they clearly pointed out (finfish and shellfish farmers, and farmer associations) the need to improve transparency, communication and collaboration among all the involved stakeholders, in order to reduce the impact of plastic and other unsustainable gear from aquaculture facilities. This was also a common understanding among all the participants, highlighted both in the personal interviews and the workshop.

For all three core aspects (Prevention and Reduction, Monitoring and Quantification, Removal and Recycling), knowledge gaps and policy challenges are commonly identified barriers. To address these knowledge gaps, identifying all the potential sectors that could provide specific information, enhancing the communication among all involved stakeholders and raising general awareness form the basis of the solution. The potential collaborations, as a result of this network creation, could also be the basis for specific trainings, promoting cleaning-up initiatives and setting up the core of the regional, national and European legislation, and international good practices criteria.

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To address the lack of specific EPR schemes, public waste management institutions should be the ones leading this network in collaboration with all the involved sectors. EPR schemes can only work if a clear development framework, including economic feasibility, is established in advance.

Improved communication between the institutions and farmers, comprehensive and feasible criteria for the approval procedure and standardisation at a national level of those criteria applied in the aquaculture sector are key to solve the policy gaps that were detected by the attendants.

This report will be combined with the parallel activities in the Baltic Sea (D3.1) and North Sea (D3.2) regions. The results obtained from this Learning Lab will help feed the AQUA-LIT "*Tide against Marine Litter Toolbox*" to be published by the end of the project (December 2020).

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1. What is an AQUA-LIT Learning Lab?

A learning lab is a methodology for transforming systems with local stakeholders. It develops productive partnerships by forming inclusive problem-solving teams of multiple local stakeholders. They share common values and design behavioural support systems responsive to their diverse needs, strengths, practices and goals and develop locally meaningful, socially just, mutually valued, culturally acceptable and sustainable systemic solutions to a common problem.

The AQUA-LIT' Mediterranean Sea Learning Lab consists of two types of stakeholder engagement approaches (Figure 1):

- Interactive workshop.
- Interviews with stakeholders using standardised questionnaires.

The AQUA-LIT interactive workshop is facilitated using a participatory method and encourages knowledge sharing and co-creation in order to develop a mutually valued and acceptable toolbox, which could become exemplary and point out the path for other sectors. Three Learning Lab workshops are organised by the AQUA-LIT partnership at three different locations. Each of them focuses on a specific sea basin: the Baltic Sea, the Mediterranean Sea and the North Sea. An additional virtual learning lab consisted of a webinar-type of stakeholder engagement that did not focus on a specific region, but rather on the potential solutions and ideas to tackle marine litter at different stages: prevention & reduction, monitoring & quantification, and removal & recycling.

The stakeholder interviews help to better understand the state of play concerning the debris and litter management by the aquaculture sector and to identify the needs, barriers, strengths, good practices, opportunities and existing tools for preventing, reducing, monitoring, quantifying, removing and recycling the debris and litter in the regions of the Baltic, Mediterranean and North Sea.

The mobilization of stakeholders using a positive and non-incriminating methodology paves the way for novel co-developed and inclusive solutions.

The interviews and the workshops - 'learning labs' for engagement across stakeholder groups focus on creation, observation and promotion of innovative actions. The learning labs provide a forum for mutual learning and work to aquaculture farmers, equipment manufacturers, engineering and construction compagnies, academic research groups, professional clusters and associations, NGOs, policy makers and implementers, port staff, certification bodies, waste processing compagnies and communicators.

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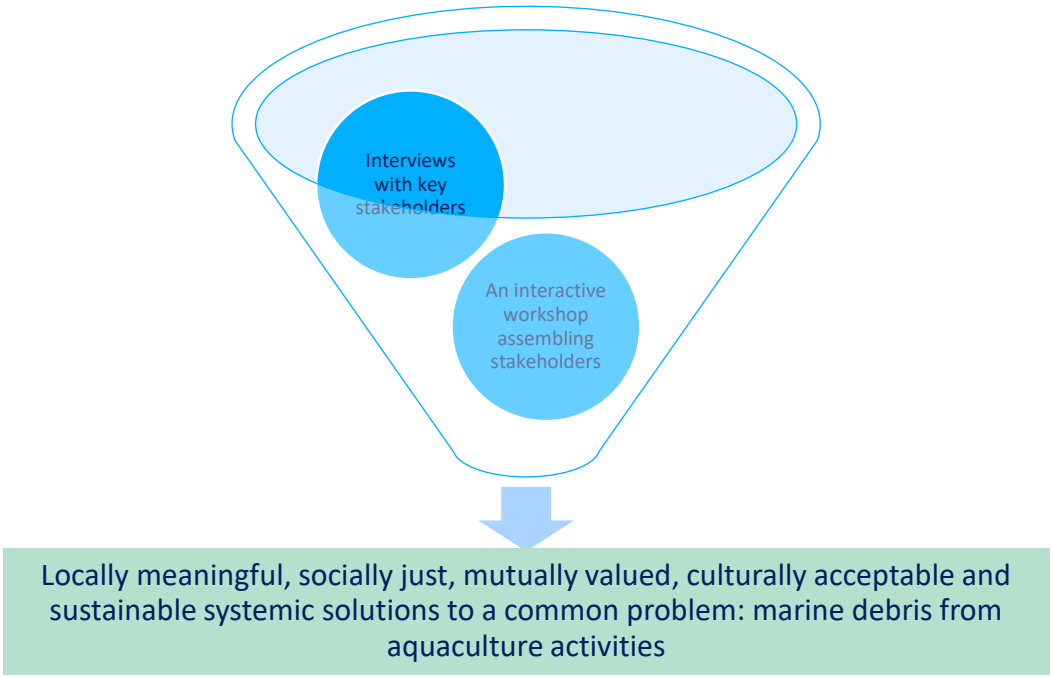

Figure 1: The AQUA-LIT' Mediterranean Sea Learning Lab consists of two types of stakeholder engagement which aim to pave the way for novel co-developed and inclusive solutions.

1.1. Learning Lab objectives

The Mediterranean Learning lab aims at:

- Creating an aquaculture stakeholder community to assess against marine litter;
- Facilitate the exchange of knowledge, expertise, tools, and best practice in preventing, reducing, monitoring, quantifying, removing and recycling aquaculture facilities, gear or equipment that are lost or carried away by the sea;
- Facilitate the adoption of successful existing solutions through capacity building;
- Explore potential innovative solutions for marine litter reduction, removal and recycling;
- Improve the understanding of stakeholders' needs and maximise the transferability of the projects' findings and impact.

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1.2. Mediterranean context

1.2.1. Aquaculture facilities in the Mediterranean Sea.

At a worldwide level, aquaculture represented 47% of the total fish production in 2016: while fishery production has not increased since the late 1980s, aquaculture has continuously expanded (FAO, 2018).

Considering that in 2015 fish provided at least 15% of the average per capita intake of animal protein to more than 4.5 billion people worldwide (Bené et. al., 2015) and that the United Nations estimate than the human population will reach 9,7 bilion by 2050 (United Nations, 2019), aquaculture is becoming essential in providing animal protein to a growing population.

In the Mediterranean context, aquaculture (particularly mariculture) has increased noticeably since the 1990s (UNEP/MAP, 2012) due to a decreasing of the wild fish stocks parallel to an increase of consumer demand for fish (UNEP/MAP, 2012).

In the Mediterranean Sea, a wide variety of **finfish** is farmed, of which the **European seabass** (*Dicentrarchus labrax*) is one of the main species. Most farmed European seabass are produced in floating sea cages, with a few produced-on land-based farms (Sandra et al., 2019). The **gilthead seabream** (*Sparus aurata*) is the second most produced species in this region of Europe. This species is normally reared in sea cages, but some land-based systems can be also found (Sandra et al., 2019). According to producing countries, after Turkey, Greece is the largest aquaculture producer of seabass and seabream in the Mediterranean Sea, followed by Spain and Italy (Sandra et al., 2019).

Atlantic bluefin tuna (*Thunnus thynnus*) corresponds to a quotum species present in both the Mediterranean and the eastern Atlantic Sea with a high market value. Due to the stagnation in the yield of the wild fisheries, countries are trying to exploit the quota to the fullest and raise wild-caught specimens in aquaculture conditions to increase the fat content. Malta, Croatia and Spain are countries bordering the Mediterranean Sea practicing tuna aquaculture in the greatest volume (Sandra et al., 2019).

Regarding invertebrates farming, mussel species are a major aquaculture product in several European countries, namely the blue mussel (*Mytilus edulis)* and the Mediterranean mussel (*Mytilus galloprovincialis*) are the core of European production (Sandra et al., 2019). In fact, the production of aquaculture mussels is much larger than the production by mussel fishing (Sandra et al., 2019).

In the Mediterranean Sea, France, Italy and Spain are the main producers of the Mediterranean mussel while Slovenia, Turkey, Greece, Croatia, Albania and Montenegro contribute to a lesser extent to the mussel production in this region (Sandra et al., 2019). The most common production method used in the Mediterranean countries is called **"suspended**

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rope culture": mussels are attached to ropes that are suspended vertically in the water from a fixed or floating structure. This technique is suitable for sea with weak tides like the Mediterranean Sea and it is now is being introduced in the Atlantic Ocean. Mussels are harvested by raising the ropes out of the water and removing the clusters (Mussels, 2012).

Regarding other species of invertebrates, most clams are cultivated in Italian waters. Other clam farming countries are France, Spain and Slovenia, while the oyster farming countries are France, Spain, Italy, Croatia and Malta. Main clam species include the pullet carpet shell (*Venerupis pullastra*), the grooved carpet shell (*Ruditapes decussatus*) and Japanese carpet shell (*Ruditapes philippinarum*) among others (APROMAR, 2019; Sandra et al., 2019).

Marine macroalgae, or seaweeds, are traditionally harvested for the extraction of hydrocolloid for industrial purposes. EU macroalgae production is limited but the demand for edible algae is increasing in EU markets, and new production models and market stream are emerging (Sandra et al., 2019). Among the Mediterranean Countries, Spain (mostly red algae) and Italy (green and red algae) are the main producers (Sandra et al., 2019).

1.2.2. Aquaculture in Spain, Italy and Greece

The Mediterranean Sea Learning Lab aims to provide a general overview of the current barriers and proposed solutions to mitigate the impact of the non-organic marine litter and debris related to aquaculture in the Sea basin. However, in this framework, considering that the workshop took place in Spain, most of the stakeholder and interviews were Spanish. Nevertheless, Italian and Greek stakeholders were interviewed. Consequently, an outline of the specific situation in the three countries is included.

Spain

In Spain, mussel farming is by far the biggest sector of aquaculture in terms of production volume, representing three quarters of the total national aquaculture output (Sandra et al., 2019). Mussel cultured in Galicia being the driving force: Galician production represents 97% of the total national mussel production, but this type of aquaculture can also be found in Catalonia, Andalusia, Valencian Community and the Balearic Islands (APROMAR, 2019).

Regarding mussels, the most common rearing method is the "batea" which consist of a floating nursery suspended by a system of floats, consisting of a lattice (traditionally made of eucalyptus wood) of rectangular shape on which the mussels are attached to the hanged ropes (Mexillon de Galicia Cultivation Techniques, 2020). Long-lines can also be found in some areas of the country like Andalucía (APROMAR, 2019).

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On the other hand, European seabass (22,460 t in 2018) and gilthead seabream (14,930 t in 2018) are the main marine finfish species produced (APROMAR, 2019) in Spain and are usually grown in floating sea cages, although tanks and ponds on land can be used as well (especially for hatcheries) (APROMAR, 2019). Rainbow trout (*Oncorhynchus mykiss*) is the most important freshwater species (18,856 t in 2018) (APROMAR, 2019).

Moreover, Spain is a world leader in research focused on integral cultivation of Atlantic bluefin tuna (*Thunnus thynnus*). Nevertheless, the majority of the current tuna production in Spain is based on capturing the Atlantic bluefin tuna alive by fencing a traditional gear known as ”almadraba” and, afterwards, maintaining and feeding them on marine aquaculture farms (APROMAR, 2019).

The marine microalgae farming is a growing and changing sector in the Spain: the annual production of manually collected algae (on foot or by diving) is approximately 12,000 t per year, and collection is concentrated in the Cantabrian and Galician coasts (APROMAR, 2014). Nowadays, there are some cultivation initiatives (which include *Laminaria* sp. and *Gracilaria* sp.) located along the northern and the Andalusian coasts of the country: 8.5 t of macroalgae were farmed in 2017 in Spain (APROMAR, 2019).

Italy

In Italy, more than 40 fish, shellfish and crustaceans species are cultivated. According to production, 97% of it is based on five species, which are rainbow trout, European sea bass, gilthead sea bream, Mediterranean mussel and Japanese carpet shell (FAO, 2015).

The most important species cultured in marine and brackish waters are European seabass and gilthead seabream. The fattening of Atlantic bluefin tuna started in 2004 in cages in coastal areas of south Italy (Sicily, Calabria, Apulia, Campania) and stopped in 2012 (FAO, 2015).

Shellfish production is mainly focused on Mediterranean mussel and Japanese carpet shell. Other species are grooved carpet shell and Pacific cupped oyster (*Crassostrea gigas)* with small productions, but representing a major diversification opportunity for shellfish culture (FAO, 2015).

Greece

Greek aquaculture is dominated by marine finfish farming in offshore cages, specifically of gilthead sea bream and European sea bass. These two species plus mussels species represent up to 97% of the Greek aquaculture production volume (FAO, 2016).

Land-based breeding stations provide fry to the ongrowing facilities, which are mostly fish cages located in areas protected from severe weather conditions. Cage technology supports

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large production volumes offshore, giving the advantages of mass production. Regarding mussel farming, traditionally, it was carried out in hanging parks located in shallow waters close to estuaries in the Northern part of Greece. Despite being partly mechanized, the work is now still labour-intensive (FAO, 2016). Indeed, along the Western coast of the Thermaikos Gulf (North of Greece) about 30,000 tons of mussels annually are being produced (between 80-90% of the Greek mussel production). Mussel culture is grouped into three areas in the Thermaikos Gulf: the Estuary of the Axios River, the Estuary of the Loudias River together with the North area of the Aliakmonas River and the Pieria coast, South of the Aliakmonas River Delta. Two mussel farming techniques are practiced in these are: long-line and pole mussel farms.

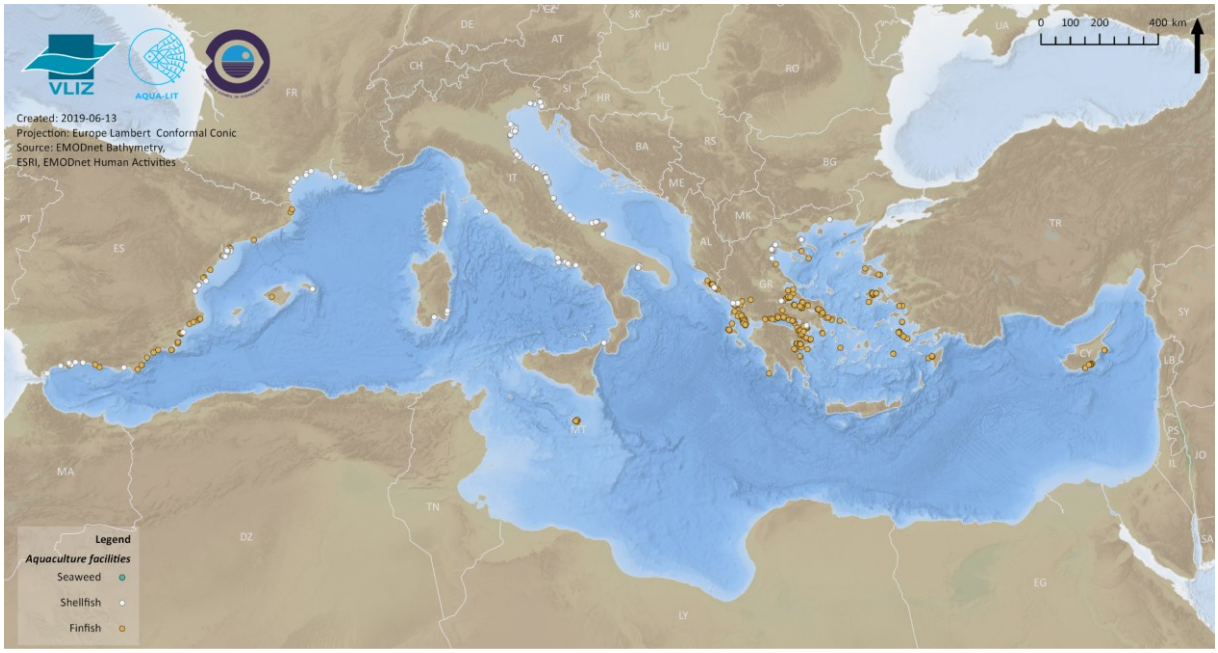

Figure 2: Distribution of aquaculture facilities for seaweed, shellfish and finfish in the Mediterranean Sea basin (*Source: EMODnet Human Activities, duplicated from D2.2*).

Current threats

The gear and structures which are used in these aquaculture facilities can sometimes be lost (after a storm, for example), discarded or abandoned. Big items like buoys can be easily tracked, but there is a remaining problem regarding small and non-durable items like mussels socks/nets, gloves or tags, which can easily end up in the sea and beaches (Sandra et. al., 2019).

In general, bivalve nets and bags were the most common items found mainly in neighbouring regions of countries with high shellfish farming activity (Western Mediterranean Sea along the coastline of Spain, France, Italy and Greece). This may give an indication of the potential source of the mussel nets found on these beaches. The second most common found item were fish tags. Interestingly, fish tags were most frequently found on Italian beaches and

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beaches along the Adriatic Sea where no fish farms were registered according to the consulted databases. Hence, this could be an indication of fish tags possibly arriving by means of ocean circulation and hydrodynamics although tags could also be related to scientific research tasks (Sandra et al., 2019).

In Spain, shellfish farmers contacted by AQUA-LIT suggested that plastic, extruded, tubular nets were the items that most frequently end up abandoned or dumped, as it is very difficult to recycle or reuse them (because of the fouling of organic material once they had reached the end of life). Cable ties were also cited as frequently littered. On the other side, buoys and nets were also reported as broken and lost elements.

Despite the general awareness that these lost or abandoned items may cause an environmental problem, the lack of accurate monitoring data is considered one of the biggest challenges to be able to estimate their real impact. This is due to most of the aquaculture items that are found during clean-up activities are misclassified as fishery gear.

In Italy, the accumulation of mussel nets on beaches and the seabed is a considerable problem. Mussel nets are found all over the Italian coast, not only nearby mussel farming facilities, but also further away, brought by currents, especially on the Adriatic coast. In the last six years Legambiente, one of the most relevant and active environmental association in Italy, has monitored over 10 000 mussel nets during their beach litter surveys. On average, 31 pieces per 100 meters of beach were found, with peaks on some beaches where it accounted for more than 70% of the total waste. According to studies conducted within the DeFishGear project, mussel nets are in seventh place of the top 20 most found objects on Adriatic beaches. These are also the third most abundant waste (8.4%) recorded on the seabed, with a density equal to 49 socks per square kilometre. On the Italian territory, the recorded density was considerably higher with 73 socks per square kilometre of seabed. Results from one of the various experimental Fishing for Litter projects in the Adriatic Coast, carried out by Legambiente in Porto Garibaldi (Comacchio, Ferrara province), reported that 80% of the "fished" waste in six months was represented by plastic socks from mussels farming activities. There is still no control or regulation of the management and disposal of used mussels socks, and often there are no collection points and well-defined recycling procedures in the ports (Legambiente, 2019).

In Greece, mussel farmers are experiencing similar problems and barriers regarding waste management and litter prevention, especially concerning mussel nets, which have been found in high quantity on beaches, muddy areas and seafloor, and plastic barrels, used as floaters in the long-line type of mussel culture. A Greek mussel farmer interviewed declared to lose around 3-5 barrels per around 1,000 square meters of long-line mussel culture per year. Moreover, due to big storm events, he usually loses approximately 15% of the production, meaning that mussel socks detach from the ropes and sink to the sea bottom; therefore, around 100 kg. of nets and plastic ropes are lost every year from his farm.

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Apart from those operating under a permit, there are still many mussel farms operating illegally (without an official license), mainly in the area of Axios Delta (Chalastra).

1.2.3. The three main core aspects to tackle marine littering

PREVENTION & REDUCTION OF MARINE LITTER

Prevention and reduction of marine litter and debris is the first component to tackle marine littering. Over the past year, regional and local plans have built on this principle. In this sense, preventing and reducing marine litter in the Mediterranean Sea is the main objective of the Regional Plan for Marine Litter Management in the Mediterranean (UNEP, 2013). Appendix 1 of this document consists of a work plan with a timetable for the implementation of the relevant Articles of the Marine Litter Regional Plan, some of which are strongly related to the aquaculture litter.

MONITORING & QUANTIFICATION OF MARINE LITTER

One of the main challenges that occurs in addressing marine littering from aquaculture facilities is quantifying and monitoring litter or debris derived from these practices. In general, as in other EU coastal Member States, monitoring marine litter needs to be done in regard to Water Framework Directive chemical (12 nm from baseline) and ecological (1 nm from baseline) status of coastal waters.

There are several monitoring protocols (UNEP, 2009, MSFD/Galgani et al., 2013, UNEP/MAP, 2014), which take into consideration a standard list of categories of litter items in order to enable the comparison of results amongst the different regions. However, in the case of aquaculture items, most of these are quantified and monitored as fishery derived items, causing a big gap of knowledge that needs to be addressed for a proper litter sector management.

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REMOVAL & RECYCLING OF MARINE LITTER

The third component, which was assessed during the learning labs, is removal and recycling of marine litter and debris. The Regional Plan for Marine Litter Management in the Mediterranean also focuses on recycling and reusing litter (UNEP, 2013). Procedures and regulations vary among the states and even regions in each country.

Nevertheless, recycling of collected non-organic litter can be very difficult due to potential high levels of material degradation. Moreover, some items used in aquaculture facilities, such as ropes or nets, consist of multiple types of plastics, which makes it difficult to recycle them. Besides that, biofouling on ropes or nets makes it even more challenging to properly remove and recycle these items. Additionally, the lack of specific disposal areas for aquaculture items in ports makes it difficult to enhance and facilitate the involvement of the fishermen and aquaculture farmers in the removal and recycling process.

1.2.4. What are the key issues / Challenges?

Current political, social, economic, technological and environmental challenges have to be taken into consideration when addressing the issue of marine litter from aquaculture activities.

POLITICAL AND LEGAL

Regulations on aquaculture facility licensing and monitoring differ widely across the Mediterranean countries and depends usually on the characteristic of the aquaculture facility (proximity to the shore, dimension of the farm etc.) and on the bureaucracy of the licensing process (type of authorities involved).

In some cases, the aquaculture sector in the Mediterranean countries suffers of a lack of specific waste management protocols; this is reflected by the fact that sometimes offshore farms such as mussels farming, as said before, are not provided with waste collecting and disposal sites. In some specific cases, like Spain, there is a lack of sufficient coordination between the state, regional and municipal levels regarding the political-administrative framework. Finally, regarding some of the national environmental regulations, it is noted that a policy related to non-organic marine litter management is lacking.

ECONOMIC

Economic challenges are mainly related with little resources available to invest by farmers for effective marine litter prevention and monitoring, as well as for a good upcycling or

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downcycling of the materials used. Besides, the use of alternative materials (such as biodegradable materials for mussel socks) can be hardly taken as a good alternative due to the higher costs. Other economic challenges arising from the conflict of interest between different businesses and stakeholders is the use of space (e.g. disposal point not possible due to a nearby touristic zone).

SOCIAL/CULTURAL

In relation to the social/cultural aspect, there is a lack of awareness regarding the harm and the impact of non-organic marine litter or debris associated to the aquaculture sector, at all levels: policy makers, waste management organizations, manufacturers, farmers, etc.

AVAILABLE DATA

Non-organic marine litter quantities related to aquaculture are currently underestimated and difficult to measure. This data-gap is due to the lack of unambiguous criteria in current monitoring protocols (such as the MSFD master list) and the lack of training on the identification of the gear which is found during clean-up and litter collection initiatives. Moreover, aquaculture items, as previously mentioned, are usually considered under "fisheries & aquaculture category", not allowing a proper distinction between the two sectors. Finally, the monitoring programmes are not harmonised throughout the regions as there is a lack of standardization and compatibility between the methods used and, consequently, the results obtained and provided.

TECHNOLOGICAL

To be able to fulfil the fishery demand, Mediterranean aquaculture has expanded from land-based and inshore facilities to mariculture facilities, especially in relation with finfish. In Spain, shellfish has been traditionally farmed in "bateas" although there have been some longline tests along the coast of the country. This requires the development of new innovative technologies that consider marine habitat types and mitigation of impacts on marine biodiversity derived from the aquaculture practices and debris loss. Multidisciplinary technologies and advances should focus on eco-friendly materials and devices, and sustainable practices that take different indicators of the Sustainable Development Goals of the United Nations into account.

ENVIRONMENTAL

On the one hand, the Mediterranean Sea is one of the areas most affected by marine litter in the world, mainly because human activities (e.g. tourism, maritime traffic and highly urbanized coastal areas) generating considerable amounts of waste that end up in the sea, and due to the basin's limited connection with other waters (UNEP/MAP, 2015).

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On the other hand, despite the development and expansion of aquaculture activity over the last 30 years, there has been no general awareness raising on marine litter produced by these activities.

As a result, and in contrast to fisheries, little is known about the impact of aquaculture litter on marine ecosystem and biodiversity. However, it is widely known that marine litter impacts biodiversity through ingestion, entanglement and colonization/rafting (Deudero and Alomar, 2015). Moreover, marine litter (mainly plastics and microplastics) have been identified in wild commercial species such as Atlantic Blue tuna, red mullet fish (*Mullus surmuletus*), anchovies (*Engraulis encrasicolus*), bogue (*Boops boops*) and sardines (*Sardina pilchardus*), as well as in other least consumable species such as the blackmouth catshark (*Galeus melastomus*) (Romeo et al., 2015; Alomar et al 2017, Nadal et al 2016; Alomar and Deudero, 2017; Compa et al, 2018, Ríos-Fuster et al., 2019).

According to recent scientific research, polyethylene terephthalate (PET), which is an important polymer making material used in aquaculture facilities, is one of the most frequently found plastic polymers in the marine environment and the digestive system of biota (Alomar et al., 2020, Compa et al., 2020; Compa et al., 2019, Alomar et al., 2016).

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2. Learning Lab workshop for the Mediterranean Sea basin

2.1. General description

The Mediterranean Sea basin **interactive workshop** took place on February 4th, 2020 at the Fundació Universitat Empresa – Universitat de València (ADEIT) venue (València, Spain), from 9.30 a.m. to 3 p.m. Due to English language limitations, and in order to facilitate the participation and communication for those attending, the workshop was carried out in Spanish.

A total of sixteen Spanish aquaculture stakeholders plus 6 members of the AQUA-LIT team attended the workshop.

In order to have harmonized learning labs across the three basins, it was organized following the guidelines documented in D3.1 *'AQUA-LIT Learning Lab's Leading Lines'* deliverable. A save-the-date, invitation and agenda were given out to participants (Annex a) and all participants were provided with a certificate of participation (Annex b). The presentations, pictures and a short news item on the learning lab are presented at the AQUA-LIT project website.

The session started with the plenary session, including:

- An overview of the marine litter in relation to the aquaculture activities in the Mediterranean Sea basin (by Salud Deudero, IEO-COB/AQUA-LIT Consortium).
- An overview of the AQUA-LIT project (Mariana Mata Lara, Geonardo/AQUA-LIT Consortium and Carme Alomar, IEO-COB/AQUA-LIT Consortium).
- A summary of the Spanish government implication regarding the marine litter (Marta Martínez-Gil, Ministry for the Ecological Transition and Demographic Challenge and Pilar Zorzo, Research Center for Ports and Coasts-CEDEX).
- An overview of the marine litter data related to aquaculture provided to the Spanish Government by the NGO Vertidos Cero (Estíbaliz López-Samaniego, Vertidos Cero).
- And, finally, a summary of the main objectives of the workshop and expected outcomes (Maria Vidal Rigo, IEO-COB/AQUA-LIT Consortium).

After finishing the plenary session, the attendants were splitted in three groups (Prevention and Reduction (component 1), Monitoring and Quantification (component 2), and Removal and Recycling (component 3)). Three rounds were hold for around 1 hour covering each topic. Once the three rounds had finished, the LL conclusions of each component were summarized by the AQUA-LIT facilitators to the audience, to aid the final discussion.

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The discussion during the round tables was facilitated by using two triggering questions per group (printed and placed on each topic table in advance, Annex c). Multiple helping questions were also printed and placed on the correspondent table, with the aim to stimulate knowledge sharing and initiate the debate within the group (Annex c).

2.2. Participants

Sixteen participants from different sectors attended the workshop, 15 of which were based in Spain while there was one attendant from a Dutch consultancy. All steps of the aquaculture chain were represented in the Mediterranean Learning Lab: certification bodies, NGO's, governance and national authorities, environmental and aquaculture consultancies, scientific research, plastic producer associations, plastic technology centres, waste managers, farmers and farmer clusters (Table 1). According to gender equality, 75% of the participants (12) were female, while 25% were male (4) (***Figure 3***).

All participants agreed on appearing in pictures taken during the workshop, which could be used for publication purposes.

Figure 3: The participants of the AQUA-LIT learning Lab workshop for the Mediterranean Sea region.

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TABLE 1

Representation of the different aquaculture stakeholder groups at the Mediterranean Sea learning lab workshop.

STAKEHOLDER GROUPS		#
1	Aquaculture farmers (fish, shellfish, seaweed)	2
2	Equipment manufacturers (e.g. of aquaculture material & gear)	1
3	Engineering, system design and construction companies	1
4	Academic research groups	3
5	Professional clusters, associations and platform representatives	1
6	NGOs	1
7	Governance (including policy makers & implementers, and port staff)	3
8	Classification and certification bodies	1
9	Companies processing waste (including waste recycling and incineration)	1
10	Communicators (media, press, science communicators)	
11	Other (student, consultancy)	2

2.3. Round tables

Initially, as specified in the Grant Agreement (GA), each of the three Learning Labs of the AQUA-LIT project was supposed to focus on one specific element of the three core aspects analysed in the project, namely: North Sea Learning Lab focused on Prevention and Reduction; Mediterranean Sea Learning Lab on Monitoring and Quantification; and Baltic Sea Learning Lab focused on Recycling and Removal.

Eventually, considering that one of the main objectives of the project itself is to provide a complete overview of the situation of marine litter regarding the aquaculture activities in the three regions, and due to the differences regarding policies and other aspects among the three study basins, it was decided to discuss all three core aspects in each workshop.

Therefore, three tables were located in the room were the Mediterranean workshop took place, one per each waste management component: Prevention and Reduction (***Table 1***), Monitoring and Quantification (***Table 2***) and Removal and Recycling (***Table 3***) (***Figure 4***). AQUA-LIT Consortium members were in charge of stimulating the discussion per table and, therefore, per component. In the case of the Mediterranean Learning lab, there was 1 member of the AQUA-LIT Consortium acting as reporter and facilitator for the Prevention and Reduction table (***Table 1***), while 2 members (1 facilitator and 1 reporter) for the Monitoring and Quantification topic (***Table 2***) and also 2 members (1 facilitator and 1 reporter) for the Recycling and Removal discussion (***Table 3***). Each facilitator and table held the specific triggering and helping questions developed for the workshop.

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For the Mediterranean Learning Lab, 3 groups of 5, 5 and 6 people were organised semi-randomly with no grouping criteria applied, except for avoiding the allocation of similar profiles in the same group. Consequently, there was one member of the governance stakeholder group, one of the scientific research group and one of the farmers/farmer association representatives in each group.

Figure 4: Participants at the round tables of the AQUA-LIT Mediterranean Sea basin learning lab workshop.

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3. Targeted Learning Lab stakeholder interviews in the Mediterranean Sea

3.1. Purpose of the interviews

The main objective of the **stakeholder interviews** was to better understand the state of play concerning the litter and debris management by the aquaculture sector and to identify the needs, barriers, strengths, best practices, opportunities and existing tools for preventing, reducing, monitoring, quantifying, removing and recycling marine litter related to aquaculture activities in the Mediterranean Sea.

Therefore, profiles covering as many sectors related to aquaculture as possible were selected. Interviews were conducted in person or by video conference.

These interviews allowed going into detail about some aspects that were also commented during the workshop and, moreover, to identify innovative solutions and currently applied good practices that were not suggested previously in the interactive workshop.

3.2. Methodology of the interviews

Sixteen interviews were performed (one of them including 4 shellfish farmers with a very similar profile). Considering that the attendants of the Mediterranean workshop were mainly Spanish (except for one participant), interviewees from Italy and Greece were also included (section 4.3).

With the aim being as consistent as possible, the same questionnaire was used during the interviews in all three sea basins (Annex d). The questionnaire was adapted to the interviewee's profile and, therefore, only the specific questions related to their speciality were used in each case. Each interview took an average of 1 h 30 minutes to answer the questions and it was held in the native language of the stakeholder.

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TABLE 2

Type of interview held with targeted stakeholders in the Mediterranean Sea region.

TYPE OF INTERVIEW	#
Face to face interview	1
Skype call	11
Written interview	4

3.3. Interviewees

TABLE 3

Representation of the different aquaculture stakeholder groups in the targeted interviews in the Mediterranean Sea region.

STAKEHOLDER GROUPS		#
1	Aquaculture farmers (fish, shellfish, seaweed)	2*
2	Equipment manufacturers (e.g. of aquaculture material & gear)	1
3	Engineering, system design and construction companies	
4	Academic research groups	2
5	Professional clusters, associations and platform representatives	3
6	NGOs	2
7	Governance (including policy makers & implementers, and port staff)	2
8	Classification and certification bodies	3
9	Companies processing waste (including waste recycling and incineration)	1
10	Communicators (media, press, science communicators)	
11	Other (student, consultancy)	

** In one of the occasions, four shellfish farmers were interviewed at the same time.*

TABLE 4

Origin of represented organisations for the interviews in the Mediterranean Sea region.

COUNTRIES	#
Spain	7 (10*)
Germany	1
Italy	4
The Netherlands	1
Greece	3

**In one occasion, four shellfish farmers were interviewed at the same time.*

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It has to be noted that the Dutch and German interviewees were both representants of certification bodies with a general worldwide overview, but also with specific information regarding the situation of the aquaculture in the Mediterranean.

TABLE 5

Gender representation in the targeted interviews in the Mediterranean Sea region.

GENDER	#
Male	12 (15*)
Female	4

** Three shellfish farmers were interviewed at the same time.*

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4. Identified barriers, solutions and good practices

This section summarises the responses of the participants in the three round tables of the workshop, combined with the information collected during the personal interviews. The responses are presented under the corresponding triggering questions used during the workshop for all three core aspects of tackling marine littering (1. Prevention and Reduction, 2. Monitoring and Quantification and, 3. Removal and Recycling). Good practices suggested in the workshop and during interviews have been identified and linked to the related core aspect of tackling marine littering and, furthermore, to specific solutions.

It should be noted that some of the proposed suggestions or solutions have been moved to the topic where it was considered, according to AQUA-LIT Consortium opinion and expertise, to fit best.

4.1 PREVENTION & REDUCTION OF MARINE LITTER

BARRIERS

What are the barriers to preventing and reducing the loss, damage or discard of gear and other equipment in the aquaculture sector?

- There is a lack of updated information on the items that are most frequently lost, broken or abandoned and the main reasons and responsible person for this issue. (Is it due to the use of non-resistant material, bad practices in use, the use of non-valuable items, lack of monitoring during special periods of concern (harvesting, storms)?

  For example, there is a big issue related to the plastic, extruded, tubular nets which are used for mussel farming in some areas of the Mediterranean Sea. This gear is usually covered with organic material once it has been used and, therefore, it is very difficult to reuse or recycle (as it needs an expensive cleaning process). Moreover, since this gear is currently not being recycled or reused, it is perceived as it has no economic value at the end of its life-cycle. Thus, it is sometimes dumped or simply abandoned nearby the aquaculture facilities.

- In general, the design of the gear is not optimized to the harsh marine conditions where some of the aquaculture activities take place.

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- The biofouling on material (e.g. aquaculture nets) that remains in the sea for a long time makes the material more fragile since fish are attracted by this organic material and can ingest fibres forming the net.
- There are currently no real alternatives to most of the items made of plastic (e.g. the tubular nets used for mussel farming). There are plastics (currently used in greenhouses) that dissolve in water, but they are very expensive. Besides, biodegradable plastics cannot yet be considered as an alternative to conventional plastics because they take some time to degrade, having an environmental impact as a consequence. In addition, they are not sufficiently resistant to harsh environmental conditions.
- There is a lack of awareness at all levels of the aquaculture life cycle regarding the prevention of non-organic marine litter.
- The prevention of marine litter should be the base of the circular economy. Currently, gear producers are not considerably involved or interested in this type of approach, making sustainable design, research on alternative materials, etc, not their priority. (This situation will have to change once the Directive UE 2019/904 on the reduction of the impact of certain plastic products on the environment is applied by all European countries).
- The aquaculture governance structure in Spain is complicated with a lack of homogenization at a national level in relation to the requirements, guidelines and authorization requests in the different autonomous communities[1].
- The procedures to be applied by farmers in their facilities to reduce and prevent non-organic litter from aquaculture activities are implemented on a voluntary base in Spain (e.g. as recommendations included in the national guidance for the minimization of the animal by-products and derived products not intended for human consumption and debris of the aquaculture activities, published by OESA and Fundación Biodiversidad in 2017).
- The environmental criteria related to the approval of aquaculture facilities do not include specifications on the non-organic litter management in some autonomous communities.
- Specific criteria related to non-organic marine litter are lacking in the Environmental Surveillance Plans (PVA in Spanish). For example, the national guidelines for offshore finfish farms PVAs (which were published in 2012 by the Ministry of Agriculture, Food and Environment) include multiple chemical and biological indicators to evaluate the environmental status of the facilities and their surroundings, but only one indicator is related to the non-organic marine litter, which is the ”presence of plastic materials,

[1] The Title VIII of the Spanish Constitution establishes the territorial organisation of Spain, which consists of three levels: the state or central organization, Autonomous Communities and Local Entities (Ministry of Territorial Policy and Public Function, 2020).

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ropes, metallic elements, containers or any other item or tool which is used for maintenance tasks on the seafloor (at the bottom of the facility)".

- In Italy, only finfish farms have to pass through an environmental assessment before starting the activity. Shellfish farms are not obliged to make this assessment. However, before the installation of a new farm, an environmental study of the site where the facility will be installed has to be done. Currents, seafloor, habitat type are all criteria checked to allow approval of the facility.
- In Greece, there is no specific environmental legislation concerning mussel culture and its waste management. In order to obtain their installation renewal permit, the mussel farmers need to ensure an approval of their environmental assessment. The waste management only consists in an agreement with the Municipality, that will collect the waste.

SOLUTIONS

What are the (technical) innovative solutions, business models and (policy) measures to prevent or reduce the loss, damage or discard of gear and other equipment in the aquaculture sector?

1. Specific prevention measures for open-sea facilities.

- Avoid, as far as possible, bringing items into open sea facilities that can potentially turn into garbage, such as plastic feed bags, which can be substituted by heavier containers that cannot fly away so easily.
- Facilitate the collection of small gear items when they are being removed by bringing containers to the facilities.
- Purchase very resistant material to harsh conditions. **Prevention and Reduction (P&R) | Good Practice (GP) 1.1: Farmers purchase very resistant anti-predator nets for mussels farming.**

2. Awareness and training.

The aquaculture gear that reaches the end-of-life becomes a marine litter problem when it is not discarded and treated properly. This may happen due to various circumstances. For example, single-use-plastic non-valuable and non-reusable/recyclable elements are frequently discarded, lost or abandoned during the daily tasks because farmers might not care about losing them or might not be aware on the impact of those items in the marine environment or because they are not fixed or assembled as strong as needed. In this scenario, some measures can be applied:

- Increase the awareness of all aquaculture stakeholders regarding the prevention of marine litter. Communication about this issue should be as easy to "digest" as possible,

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preferably by means of online workshops/webinars. **P&R | GP2.1: Sustainable aquaculture and circular economy project.**

- Establish management practices and train the staff in good procedures about how to handle, fix and assembly all types of gear in order to reduce the quantity of elements that are frequently lost. Trainings could be done in collaboration with technicians from the gear production companies.
- Support campaigns organized by the public administration focused on good practices applied by the aquaculture sector and the certified products related to those good practices. Promote the idea that an improvement in the reduction of non-organic litter implies a better public image of the sector. And, at the same time, increase the customer awareness related to the fact that higher prices (derived from new EPR systems in place, alternative materials, etc) are related to a better environmental quality of the aquaculture product. **P&R | GP2.2.: Creation of good practice guidelines related to marine litter specific for shellfish farming.**
- Include the identification of potential sources of waste and the estimation of non-organic marine litter related to an aquaculture facility in the PVAs, with the aim to improve the transparency and to raise awareness from the beginning of the operation of the facility.

3. Setting up preventive maintenance schedules for the aquaculture facilities.

- Create surveillance plans which include checking the state of the aquaculture facilities regularly, with the objective to prevent potential gear losses and damages. These pre-scheduled checks can also be considered a source of information on the life cycle, durability and resistance, etc of the gear and the items used, and, therefore, they can be the basis of the farmers' customized traceability systems. Surveillance plans should be included in the good practices' certification. **P&R | GP3.1: Scheduled maintenance surveillance plans of the good status of the shellfish farms.**
- Establish official reference values in relation the potential waste generated by the aquaculture sector. The non-organic marine litter ranges should be exclusive of each type of aquaculture main activities (shellfish, finfish, algae) and should be public.

  This kind of litter-frame would help to build trust among the multiple aquaculture stakeholders involved in the non-organic marine litter management (by not feeling only blamed for the non-organic marine litter and including them in the solutions approach) and, therefore, it would facilitate the communication of the gear losses among the stakeholders, hence improve the transparency of the sector.

4. Insurance companies' role in marine litter prevention regarding the knowledge of the items which are lost or broken more frequently.

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- The information provided by the farmers to the insurance companies regarding their facilities in place (main structures, important elements, gear, etc) and what is lost after a large storm event could help to identify the items that are more vulnerable in a critical situation and, therefore, to reduce the damages and losses.

5. Good practices and certification.

- The creation and agreement upon an official regulation should be the basis for the good practices' certification. This official set up of rules, under the European Committee for Standardization (CEN) frame or any national initiative like the Asociación Española de Normalización (UNE), should include establishing standards that consider the life cycle analysis, promoting resistant materials and durable items and supporting sustainable designed gear. **P&R | GP5.1: Good practices certification set up at a worldwide level and, specifically, in Spain.**
- The certification of adopted good practices to reduce and prevent the potential non-organic litter or debris should be encouraged by positive economic stimuli, such as tax reduction or fiscal incentives.
- Good practices regarding the waste prevention should be mandatory (no alternative accepted) and they should become another part of the daily work flow.
- Improve the control points of waste prevention in the aquaculture standards for good practices certification: control points should be feasible to be implemented by producers and feasible to be verified by the certification body.
- Emphasize the value of the good practices that are currently in place and being applied by the farmers.

6. Apply the circular economy approach and the 5R's schemes to prevent and reduce the non-organic marine litter from aquaculture activities.

- Consider the circular economy approach when designing any aquaculture gear, to provide an economic value from the first step in the production to the end-of-life. This makes the collection of used gear and disposal to the available disposal points worthy, with the aim to integrate aquaculture gear in a circular cycle scheme. This requires information of any aquaculture gear on the market demand and the potential for being reused and/or recycled/upcycled .
- Enlarge the life-cycle of the nets by following a regular maintenance scheme including washing, disinfection, repairing and applying anti-fouling treatments, among others. This kind of regular schemes can help to enlarge the life-cycle of the big nets and, therefore, to reduce the probability of break and/or loss. **P&R | GP6.1: Enlarge the life-cycle of the nets by following a regular maintenance scheme.**

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- Promote the local repair and reuse of nets. **P&R | GP6.2: Reuse of net bags for selling mussels and sacks used for mussel transport from the farmer to the processing companies.**

  For example, the "redeiras" are the Galician women specialised in repairing and recovering damaged fishing nets. Currently, there are no "redeiras" linked to aquaculture activities, but these job profiles and positions could be brought to the aquaculture life cycle and included as part of the corporate social responsibility of the aquaculture farmers and/or the gear producers.

7. Technical improvement and innovation of materials

Mitigate the price impact on aquaculture gear and materials composed of more durable materials instead of cheap plastics by a gradual shift in the production of materials by gear producers to facilitate the adaptation of the aquaculture farmer. Moreover, the customer will need to make aware that the higher prices are related to a reduced environmental impact of the aquaculture product.

- Carry out a complete analysis of the technical characteristics of suitable material for aquaculture gear (flexibility, resistance to harsh conditions, corrosion resistant, among others) and life-cycle steps (from production to end-of-life treatment). Those materials should be resistant to harsh environmental conditions. This research and development analysis should result in recommendations on types of materials or mixtures of materials needed to produce the most frequent aquaculture items. Moreover, this analysis should be incorporated in environmental aquaculture regulation and gear made following these recommendations should be included as a certified good practice.
- Focus on producing nets with materials that do not get residuals and biological components attached (biofouling), in order to avoid fast degrading processes.
- Alternative material research should include tests and analyses on substances that were used prior to plastics, e.g. wood for mussel stoppers or for fish transport.

  For example, the plastic stoppers used in the Galician mussel farms were traditionally made of Acacia wood. Nowadays, Acacia cannot be planted in Spain since it is an invasive species. Research could focus on finding an alternative native wood suitable to produce plastic stoppers.

  Another example is related to the expanded polyethylene boxes that are currently being used for transporting fish. Before the plastic expansion, fishes were usually transported in wooden boxes, which are currently considered not hygienic enough. In this scenario, and considering the circular economy approach and the sustainable design concepts, it would be interesting to make a research effort focused on finding the most suitable system to reduce the hygienic limitations associated with the wooden boxes.
- Improve the technical characteristics of the biodegradable plastics. Enlarging the life-cycle of the small/non-valuable/single-use-plastic items, which are frequently abandoned, discarded or lost, is currently not an option to reduce their impact. Therefore, efforts

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should focus on improving their design (see next point) or on finding alternative materials to the conventional plastics. Biodegradable plastics were considered a good alternative in the past, but they have proven not to be resistant enough to harsh conditions. Besides, these plastics still contribute to marine litter before they completely disappear. Therefore, to consider biodegradable plastics as a real alternative to the conventional plastics, an effort should be done to reduce the time needed to degrade them and to increase their resistance to harsh conditions. **P&R | GP7.1: Testing the biodegradable plastic nets used for marketing.**

- Focus the design of aquaculture facilities on creating stable and solid infrastructures to minimize losses and damages. All aquaculture gear should be designed to be as resistant as possible to harsh marine conditions and to be able to attach to other items to avoid loss or damage (this is especially important for small items made up of single-use-plastics). **GP1.7.2: Shifting to different type of mussel technique such as "The "New Zealand" system or SMART FARM system.**

  Therefore, it is important to raise efforts to find and promote alternatives to cable ties, like more resistant and durable fixing systems. Any breakthrough related to eco or sustainable designs should be integrated in the aquaculture regulation.

8. Create synergies among all aquaculture stakeholders to facilitate the prevention and reduction of non-organic marine litter.

- Create a communication channel that connects all involved stakeholders to help to identify the main needs and priorities in relation to non-organic litter prevention and reduction in the aquaculture sector. This channel would facilitate sharing the information about the items that have been lost, broken or abandoned by the farmers and the items collected during the marine litter clean-up initiatives. Therefore, this initiative could help to identify and recover some of the lost/abandoned/discarded gear (as a part of the Monitoring and Quantification and Removal and Recycling core aspects) as well as to estimate which are the most frequently lost, abandoned and discarded items and the reasons why.
- Share this information with the gear manufacturers, material producers and the policy makers, with the aim to create a set of rules that would apply to the gear design and material selection, to ensure resistance and durability in a regulation framework. Finally, this regulation would be the basis for the good practice criteria certification. **P&R | GP8.1: Enhancing the communication among the aquaculture stakeholders.**

9. Enforcement of the governance related to non-organic marine litter.

- Incorporate the European Directive 2019/904 on the reduction of the impact of certain plastic products on the environment into the Spanish law.

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- Create a specific Spanish Single-Use-Plastic regulation and Extended Producer Responsibility scheme regulation for fisheries and aquaculture.
- Synchronize the license renewals that shellfish farmers need from the approving authority and from the Port Authority.

  In some regions of Spain, shellfish farmers need to renew licenses from the approving public authority every 10 years but, on the other side, the licenses from the local Port Authority have to be renewed every 3 years. In this scenario, the temporal horizon to invest in the facilities is very short and, therefore, the economic effort to make the farms more durable and resistant are not perceived as a priority. If both licenses could be synchronized to 10 years, farmers would make more long-term investments that could help to keep their installations in a good status.
- Currently, there is no specific Spanish regulation regarding the management of the non-organic marine litter that comes from the aquaculture activities. Besides, each autonomous community can have its own specific waste regulation that might be applied to the non-organic marine litter from the aquaculture activities in the frame of the approval procedures. Therefore, it would be advisable to homogenize as much as possible the criteria of the multiple autonomous communities regarding waste management.
- Include or expand (depends on each autonomous community) the development of a non-organic waste management plan in the environmental authorization procedures and/or the PVAs.
- Involvement of the policy makers environmental authorities in the identification of areas for the development of the aquaculture, to guarantee the harmonious integration of the aquaculture facilities in the coastal zones, minimize land-use conflicts and reduce the potential impacts. P&R | GP9.1: Establishment of POAY, consortia that manage operations of mussel farms in the North of Greece

10. Taxes and fines

- Raise taxes on non-sustainable (like plastic) materials but not on alternative materials to create a clear benefit in using the sustainable gear. Aquaculture farmers hold the final responsibility to choose among the multiple market options. This means that they create the demand by their buying decisions. This solution can only be adopted once there are real alternatives to the non-sustainable materials.
- Apply penalties to the companies that do not put in place prevention measures.

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GOOD PRACTICES

Do you know of any good practices already in place to prevent or reduce the loss, damage or discard of gear and other equipment in the aquaculture sector?

1. Specific prevention measures for open-sea facilities

P&R | GP1.1: Farmers purchase very resistant anti-predator nets for mussels farming.

Those nets can be considered themselves as a preventive measure for reducing the gear losses. Besides, those nets are being selected by the shellfish farmers depending on their resistance, to maximize their use. Once they have reached the end-of-life, mussel farmers clean them, dry them off and bring them to the larger-items waste management collection point (which is actually the best current practice, while there is no specific EPR system in place).

2. Awareness and training

P&R | GP1.2: Sustainable aquaculture and circular economy project.

A project was initiated in 2019 as collaboration between a Spanish Protected Designation of Origin (PDO) organization and a research institution, funded under the Fundación Biodiversidad-PLEAMAR Call. The main aim of the project is to reduce the impact of the marine litter related to shellfish farming activities by: encouraging best practices related to circular economy and involving gear producers and policy makers to identify the needs of the sector regarding this issue.

P&R | GP2.2: Creation of good practice guidelines related to marine litter specific for shellfish farming.

A Spanish PDO organization published an online guideline about good practices related to marine litter in 2018. This guideline is specific for the shellfish farming sector. The aim of the publication is to increase awareness in the sector on marine litter and to encourage applying good practices.

3. Setting up preventive maintenance schedules for the aquaculture facilities

P&R | GP3.1: Scheduled maintenance surveillance plans of the good status of the shellfish farms.

Spanish shellfish facilities are regularly (although not following a schedule) checked by their own farmers, to ensure that there has not been any loss or there is nothing broken). Besides, Port Authorities perform scheduled checks of the farming installations in Spain.

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4. Insurance companies' role in marine litter prevention regarding the knowledge of the items which are lost or broken more frequently.

The stakeholders participating in the learning lab did not mention specific good practices for this topic.

5. Good practices and certification.

P&R | GP5.1: Good practices certification set up at a worldwide level and, specifically, in Spain.

Accredited certification bodies perform the verification of the control points at primary production. There are different certification bodies accredited to do aquaculture audits and certification, worldwide. In the general regulations it is stipulated which are the conditions for a certification body to be allowed to do audits/certification. The accreditation system is based on ISO17065.

The main role of the certification bodies is to ensure that the aquaculture companies are accomplishing specific criteria that include multiple aspects related to fish farming: environmental criteria, ecological production, animal welfare, among others. Criteria for waste prevention and management are included in the aquaculture standards. In some cases, the criteria include using gear which is certified according to national legislation.

The worldwide aquaculture certification company ASC is now working together with some the biggest aquaculture companies in Europe to find solutions and preventions for aquaculture littering. A white paper that addresses this problem has been published in November 2019.

Apart from the international standards, there are specific national guidelines provided by certification bodies in Spain.

6. Apply the circular economy approach and the 5R's schemes to prevent and reduce the non-organic marine litter from aquaculture activities.

P&R | GP6.1: Enlarge the life-cycle of the nets by following a regular maintenance scheme including washing, disinfection, repairing and applying anti-fouling treatments, among others.

There are many international companies that produce aquaculture gear which also provide maintenance services, mainly aquaculture nets, in multiple areas of the world like Spain (e.g. Amposta, in Catalunya).

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P&R | GP6.2: Reuse the net bags for selling mussels and the sacks used for mussels' transport from the farmer to the treatment companies.

Both items are usually in good state, as they are only used for mussel transport from the aquaculture installation to the final consumer or from the farmer to the processing company. Therefore, in case of direct marketing, farmers can request those nets and sacks to be returned once mussels have been removed and, thus, both items can be reused with no extra cost. This is currently done by the Menorcan mussel farmer Muscleres González and the mussel farmers associated to a Spanish PDO organization.

7. Technical improvement and innovation of materials

P&R | GP7.1: Testing the biodegradable plastic nets used for marketing.

NOVAMONT, an Italian innovative material production company, developed a new biomaterial for producing aquaculture mussels' nets. Together with Rom Plastics S.r.l., University of Siena and a mussel farm based in La Spezia managed by Cooperativa Mitilicoltori Spezzini, they are testing the new biomaterial in the lab and on the field. Nets are being tested in different ecosystems and sediments, in the lab and in the natural environment, to check their degradable time and resistance. The first trials gave positive feedback from farmers involved in the project. Once used, the nets can be placed in special containers for compost, reducing the price for disposal, cleaning and recycling process. The material is still under refining process, since it proved to be less resistant and durable than plastic nets, and more expensive to be purchased.

In the project BIOGEARS, led by AZTI and in collaboration with the Basque rope producer company Itsaskorda, long-line ropes made of biodegradable and compostable material for mussel production are being developed. They are also developing the BLUENET project, in which the feasibility of recycled discarded fishing nets and aquaculture long-lines ropes are being tested to manufacture ropes for long-line mussel production.

P&R | GP7.2: Shifting to different type of mussel technique such as "The "New Zealand" system or SMART FARM system.

Due to its particular structure, the New Zeeland system performs better than the longline technique because it is more resistant to storms and, therefore, it decreases the possibility to lose products and nets in the water. The "New Zealand"system, as is the case of normal longlines, uses a basic element consisting of the cable or beam, anchored to the bottom by heavy bodies and maintained at a depth of about 3 meters relative to the surface of the sea thanks to a series of floats. The mussels are bred on a continuous rope called "watershed", which is fixed to the beam through the use of silhouettes spaced about 8 meters apart and positioned along the row with a serpentine pattern. The sharp produces "festoons" of about 4 meters, arranged to loop in a perpendicular direction with respect to the horizontal axis of

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the sea and the shellfish are kept compact on the rope through the use of a special water-soluble cotton sock, which after a certain period of time, in contact with seawater, melts.

The SMART FARM system is nowadays used more frequently in North Europe. This type of technology allows to cope better with the wave movements and brings a number of advantages in relation to the safety of facilities and personnel, the limitation of product losses, as well as the reduction of environmental impact, as no plastic socks are used, which could detach and settle on the sea bottom. However, the tests in Italy reveal that the system does not work really well in stormy conditions.

8. Create synergies among all the aquaculture stakeholders to facilitate the prevention and reduction of non-organic marine litter.

P&R | GP8.1: Enhancing the communication among the aquaculture stakeholders by involving farmers, farmer associations, PDO organizations or good practices certification bodies and policy makers (at Spanish and European level).

A Spanish PDO organization is strongly linked not only to the associated shellfish farmers, but also to the regional (they are members of the PDO governing body although they are not allowed to vote) Spanish and European policy makers, to the European Molluscs Producers Association (EMPA), Spanish Advicer Assembly of Marine Cultures (JACUMAR due to the Spanish abbreviations), among others.

9. Enforcement of the governance related to non-organic marine litter.

P&R | GP9.1: Establishment of POAY, consortia that manage operations of mussel farms in the North of Greece.

Recently, two mussel farming consortia (POAY, "Areas of Organized Development of Aquaculture"), were established in the norther part of Greece, which will be governed by a Board of Councils, composed of members which are representatives of the involved municipalities, farmers and other authorities. **POAY Thermaikos,** which will manage the activity in the northern part of the Thermaikos gulf, and the **POAY Pydnas – Makgygialou** will manage the activity in the southern part of the Thermaikos gulf). Stakeholders in charge of the POAYs expect that the full function of the consortia will change the situation radically, with better management and legislations, including waste monitoring and management.

POAY were defined and stablished by the Greece Government in the Law 2742/1999 "Spatial Planning, Sustainable development and other provisions" and the "Strategic Plan for Aquaculture" (2002) with the aim to identify suitable areas for the development of aquaculture (FAO, 2020).

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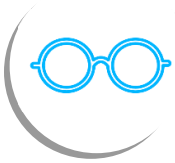
10. Taxes and fines.

The stakeholders participating in the learning lab did not mention specific good practices for this topic.



4.2 MONITORING & QUANTIFICATION OF MARINE LITTER

BARRIERS

What are the barriers to monitor and quantify the loss, damage or discard of gear and other equipment in the aquaculture sector?

- The current monitoring performed and promoted by the government is not efficient enough in Spain.
- There is a lack of standardised criteria for environmental monitoring systems (e.g. in Spain each Autonomous Community deals with their own regulation).
- There is a lack of monitoring systems for marine litter and for non-organic marine litter from aquaculture activities specifically.
- The standardised forms used at a European level to collect information about the floating marine litter and the debris located on the seafloor are not complete or updated as they lack item categories that are frequently found in the Mediterranean Sea.
- There is a lack of specific data related to material losses from aquaculture activities.
- There is a lack of specific information on the impact of marine litter from the aquaculture sector to showcase the problem.
- There is a lack of knowledge to identify aquaculture items in marine litter collections.

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SOLUTIONS

What monitoring measures and schemes should be introduced, improved or enforced to encourage and empower every stakeholder to tackle the issue efficiently?

1. Including monitoring protocols in the environmental regulation of the aquaculture facilities.

- Expand the current environmental objectives of the Marine Strategies[2] to include the criteria of monitoring marine litter (related to descriptor 10 - MSFD) in the Compatibility Reports[3]. Nowadays, the environmental objective B 1.5 that applies to the aquaculture facilities in the Compatibility Report frame is "Reducing the quantities of marine litter that comes from land and marine sources" which is not specific enough and could be improved by including the monitoring point of view.
- Add monitoring marine litter as criteria in all the PVAs related to any kind of aquaculture activity.
- Simplify the proposed PVA guidelines for farms smaller than 500 t.
- Include also material lost data in the report on sustainability. Some aquaculture companies develop sustainability reports which are usually based on the evaluation of their performance on environmental (and social) indicators. But lost material information is not frequently included.
- Include an indicator of collection of marine litter around the farm on the report on sustainability.

2. Promote the research on quantification and monitoring of no organic marine litter from aquaculture activities.

- Perform a rigorous analysis regarding the marine litter that is generated by the aquaculture sector.
- Develop research programmes on quantification and type of litter coming from the aquaculture sector in the Mediterranean Sea and increase general awareness.
- Generate knowledge on which type of litter comes from which type of aquaculture, creating a database that quantifies the contribution per type of category. This allows to estimate the correlation between the type and amount of aquaculture produced and the potential litter associated.

[2] Spanish Marine Strategies constitute the general framework to which the multiple sectoral policies and administrative actions with an impact on the marine environment must necessarily comply.

[3] In Spain, all marine aquaculture facilities (growing or fattering any commercial species) need to develop a Compatibility Report (regulated with the Decree 79/2019) regarding the Marine Strategies, and they have to be approved by the Ministry for the Ecological Transition and the Demographic Challenge.

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- Include topics on monitoring of marine litter in the curricula of aquaculture professionals (universities or research centres) and carry out workshops/awareness activities.

3. Increase synergies and enhance communication among the stakeholders.

- Increase synergies among academia, policy and farmers for a common understanding and knowledge of aquaculture marine litter quantification.
- Communication is very important, as a form of awareness and for showcasing a current problem needed to be addressed. Monitoring & Quantification (M&Q) | GP3.1: Targeted communication.

  A communication channel that connects all the involved stakeholders should be created, with the aim to facilitate sharing the data about the items that have been lost, broken or abandoned by the farmers and the items collected during the marine litter clean-up initiatives. This channel could help to monitor marine litter, to improve aquaculture gear identification and update the forms used to collect information during the clean-up initiatives, and to estimate which are the most frequently lost, abandoned and discarded items.

  Once government and involved stakeholders have access to real data regarding the problem, they will probably more easily engage in addressing the problem.
- Incentivize collaboration among farmers through the creation of clusters of aquaculture services acting in a sustainable way (e.g. sustainable waste management).
- Estimate losses based on the information provided by the farmers to the insurance companies regarding their facilities in place (main structures, important elements, gear, etc) and what is lost after a large storm event.

4. Improving monitoring schemes.

- Train professionals and volunteers to characterise and differentiate the non-organic marine litter related to aquaculture from other sectors. This will increase the knowledge at a European and national level and improve monitoring programmes.

  This recommendation would have an impact on the marine waste statistics, as the proportion of aquaculture gear would probably increase. Therefore, the statistics would reflect more realistically the impact of the aquaculture regarding the marine litter and would help to indentify the most frequently lost/abandoned/broken items. Thus, this information would help to focus the needs on research and development regarding alternative materials and sustainable design.
- Adapt the list of found items and characterized categories in the standardised monitoring forms, in response to the changing market of aquaculture gear.

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For example, the frequency of 4/6-pack yokes found on the clean-up initiatives has diminished throughout the last years, but they are kept in the current forms as a specific item to be characterized. On the other side, due to the single-use-plastic-bags taxes, there has been an increase in the presence of paper bags, but they still have not been included in the forms as a differentiated element.

- Standardise monitoring protocols and characterization of marine litter derived from aquaculture facilities at a national level **(M&Q | GP4.1: The Spanish Ministry for the Ecological Transition and the Demographic Challenge (MITECO) is involved in the marine litter monitoring)** and international level **(M&Q | GP4.2: Fostering incentives for following environmental certification which include also marine litter monitoring in the criteria).**

  The standardization protocols and characterization should also apply, as far as possible, to the litter produced in inland facilities (which monitoring is under the Deputy Directorate for Waste Prevention and Management instead of the Directorate for the Coast and the Sea, in the Spanish case). This action would help to keep better track of all types of aquaculture waste.

- Improve the monitoring schemes for floating and seafloor marine litter.

  Standardization of the methodology, the measurement units and the categories of the filling form should be implemented at European level: it has been detected that, currently, items that are frequently found in the Mediterranean Sea are not included in the forms that are nowadays being tested.

- Enforce marine litter monitoring in aquaculture plants using the correlation between biomass and material losses. Especially for mussel farming, biomass loss provoked by storms or any other environmental cause can be easily quantified by farmers. This can be used to estimate the gear loss (e.g. mussels nets) by correlating the two factors.

- Improve the marine litter quantification around the farms, which needs to be included in the monitoring programme of the water quality (not only of the seafloor).

- Monitor the seabed using specific technology (underwater drones, robots)

- Implement the use of material tracking systems to trace e.g. buoys, etc.

- Oblige, by law, to tag the aquaculture nets and other big gear like buoys, so that they can be traced. Gear should be tagged by the manufacturer and by the farmer.

  In Spain, fixed fishing nets are tagged by law.

  Floats/buoys are usually found tangled with the nets on the seafloor. Therefore, it would be advisable to mark nets and floats/buoys together.

- Fill in a logbook, keeping track of the bought items, installed and/or used items, the major events happened and any gear loss or break.

  Basically, comparing the bought items versus the items that have been used and returned to the aquaculture facility once they have reached the end-of-life point can help to estimate the gear losses.

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GOOD PRACTICES

Do you know of any good practices already in place whereby monitoring measures and schemes are encouraging and empowering stakeholders to tackle the issue efficiently?

1. Including monitoring protocols in the environmental regulation of the aquaculture facilities.

The stakeholders participating in the learning lab did not mention specific good practices for this topic.

2. Promote the research on quantification and monitoring of no organic marine litter from aquaculture activities.

The stakeholders participating in the learning lab did not mention specific good practices for this topic.

3. Increase synergies and enhance communication among the stakeholders.

M&Q | GP3.1: Targeted communication is a tool to increase awareness and to showcase a current problem needed to be addressed.

As an example, in Italy, thanks to the project CleanSeaLife (funded by the EU), data have been collected on mussel nets stranded on beaches and on the seafloor along the Italian coast, and presented to governmental institutions, farmers and other stakeholders, increasing awareness and willingness to find solutions.

4. Improving monitoring schemes.

M&Q | GP 4.1: The Spanish Ministry for the Ecological Transition and the Demographic Challenge (MITECO) is involved in the marine litter monitoring.

Spanish MITECO is involved in the marine litter monitoring through two departments. Firstly, the Directorate for the Coast and the Sea has been involved in the monitoring of the marine litter on beaches for more than 12 years. Currently (2020), there are 26 beaches included in the monitoring scheme, which is performed by the MITECO technicians by following a protocol and filling in a form in which the found items are characterised by material (plastic, metal, wood, fabrics, rubber, paper and glass) and, in some cases, by litter source. Secondly, the Deputy Directorate for Waste Prevention and Management is working on the development of a protocol (that, ideally, should be harmonised with the protocol used for beaches monitoring) specific for waste monitoring on land; currently, any specific item regarding the aquaculture activities is included in the official form.

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M&Q | GP4.2: Fostering incentives for following environmental certification which include also marine litter monitoring in the criteria.

ASC certification company is working to include marine littering as criteria in its certification programme. Farms should have incentives in applying to these kinds of certifications, that require specific criteria.

4.3 REMOVAL & RECYCLING OF MARINE LITTER

BARRIERS

What are the barriers to removal and recycling of gear and other equipment that is damaged, discarded or lost?

- Directive (EU) 2019/883 on port reception facilities for the delivery of waste from ships refers only to nets as the passively fished waste. To design a complete removal and recycling process of the aquaculture (and fishery) gear, it would be necessary to include other equipment and material,
- There is no specific waste management regarding the aquaculture sector, including lack of information regarding roles and responsibilities (in Spain). A large percentage of aquaculture gear that has reached the end-of-life is likely dumped or incinerated. There is a need to have a standardized and approved management system at a national level.
- There is additional legislation needed (decrees) to put in place specific EPR schemes in Spain.
- High-level policy makers show little awareness of the necessity to develop specific decrees for the EPR system. Besides, an EPR system is very complex and needs the involvement of many sectors and many public and private institutions.
- The set up of the EPR schemes may imply an increase on the gear prices.
- Circular schemes based on recycling end-of-life nets to produce recycled nets does not seem to have, currently, economic viability since recycled nets are much more expensive than regular nets.
- There is a lack of protocols for the cleaning and recovery of materials prior to recycling. There is a resistance to collecting all types of materials in ports. For example, dirty materials are not taken by all recyclers.

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- Marine litter recycling (e.g. nets) is very difficult and complicated because of the degradation level. Besides, aquaculture gear sometimes has mixed different types of material, which makes recycling even more difficult and expensive.
- In Greece, it is the Municipalities' duty to collect the mussel farming waste, but the mussel farmers should be charged for this service. As there are no proper disposal points, farmers often burn the nets and pile barrels close to the ports.
- Waste management points or recycling centres are not usually near the collection points for aquaculture litter and the transportation costs are very expensive (payment of taxes or management/transport of waste to waste management facility. Even more, some ports do not have facilities for collecting nets or other type of waste.

  For example, Italian and Greek mussel farms do not necessarily have eco point in the port where they unload their waste. Italian farmers have to pay a tax for collection of nets but when they do not have the facility, they have to contract directly an external agency to deal with their waste, which is much more expensive. In this way, farmers place nets in normal bins (preventing recycling) or do not care too much when losing them in the sea.
- There are no containers for small size material.
- Market is lacking to use all types of recyclable material.
- There are no plants adapted for recycling all types of material.
- Bottom and water column waste is not always accessible.
- Waste collection points sometimes compete with touristic places which generates spatial conflicts of interests.
- In Greece, some of the most common wastes from mussel farms are barrels used as floating material in the longline mussel culture. Since they have a value, individuals collect them randomly for recycling purposes, when they find them in the ports. But sometimes barrels get stranded on beaches and muddy areas, since they are not disposed of properly.
- There is no quantification of the general volume of waste.

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SOLUTIONS

What are innovative solutions and business models that can be used to remove or recycle the gear and other equipment that is damaged, discarded or lost?

1. Collect and remove the marine litter nearby the aquaculture source.

- Fix collectors at sea around the farms to collect waste at the sea surface.
- Increase the number of companies collecting and cleaning material in the water column and bottom (including divers). **R&R | GP1.1: Methodology for removing and preventing the abandonment of fishing gears at sea, including aquaculture nets.**
- Increase efforts on innovation for automated seafloor waste collection systems.

2. Development of specific removal and recycling regulation of the marine litter related to aquaculture.

- Develop a specific decree for the aquaculture EPR scheme. Although the EPR concept is included in the Spanish Waste Legislation (Law 22/2011, Title IV), affecting all economic activities, there has been no further development of the specific decree needed to create the EPR scheme for each sector, including aquaculture.

  It has to be considered that in the absence of a specific decree to develop the EPR scheme for the aquaculture sector, there will be no specific flow of litter from the aquaculture producer to the waste management sector and the litter will probably end up in the marine environment, in incinerators or in dumping areas.
- Put in place new legislation that favours a national strategy with local waste collection and waste managers for specific type of litter.
- Make it mandatory for the aquaculture farmers to have a garbage collection program and regular cleaning of the facility in order to obtain the concession.
- Perform inspections to enforce regulations and deny concession renewals if criteria are not met.

3. Promotion of synergies among aquaculture stakeholders and with other sectors regarding removal and recycling initiatives.

- Make every farmer responsible, as far as possible and considering the recycling and removal schemes in place and in development, for the management and the treatment of their own litter. **R&R | GP3.2: In Spain, aquaculture farmers are currently managing the waste that is produced in their own installations, through specialized waste companies if possible.**

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- Use the current farmer's associations as the basis to establish collaboration schemes to facilitate recycling and removal activities.
- Collaborate with the fishing sector to collect garbage in the sea. **R&R | GP3.4: Salva Mare, a Fishing for Litter scheme under consultation in Italy.**
- Enhance collaboration with Marine Protected areas authorities, environmental institutions and NGOs in order to ensure a constant support for marine litter removing. **R&R | GP3.1: Collaboration between farmers and Marine Protected areas authorities.**
- Create a communication channel that connects all involved stakeholders with the aim to recover some of the items that have been lost, broken or abandoned by the farmers. **R&R | GP3.3: Reusing the wood from the older bateas for decorative purposes.**
- Set up collaborations between farmers, port authorities and gear producers to locate and establish collection points for disposal of aquaculture gear in the port reception facilities.

  Farmers could be responsible for bringing the gear to the port facilities (encouraged by implementing a deposit-to-be-returned system, for example) and, on the other hand, gear producers (as responsible for the whole EPR system) could economically compensate the port authorities for using their installations.
- Create synergies among the European countries to facilitate the setting up of removal and recycling systems.

4. Identification of the roles of stakeholders involved in the removal and recycling activities of non-organic marine litter from the aquaculture sector.

- Establish a clear management and description of responsibilities in each part of the process (collection, treatment, transport and recycling). Stakeholders to be considered are farmers (which, under the European Directive, would be responsible for bringing the litter to the facilities), Spanish gear manufacturers (responsible for creating and maintaining the EPR scheme), gear importers (which are responsible for setting up the EPR scheme for material that has been produced in other countries), port authority managers, waste management organizations, upcycling and recycling initiatives, policy makers, waste management and aquaculture public departments, among others. For each of them, a clear role and identification of responsibilities should be performed before the creation of the EPR system.

5. Creation of feasible EPR schemes based on Circular Economy and 5Rs approaches. GP3.5.1: In Italy, a tax is applied to all plastic packaging producers

- Consider the ideas, expectations and interests of the aquaculture gear manufacturers and importers regarding the EPR system, as they will be responsible for the waste

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management. The basis of the EPR and the circular system is on the producers and importers of aquaculture gear, which have the responsibility to set up the EPR system. The level of implication of the aquaculture farmers, the necessities to create a functional EPR scheme and the market value of the recycled products should be analysed and defined previously to setting up the EPR scheme. It is also possible that gear producers will switch to using other materials or to improve the gear design when they are responsible for the creation and maintenance of the EPR system.

- Install collection points for disposal of the aquaculture gear. It is essential to add specific and easily accessible aquaculture gear collection points as close as possible to the aquaculture installations. In the case of the offshore farms, those collection points could be located in the port reception facilities. In the case of nearshore or onshore aquaculture facilities, waste collection points could be located nearby the farms, or gear producers could set a door-to-door pick up scheme. These collection points could also address fisheries activities. Provide disposal points targeting specific material and/or gear, such as mussel nets, anti-predator nets, etc. In this way, concentrating bigger amount of waste in one point and hiring a company for the disposal operations can become economically feasible. Any of these options are much more suitable and accessible for the farmers than transporting the gear to the specific waste management points. Install some cameras around the collection points to avoid bad practices and/or vandalism.
- Support the creation of deposit schemes for cages and passive aquaculture gear to raise the return rate of those products (including non-valuable items and/or single-use-items), with the aim to promote the reutilization and the recycling of the aquaculture elements once they get to the end of their life cycle. These deposit schemes could be shared with fishermen. There are two options, but both of them need an EPR system in place and, therefore, an official decree that supports it:

    a) Grant a discount on following purchases: the farmer brings back the used items to the seller/manufacturer and gets a discount on the price of the following purchase depending on the weight/volume/quantity returned.

    b) Return a deposit: to purchase an order, the farmer pays not only for the bought items but he also leaves a deposit, which will be returned by the seller/manufacturer once the farmer returns the used items.

- Optimise existing recycling plants, including the cost reduction of bringing the aquaculture gear to waste management points. Currently, and while there are no specific EPR schemes in place, bringing the aquaculture gear to large-items waste management collection points has a cost (fee payment) that can be hardly assumed by the smaller companies. Therefore, prices should be adapted to the farmer volume production or economic benefits, not only to the volume of the gear that is collected and brought.

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- Support and promote the upcycling processes to ensure the economic viability of the 5R's schemes regarding the aquaculture gear. The end-of-life nets, that usually have a mix of different type of materials, are degraded and covered with organic material. Therefore, recycling processes applied are expensive as previous cleaning has to be performed. Additionally, more expensive and complicated chemical treatments have to be applied since conventional treatments do not work properly on this type of gear. As a result, the production of recycled nets is more expensive than the production of new nets. This extra cost could be paid by the farmers or by the final consumer, which could be an economic challenge and limitation. In this scenario, upcycling processes could be an alternative. For example, using nets to produce more expensive items (e.g. nylon for textiles) can help to cover the costs associated to the EPR systems, avoiding extra economic efforts for farmers and consumers.
- Support the valorisation of the waste market (look for markets): create businesses that use another type of material (not just nylon for example) to assess the type of waste and increase the demand of such materials.
- Support the development of waste flows which include as much types of polymers as possible, and increase the number of plants that treat all types of polymers.
- Oblige farmers to fill in a logbook, keeping track of the bought items, installed and/or used items, major events happening and any gear loss or damage. Logbooks can help to generate information on the lifecycle of the larger gears like nets, the duration of their use, details on possible repairs, washes or treatments with anti-fouling products, etc. This information can also help to enlarge the lifecycle of the gear.
- Create a control system of the aquaculture nets that have reached the end-of-life. In the case of aquaculture activities, this kind of control is much easier than for fishery activities since nets are usually not abandoned or discarded (except in the case of loss or damage due to a storm or an accident). The control system should be as simple as possible and based on the idea of returning the old nets to buy new ones.
- Policy makers should provide the financial and organizational support needed to establish a specific aquaculture EPR system. But once the EPR system is in place, all involved stakeholders should implement the system as part of their daily work tasks.
- Apply financial fines to the farming companies that do not follow the EPR rules and do not discard properly the gear that has reached the end-of-life. These fines could include direct economic sanctions or disengagement from European funding, for example.
- Provide financial incentives to the companies that have a higher proportion of gear (e.g. nets) recycling and reusing. This could only be possible if the traceability system (including manufacturer and farmers tagging) works properly.

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6. Increasing the awareness in the sector and among the consumers regarding removal and recycling activities.

- Raise the awareness related to the non-organic marine litter from the aquaculture sector as this will increase the willingness of farmers and/or consumers to pay more to cover the extra cost related to the use of recycled nets (if no other option could avoid the price increase), and thus the reduced impact on the marine environment.
- An increased awareness of all aquaculture stakeholders, especially the farmers, should imply a larger involvement of the sector in voluntary initiatives focused on reducing the impact of their economic activities (e.g. voluntary initiatives related to Fishing for litter).
- Promote clean-up volunteering programmes among all stakeholders and potential consumers. In this scenario, it is not a good option to depend on economic incentives to try to secure the involvement of the multiple stakeholders in these kinds of environmental-friendly activities. **R&R | GP6.1: International and Spanish removal, recycling and upcycling initiatives related to marine litter.**
- Raise awareness on the EPR scheme to the policy makers.

7. Good practices certification applied to removal and recycling

- Include controls on marine waste generation in aquaculture farms during audits. Audits must have a waste control protocol including valid indicators to assess the removal and recycling efficiency of the facility. These indicators can be used to hold the producer responsible for good practices and also bad practices in removal and recycling.
- Good practice certification systems based on rates and indicators of waste removal and recycling schemes.

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GOOD PRACTICES

Do you know of any good practices already in place involving the removal or recycling of gear and other aquaculture equipmebnt that is damaged, discarded or lost?

1. Collect and remove the marine litter nearby the aquaculture source

R&R | GP1.1: Methodology for removing and preventing the abandonment of fishing gears at sea, including aquaculture nets.

The GHOST project (LIFE funded programme - 2013-2016) based on a study conducted in the North Adriatic coastal areas, developed an operating handbook describing the methodology for a effective prevention and mitigation of fishing and aquaculture gears lost at sea. The handbook contains methods and protocols for the removal of abandoned gears, indications and best practises for fishing and aquaculture equipment and waste management and guidelines for fisheries and aquaculture operators' engagement. This handbook is designed for fishing and aquaculture stakeholders, public and private institutions and environmental associations engaged in actions for the protection of marine ecosystem from littering. The proposed methods are particularly suitable for shallow coastal areas, and for discarded fishing and aquaculture gears of small size.

2. Development of specific removal and recycling regulation of the marine litter related to aquaculture.

The stakeholders participating in the learning lab did not mention specific good practices for this topic.

3. Promotion of synergies among the aquaculture stakeholders and with other sectors regarding the removal and the recycling initiatives.

R&R | GP3.1: In Spain, aquaculture farmers are currently managing the waste that is produced in their own installations, through specialized waste manager companies if possible.

In the recent national guidance for the minimization of the sub products and litter of the aquaculture activities (OESA - Fundación Biodiversidad, 2017) it is highlighted that, among all the farmer's obligations related to any kind of waste, they have:

a) To ensure the proper treatment of the waste by themselves or by the authorized waste managers (assuming the costs of the treatment or the management).

b) To submit a minimization plan report to the autonomous community in the case the owners of aquaculture facilities produce hazardous waste (except for the smaller ones).

c) To keep the stored waste in good condition, following hygienic and safety recommendations. Hazardous waste can only be stored for six months maximum.

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d) To avoid mixing or diluting hazardous waste.

e) To store, package and label the hazardous waste at the production place and following the regulations.

Recently, and while there is no specific EPR scheme in place, some projects have been developed regarding the waste management related to aquaculture activities in Spain, focusing on identifying innovative strategies for the recovery of aquaculture waste.

R&R | GP3.2: Salva Mare, a fishing for litter scheme under consultation in Italy.

The directive "Salva Mare" which allows fishermen to collect any type of plastic and nets found in the sea, and to bring them to special collection sites was recently approved by the Italian chamber but it is still under final consultation. The directive, if approved, will encourage fisherman, and eventually farmers, to collect waste encountered while fishing, including mussel nets and other aquaculture dispersed items.

R&R | GP3.3: Collaboration with Marine Protected areas authorities.

CleanSeaLife, a LIFE funded project working on marine litter in Italy, has engaged Marine Protected areas (MPA) authorities for a "fishing for litter" system. Carrying on a "fishing for litter" project together with local fishermen, the project managed to engage fishermen in bringing plastic and litter found in their nets on land and dispose properly in the collective sites made available temporarily by the local MPA authorities.

R&R | GP3.4: Reusing the wood from the older bateas for decorative purposes.

In Galicia, the structure of the bateas was traditionally made of eucalyptus. Once the batea had reached the end-of-life and was dismantled, the wood pieces were burned. But lately, decorators and architects have started using them as a decorative element in houses.

4. Identification of the roles of the stakeholders involved in the removal and recycling tasks of the non-organic marine litter related to aquaculture.

The stakeholders participating in the learning lab did not mention specific good practices for this topic.

5. Creation of feasible EPR schemes based on Circular Economy and 5Rs approaches.

R&R | GP5.1: In Italy, a tax is applied to all plastic packaging producers.

The producers are in a consortium that manage their taxes (CONAI). Their contribution is used for the disposal process of the packaging. A similar idea is represented by the European collaborative initiative of a European consortium of companies and associations representing the entire value chain of flexible packaging (CEFLEX.EU). The CEFLEX mission is to further enhance the performance of flexible packaging in the circular economy by designing and advancing better system solutions identified through the collaboration of companies

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representing the entire value chain This kind of consortia can support partnership and common effort in finding valuable solutions.

6. Increasing the awareness in the sector and among the consumers regarding the removal and recycling activities.

R&R | GP6.1: International and Spanish removal, recycling and upcycling initiatives related to the marine litter.

Although these initiatives are not strictly linked to aquaculture, they can be considered a first step for the sensibilization of the fishery and aquaculture sectors and, besides, they can open up new opportunities and possibilities regarding any recycling initiative related to both sectors.

The big majority of them are related to schemes like 'fishing for litter' and linked to recycling & upcycling initiatives, while a few are strictly related to fishery gear like the following ones:

1. In October 2019, first tests to recycle and upcycle the fisheries nets to produce sport clothing were conducted in the frame of a collaboration among AIMPLAS, research institutions, fishery cooperatives, Asociación Vertidos Cero and textile and clothing companies.
2. Projecte Xarxes: Catalonian initiative that involves 14 Catalonian ports. Once nets have reached the end-of-life, they are brought and left in specific collection points located in the port facilities, and the recycling company collects them and brings them to their own facilities, select the plastic fractions that are in good status and that can also be recycled and, afterwards, they send those pieces to another company located in Euskadi that transform them to plastic scales, which can be used to produce multiple types of plastic products like glasses or phone cases.
3. Bluenet: this project involves 3 fishing ports of the Basque Country, accounting for 24 fishing vessels. Recovered nets, nets that have reached the end of life and aquaculture ropes are being recycled and upcycled to produce aquaculture ropes for mussel production.
4. Sponsored volunteering activities to pick fishing gear, like the initiative supported by GLOBALG.A.P. in 2019 in Almería (Spain). During two days, more than 15 fishing traps, around 400 meters of ropes and fishing lines, 33 fishing weights and some fish hooks and baits were collected, with the aim to increase the awareness related to marine litter.

7. Good practices certification applied to removal and recycling

The stakeholders participating in the learning lab did not mention specific good practices for this topic.

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5. Efficiency and timeframe relevance of proposed solutions

During the innovative workshop, the above solutions for each of the waste management core aspects were grouped and characterised depending on their expected efficiency and the timeframe according to the participants.

Information from interviews was grouped and linked to the most suitable solutions already characterised for the workshops based on their efficiency and timeframe. In the case of new solutions not previously identified, they were characterised by the AQUA-LIT consortium using the references provided by the interviewee.

Efficiency and time were defined as follows:

- Efficiency: a subjective estimation of the relative degree to which the proposed solutions will contribute to improve Prevention and Reduction, Monitoring and Quantification and, finally, Removal and recycling of the marine litter from the aquaculture sector. They were classified from 1 (low efficiency level) to 5 (high efficiency level),
- Time: a subjective estimation of the time needed to implement the proposed solutions was defined as: short-term (less than 1 year), medium-term (to 1 to 5 years) and long-term (more than 5 years).

For each of the 3 core aspects, a conclusive graph of the workshop was filled in with the proposed solutions considering this time-efficiency approach (*Figure 5*).

Results can be seen in *Figures 6, 7* and *8*.

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Figure 5: Results of one of the three round tables, in which participating stakeholders ranked the solutions they proposed in terms of their expected efficiency and timeframe so that they would become feasible and acceptable for the aquaculture sector to tackle the marine litter problem.

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PREVENTION AND REDUCTION OF MARINE LITTER

Following a list of the different solutions (S) according prevention and reduction is presented.
S1: Specific prevention measures for open-sea facilities
S2: Awareness and training.
S3: Setting up preventive maintenance schedules for the aquaculture facilities.
S4: Insurance companies' role in marine litter prevention regarding the knowledge of the items which are lost or broken more frequently.
S5: Good practices and certification
S6: Apply the circular economy approach and the 5R's scheme to prevent and reduce the marine litter from aquaculture activities.
S7: Technical improvement and innovation of materials
S8: Create synergies among all the aquaculture stakeholders to facilitate the prevention and reduction of non-organic marine litter
S9: Enforcement of the governance related to non-organic marine litter.
S10: Taxes and fines

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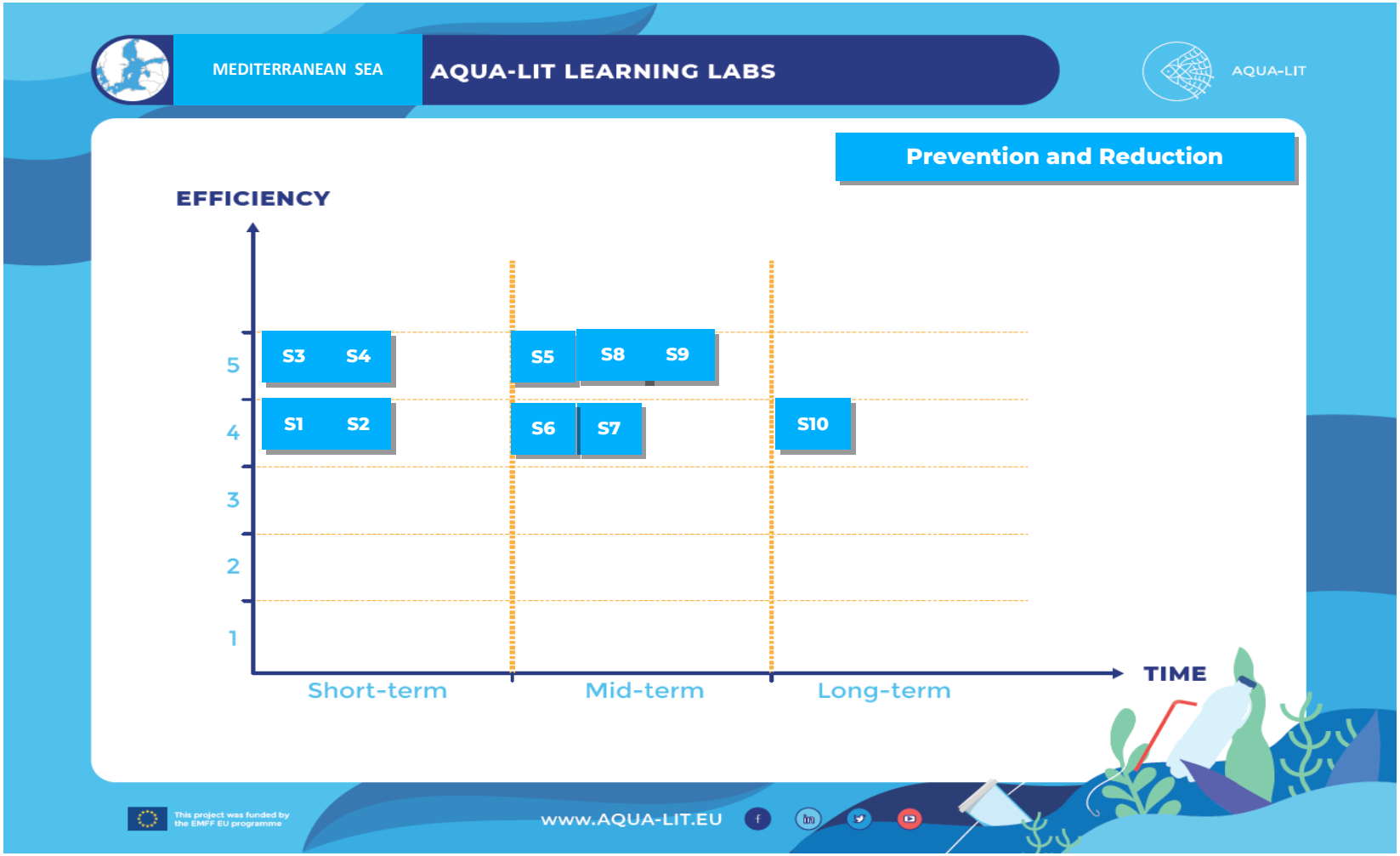

Figure 6: Efficiency and time of the proposed innovative solutions and measures given by workshop participants and interviewees to prevent or reduce the loss, damage or discard of gear and other equipment in the aquaculture sector.

MONITORING AND QUANTIFICATION OF MARINE LITTER

Following a list of the different solutions (S) according monitoring and quantification is presented.

S1: Including monitoring protocols in the environmental regulation of the aquaculture facilities.
S2: Promote the research on quantification and monitoring non-organic marine litter from aquaculture activities.
S3: Increase synergies and enhance communication among the stakeholders.
S4: Improving monitoring schemes.
S5: Fostering incentives for following environmental certification which include also marine litter monitoring in the criteria.

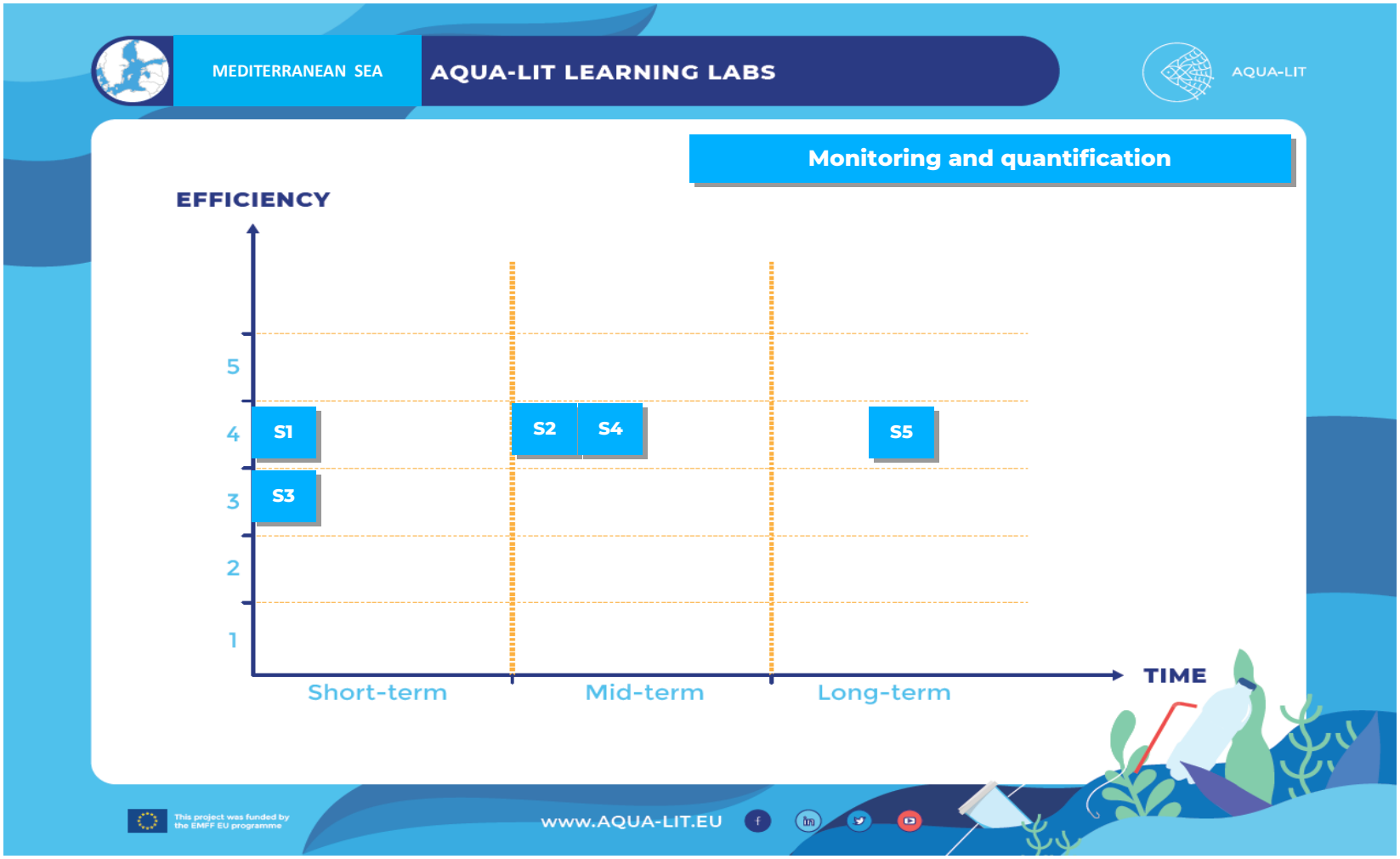

Figure 7: Efficiency and time of the proposed innovative solutions and measures given by workshop participants and interviewees to improve the quantification and monitoring of the loss, damage or discard of gear and other equipment in the aquaculture sector.

REMOVAL AND RECYCLING OF MARINE LITTER

Following a list of the different solutions (S) according removal and recycling is presented.

S1: Collect and remove the marine litter nearby the aquaculture source
S2: Development of specific removal and recycling regulation and regulation of the marine litter related to aquaculture.
S3: Promotion of synergies among the aquaculture stakeholders and with other sectors regarding the removal and the recycling initiatives.
S4: Identification of the roles of the stakeholders involved in the removal and recycling tasks of the marine litter related to aquaculture.
S5: Creation of feasible EPR schemes.
S6: Increase the awareness in the sector and among the consumers regarding the removal and recycling activities.
S7: Good practices applied to removal and recycling.

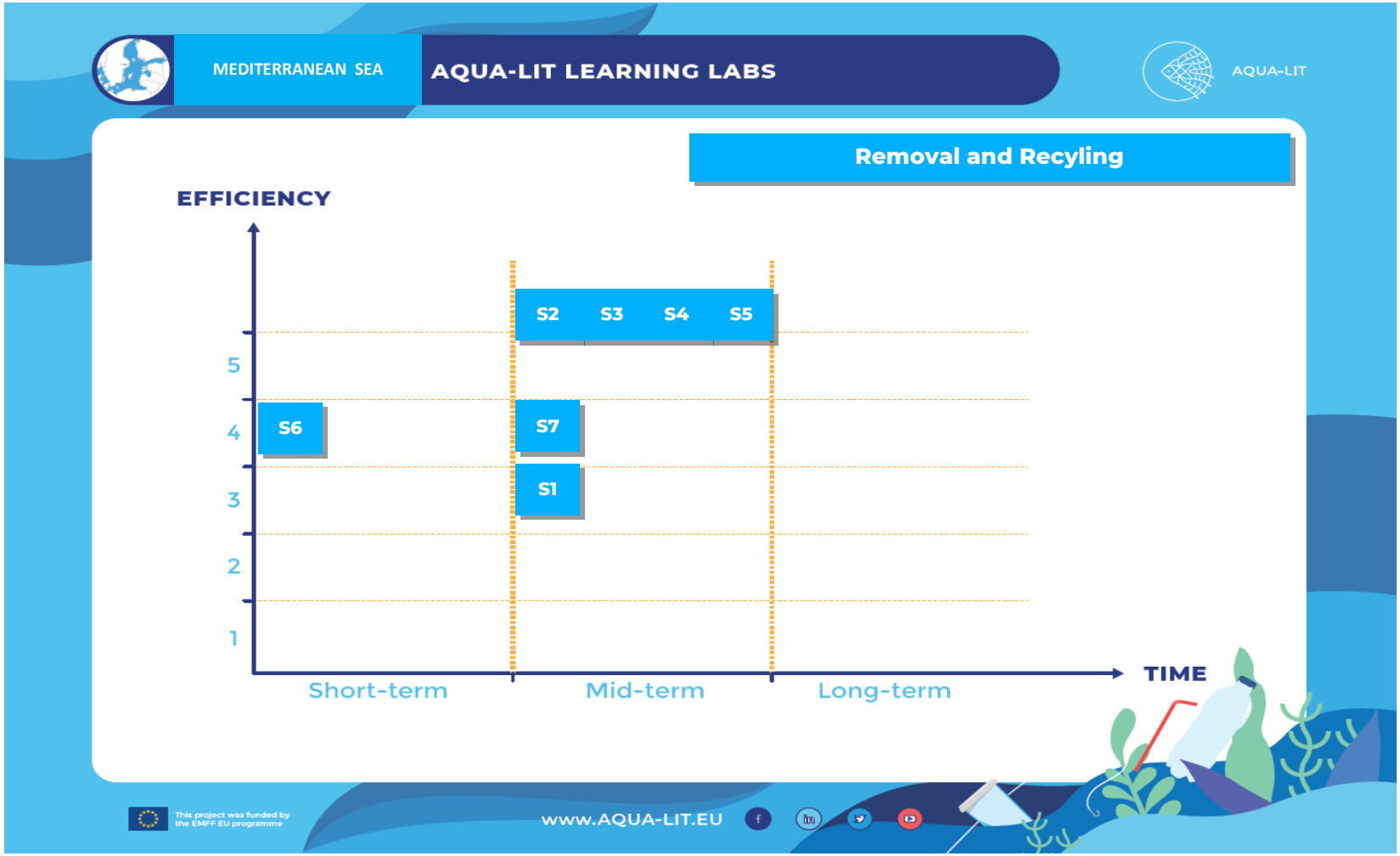

Figure 8: Efficiency and time of the proposed innovative solutions and measures given by workshop participants and interviewees to remove and recycle the lost, damaged or discarded gear and other equipment in the aquaculture sector.

6. Conclusions and recommendations

6.1. Conclusions

This report combines the information received from the aquaculture stakeholders during the AQUA-LIT Learning Lab initiatives and focuses on aquaculture activities in the Mediterranean Sea region. In this conclusion the three core aspects of tackling marine litter (1. Prevention & Reduction, 2. Monitoring & Quantification, and 3. Removal and Recycling) are combined.

BARRIERS

What are the barriers with regard to the prevention & reduction, monitoring & quantification, and removal & recycling of litter from the aquaculture industry

The barriers identified by the stakeholders could be grouped in the following four main topics:

- **SUPPORT,** e.g.
  - Lack of interest from and support to aquaculture technicians regarding specific technical training focused on system stability of aquaculture facilities.
  - Limited support and awareness by governments regarding the marine litter management issues related to aquaculture.
  - Limited support by governments to creating a proper waste management system for aquaculture farmers, including specific mussel culture waste flows in some Mediterranean areas (e.g. Italy and Greece), plants adapted for recycling all types of materials, disposal points located in proper places, among other issues.
  - Lack of sustainable design criteria (which should be agreed among all the stakeholders considering the farmer's identified needs) for gear, equipment and materials.

- **LEGISLATION,** e.g.
  - Not homogeneous and consistent environmental criteria applied to Spanish aquaculture activities. Criteria depend on each autonomous community that regulate the local activities.
  - Specifications on the non-organic litter management are frequently missing in the environmental criteria related to approval procedures, facility surveillance plans, etc.
  - In some countries (e.g. Greece) there is no specific environmental legislation concerning mussel culture and its waste management.

- There is a lack of the needed legislative frame (specific decrees) to put in place appropriate EPR schemes in Spain.

- **RESPONSIBILITY**, e.g.
  - Lack of role and responsibility of all stakeholders regarding the aquaculture marine litter and/or debris issue. This includes lack of responsibility to manage the lost, abandoned, and broken items as well as waste items that reached the end-of-life.

- **KNOWLEDGE**, e.g.
  - Lack of specific data related to material losses from aquaculture activities, including (1) which items are most frequently lost, broken or abandoned and (2) an estimation of their environmental impact in the Mediterranean Sea. Lack of standardised quantification protocols.
  - Low knowledge level regarding innovative and/or alternative material, improved fixing systems and facility stability criteria.
  - In relation to the EPR, lack of knowledge related to waste valorisation, upcycling and recycling processes of the aquaculture gear once it has reached the end of life.
  - Lack of synergies and collaboration among all the stakeholders (including farmers, researchers, plastic manufacturers, gear manufacturers, waste managers, policy makers and clean-up organizers) to assess the marine litter related to aquaculture.

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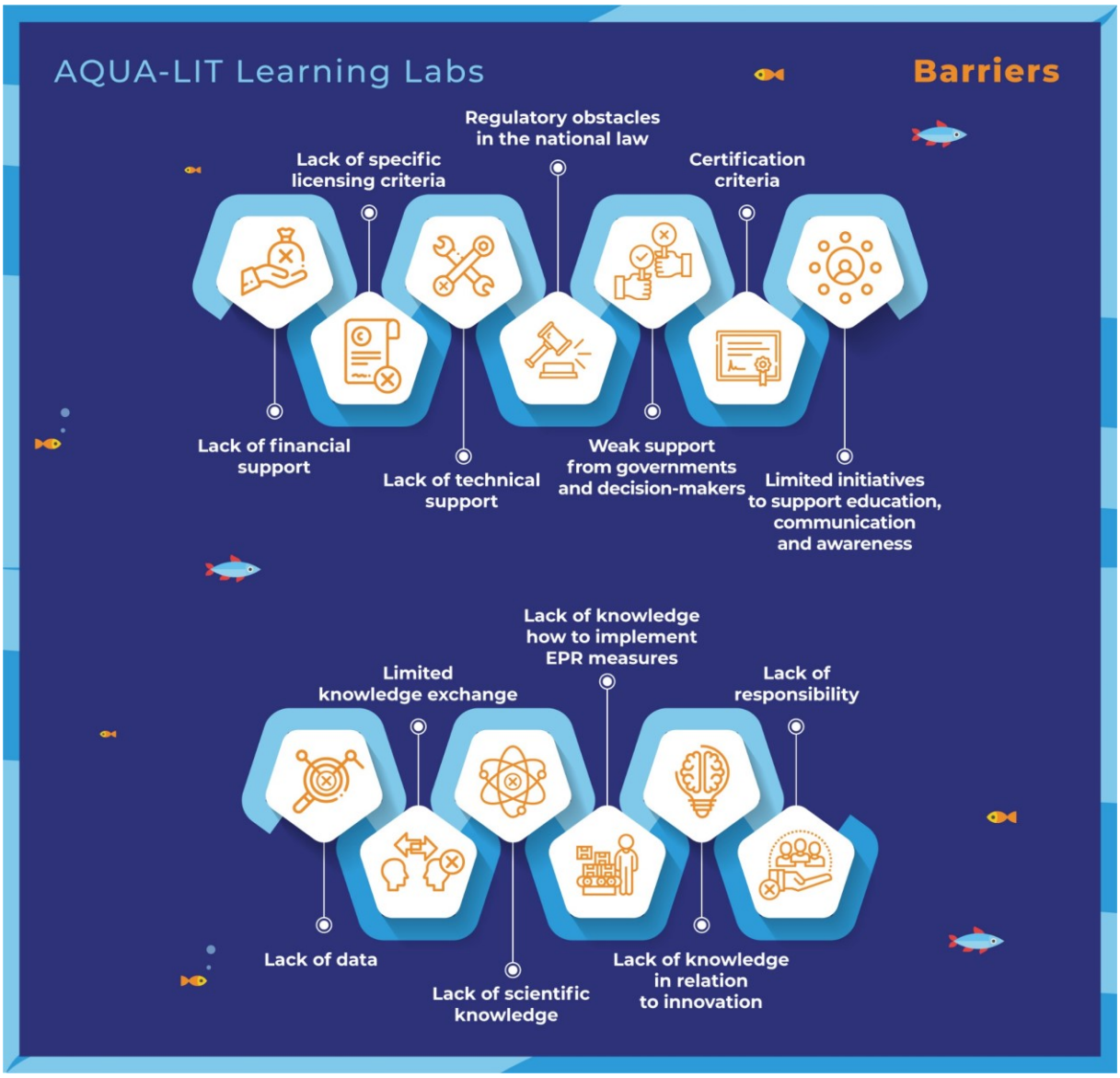

Figure 9 Infographic summary of the identified barriers during the AQUA-LIT Learning Labs in the North Sea, Baltic Sea and Mediterranean Sea.

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SOLUTIONS

What are innovative solutions and business models that can be used for the prevention & reduction, monitoring & quantification, and removal & recycling of litter from the aquaculture industry

- **SUPPORT**, e.g.
  - Organise trainings for the aquaculture staff in collaboration with gear production companies about good procedures for fixing systems and facility stability improvements.
  - Train professionals and volunteers to characterise and differentiate from other sectors the non-organic marine litter related to aquaculture.
  - Support campaigns organized by the public administration focused on good practices applied by the aquaculture sector and the certified products related to those good practices.
  - Incentivise support of innovative ideas: sustainable design (materials and equipment), improve the marine litter quantification around the farms, monitor the seabed using specific technology (underwater drones, robots), increase efforts on innovation for automated seafloor waste collection systems, among others.
  - Policy makers and authorities should provide the financial and organizational support needed to establish specific aquaculture waste collection and EPR systems, including: (1) establishing collection points for aquaculture gear disposal in the port reception facilities, (2) the creation of deposit schemes for cages and passive aquaculture gear, (3) the valorisation of the waste market, (4) the promotion of the upcycling processes to ensure the economic viability of the 5R's and, finally, (5) the development of waste flows which include as much types of polymers as possible.
  - Promote clean-up volunteering programmes among all stakeholders and citizens (potential consumers).

- **LEGISLATION,** e.g.
  - Include the identification of potential sources of waste, the estimation of non-organic marine litter related to an aquaculture facility and the monitoring of the litter in the PVAs.
  - Incorporate the European Directive 2019/904 on the reduction of the impact of certain plastic products on the environment into the Spanish law.
  - Create a specific Spanish Single-Use-Plastic regulation and Extended Producer Responsibility scheme regulation for fisheries and aquaculture.
  - Homogenize as much as possible the criteria of the multiple autonomous communities regarding waste management in Spain.

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- Expand the current environmental objectives of the Marine Strategies to include the criteria of monitoring marine litter (related to descriptor 10 - MSFD) in the Compatibility Reports.
- Perform inspections to enforce regulations and deny concession renewals if criteria are not met.

- **RESPONSIBILITY,** e.g.
  - Clear identification of the role and responsibility of all the stakeholders involved in the waste management process/EPR scheme.
  - To increase the farmer's responsibility, (1) create surveillance plans which include checking the state of the aquaculture facilities regularly and (2) fill in a logbook, keeping track of the bought items, installed and/or used items, the major events happened and any gear loss or break.
  - Good practice certification control points should be feasible to be implemented by producers, based on the official regulations and feasible to be verified by the certification bodies. Encourage the adoption of good practices by positive economic stimuli, such as tax reduction or other fiscal incentives.
  - Introduce financial incentives, e.g. to the companies that have a higher proportion of gear recycling and reusing.
  - Apply penalties to the companies that do not put in place prevention measures and/or do not discard properly the gear that has reached the end-of-life
  - As a part of the corporate social responsibility of the aquaculture farmers and/or the gear producers, include the circular economy approach when designing and producing any aquaculture gear and facility or when choosing any material.

- **KNOWLEDGE,** e.g.
  - Create synergies among all the involved stakeholders to identify (1) the farmer's needs regarding the aquaculture marine litter management, (2) the necessities to create a functional EPR scheme and (3) the market value of the recycled and upcycled products, with the aim to create a feasible EPR scheme.
  - Create synergies among all the involved stakeholders (and also the fishing sector) to (1) increase the knowledge related to the aquaculture marine litter and, specifically, (2) to improve and increase the current marine litter data quantification and methodologies, including farmers, clean-up initiatives, insurance companies, gear manufacturers, material producers and the policy makers. The main objectives are (1) to create a set of rules that would apply to the gear design and material selection, to ensure resistance and durability in a regulation framework (e.g. UNE or CEN) and (2) to better estimate the impact of the aquaculture debris and litter in the marine environment.

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- Carry out a complete analysis of the technical characteristics of suitable material for aquaculture gear and equipment (flexibility, resistance to harsh conditions, corrosion and bio-fouling resistant, among others) and life-cycle steps (from production to end-of-life treatment).

GOOD PRACTICES

Do you know of any good practices already in place involving the prevention & reduction, monitoring & quantification, and removal & recycling of litter from the aquaculture industry

The examples of Good Practices provided by Mediterranean Sea aquaculture stakeholders show that many aquaculture companies and local authorities are taking initiatives to prevent the loss of waste. The Good Practices identified by the stakeholders are grouped under the same topics as the 'solutions' section:

- **SUPPORT,** e.g.
  - Testing innovative materials (e.g. biodegradable plastic nets for marketing) and methodologies (e.g. new mussel techniques)

- **LEGISLATION**, e.g.
  - Establishment of "Areas of Organized Development of Aquaculture" (POAY), consortia that manage operations of mussel farms in the North of Greece, which are supported and regulated by the Government.

- **RESPONSIBILITY,** e.g.
  - Farmer's responsibility, e.g. purchasing very resistant gear, scheduled maintenance surveillance plans of the shellfish farms of for specific gear (e.g. nets), reusing bags for selling mussels and mussels sacks,
  - Good practices certifications at international and national levels that are currently being set up in many aquaculture farms
  - In Italy, a tax is applied to all plastic packaging producers

- **KNOWLEDGE**, e.g.
  - Projects focused on the creation of synergies to reduce the impact of the marine litter and to increase the awareness related to shellfish farming.
  - Projects focused on recycling and upcycling initiatives.
  - Publications to increase the awareness of the sector, to provide a guidance for the waste minimization, and to encourage applying good practices

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- Enhancing the communication among the aquaculture stakeholders by involving farmers, farmer associations, PDO organizations, Marine Protected areas authorities, certification bodies and policy makers.
- Governmental implication on collecting data related to marine litter.
- Collaboration among aquaculture farmers and other sectors like fathering (e.g. Fishing for Litter schemes), decorators and architects (e.g. reusing the wood from older bateas for decorative purposes).

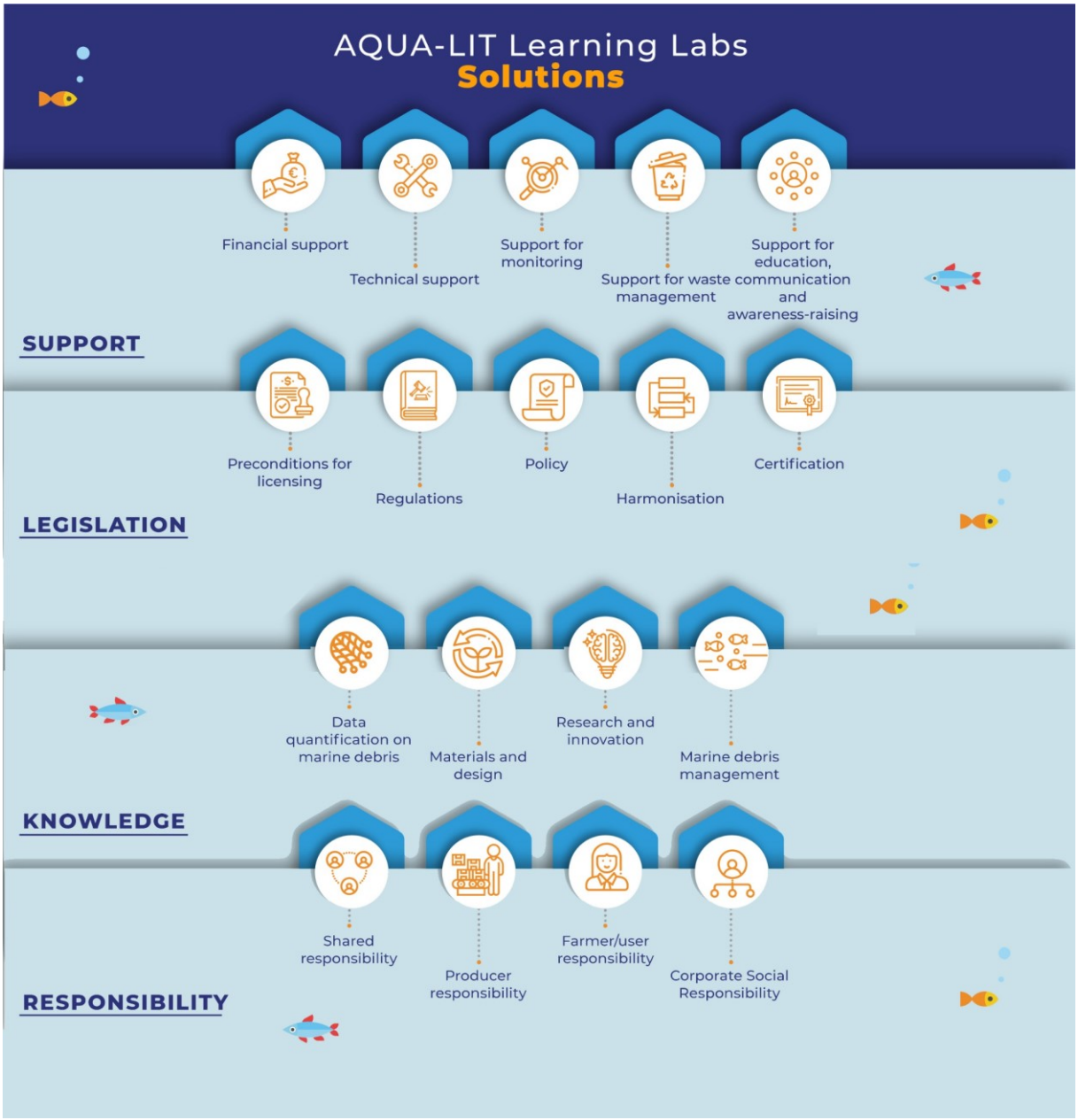

Figure 10 Infographic summary of the identified solutions during the AQUA-LIT Learning Labs in the North Sea, Baltic Sea and Mediterranean Sea.

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6.2. Recommendations

Based on existing barriers, some recommendations about the Mediterranean context are summarised below.

For all three core aspects (Prevention and Reduction, Monitoring and Quantification, Removal and Recycling) knowledge gaps were strongly related to:

- **The lack of clear role and responsibility assignation on the waste management in the aquaculture sector.** The first step to be taken should be identifying all the potential stakeholders that could provide specific (e.g. farmers, gear producers, etc) and complementary (e.g. insurance companies) information and enhance the communication among all of them, plus increasing awareness, and making sure that all farms have a waste collection system in place, and proper disposal infrastructures.
- **The lack of standardised methodologies and of specific data related to this issue** needs an extra effort from researchers, technicians working in monitoring programs and volunteering initiatives, at a national, Sea basin and European level. Gaps in the current protocols need to be clearly identified and should be addressed with a common approach with the aim to obtain comparable data at all levels. The next step involves performing specific trainings.
- **The lack of an accurate estimation of the marine litter quantities which are related to the aquaculture activities** could be mitigated (1) by a better characterization during the monitoring and clean-up initiatives, as proposed previously, (2) by keeping logbooks and (3) by establishing public and official non-organic marine litter range quantities of the produced waste for the aquaculture activities. All the generated knowledge regarding which items are most frequently abandoned or broken will provide feedback about alternative solutions related to sustainable design and alternative materials.

To create a suitable aquaculture waste disposal process, creation of synergies including representants of all the aquaculture waste management chain steps should be promoted. Considering that EPR scheme depends on policy makers, public waste management institutions should be the ones leading this network. EPR schemes based on circular economy approach can only work if a clear development frame has been created previously, including the economic feasibility. Use economic incentives if possible once the EPR system and feasible gear traceability systems are in place.

The development of the EPR schemes leads to the policy challenges that have been identified by the participants. Efforts should be focused on: facilitating the communication between the approving institutions and farmers, homogenization of the administrative procedures among

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the autonomous communities (in Spain) and including specific criteria for the management of potential litter in all the environmental procedures.

All the learned lessons and information collected during the previous steps has become the basis of the good practices' certification, especially the regulation that can be generated during the suggested networks and the process of putting in place the EPR scheme.

6.3. Next steps

This report will be combined with the parallel activities in the Baltic Sea (D3.1) and the North Sea (D3.2) regions. The results obtained from all three regional Learning Lab Reports – for the North Sea, the Baltic Sea and the Mediterranean Sea – plus from the Virtual Learning Lab Report will help feed AQUA-LIT " *Tide against Marine Litter Toolbox*" to be published by the end of the project (December 2020), including a mobile app. Such a toolbox will be centred on helping on the three core aspects of marine littering (prevention and reduction, monitoring and quantification, and removal and recycling) by providing integrated frameworks, offering ideas, solutions and facilitating the matching of stakeholders in the aquaculture sectors to foster more sustainable services, connections and cleaner aquaculture practices. The good practices collected in the Learning Lab reports will be evaluated of what has worked best; this knowledge will flow into the toolbox as well.

This project has received funding from the European Union's EASME-EMFF funding programme under grant agreement EASME/EMFF/2017/1.2.1.12/S2/04/S12.789391.

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8. Annexes

Annex a: Save-the-date, invitation and programme of the *AQUA-LIT Mediterranean Sea Learning Lab*

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Asunto: Taller AQUA_LIT: Agenda
De: Maria Vidal Rigo <maria.vidal@ieo.es>
Fecha: 21/01/2020 14:27
CC:
BCC:

Buenos días,

tenemos el placer de adjuntarles la Invitación con la Agenda del Taller del Proyecto AQUA-LIT con el título **¿Cómo puede el sector de la acuicultura contribuir a la reducción de la basura marina?**.

Como ya saben, tendrá lugar en València el 4 de febrero en la sede del ADEIT (Plaça de la Mare de Déu de la Pau, 3). Se empezará a las 9.30 y se terminará a las 15hs.

En breves días nos pondremos otra vez en contacto con ustedes para hacerles llegar el documento que nos servirá de punto de partida para el desarrollo del Taller, así como para concretar detalles logísticos.

Por favor, no duden en ponerse en contacto con nosotros en cualquier momento.

Atentamente,

el Equipo AQUA-LIT.

Adjuntos:

AQUA-LIT_MedLL_programme.pdf	191 KB

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AGENDA

AQUA-LIT – Taller del mar Mediterráneo

"¿Cómo puede el sector de la acuicultura contribuir a la reducción de la basura marina?"

04 de Febrero del 2020, 9.30-15.00 hrs.
Fundació Universitat - Empresa de la Universitat de València (ADEIT).
Plaça de la Mare de Déu de la Pau, 3. 46001. València.

El taller de AQUA-LIT es un **taller interactivo** que va a reunir a representantes de diferentes grupos de interés relacionados con el sector de la acuicultura **para intercambiar puntos de vista y opiniones sobre el tema de la basura marina, así como discutir posibles soluciones.** La comunicación e interacción entre los asistentes va a ser alentada a través de una metodología participativa con los objetivos de favorecer el intercambio de conocimientos y la generación de nuevas ideas, así como desarrollar una caja de herramientas de utilidad e interés para todos los involucrados, la cual podría convertirse en un ejemplo para otros sectores.

Los objetivos del taller son:

- Involucrar a los grupos de interés de toda la cadena de la acuicultura en la prevención, reducción, seguimiento, cuantificación, recogida y reciclaje de la basura marina relacionada con las actividades del sector.
- Fomentar la adopción de soluciones ya existentes a través de la formación y el intercambio de conocimiento.
- Explorar nuevas soluciones potenciales con relación a la reducción, recogida y reciclaje de la basura marina.
- Identificar las necesidades específicas de los múltiples grupos de interés para maximizar el impacto positivo del proyecto.

Resultados esperados derivados del taller

Los asistentes, como representantes de los múltiples grupos de interés de la cadena del sector de la acuicultura, van a participar en la identificación y desarrollo colaborativo de ideas y herramientas para la prevención, reducción, seguimiento, cuantificación, recogida y reciclaje de la basura en el mar (de elementos como, por ejemplo, flotadores de poliestireno, cuerdas plásticas, sacos plásticos de comida, boyas, etc.). Esto se va a conseguir gracias a su experiencia en el sector, las lecciones aprendidas, la selección de propuestas que ya están en marcha o la identificación de nuevas.

Agenda

09:30-10:00 **Recepción e inscripción de asistentes y café de bienvenida.**

10:00-11:00 **Presentación del proyecto y de los objetivos del taller**

- **Contextualización del Proyecto en el Mar Mediterráneo: basuras marinas y acuicultura** (Salud Deudero, Instituto Español de Oceanografía - Centre Oceanogràfic de Balears).
- **Presentación del proyecto** (Mariana Mata Lara, Geonardo / Carme Alomar, IEO-COB).
- **Implicación del Gobierno en la gestión de las basuras marinas** (Marta Martínez-Gil, Subdirección General para la Protección del Mar, Ministerio para la Transición Ecológica y el Reto Demográfico; y Pilar Zorzo, Dirección de Medio Marino, Centro de Estudios de Puertos y Costas, CEDEX).
- **Situación General del Mediterráneo, datos adicionales MARNOBA** (Estíbaliz López-Samaniego Área Técnica Asoc. Vertidos Cero y Consultor UNEP/MAP).
- **Metodología y principales objetivos del Taller** (Maria Vidal Rigo, IEO-COB).

11:00-11:45 **Primera ronda de mesas de trabajo**

Taller participativo en el que los asistentes trabajarán en grupo para generar ideas e identificar soluciones potenciales respecto a los siguientes componentes:

- **Mesa 1**: ¿cómo podría la industria de la acuicultura ser más eficiente con relación a la **prevención y reducción** de los residuos no-orgánicos?
- **Mesa 2**: ¿cómo podría la industria de la acuicultura ser más eficiente con relación al **seguimiento y cuantificación** de los residuos no-orgánicos?
- **Mesa 3**: ¿cómo podría la industria de la acuicultura ser más eficiente con relación a la **recogida y reciclaje** de los residuos no-orgánicos?

11:45-12:30 **Segunda ronda**

12:30-13:00 Comida

13:00-13:45 **Tercera ronda**

13:45-14:15 **Preparación de conclusiones por mesa de trabajo.**

14:15-14:45 **Presentación de conclusiones por mesa de trabajo y cuestiones finales.**

- Presentación de los resultados por tres representantes.
- Discusión y cierre de la sesión.

14:45-15:00 **Clausura del taller**

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Annex b: Certificate of participation

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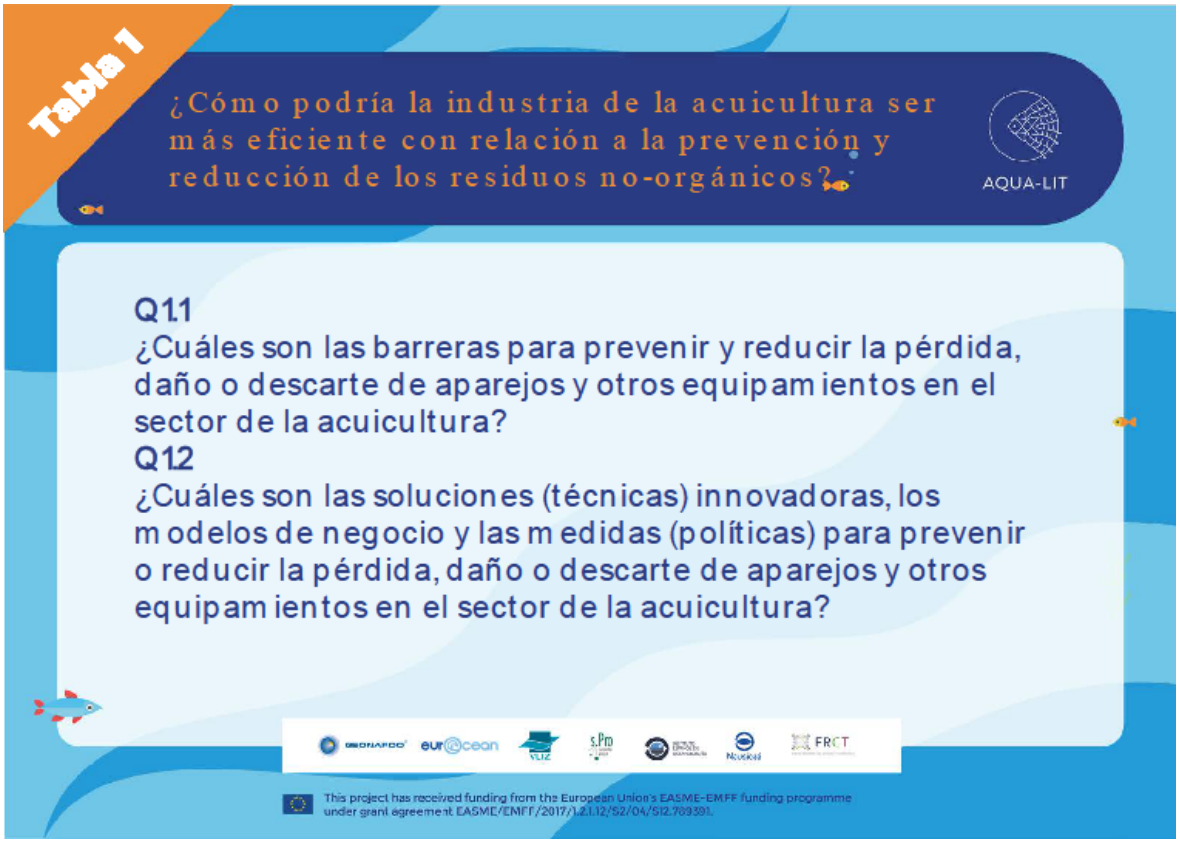
Annex c: Triggering questions used by facilitators of the interactive workshops

PREVENTION & REDUCTION
OF MARINE LITTER



Preguntas de apoyo que el facilitador puede usar para estimular la discusión:

1. ¿Cuál es su opinión acerca de seguir un Diseño de Economía Circular?
2. ¿Cuáles son las alternativas de productos reutilizables para jaulas, aparejos u otros equipos?
3. ¿Qué tipo de cooperación entre la investigación y las industrias acuícolas existe en su área? Por favor enumérelos.
4. ¿Cuál es su opinión acerca del Análisis del Ciclo de Vida en la gestión y diseño de productos?
5. ¿Qué mejores prácticas son las más eficientes para su negocio?
6. Enumere las medidas para considerar una producción acuícola como sostenible (incluidas las certificaciones y las aprobaciones por parte de instituciones) que conozca.

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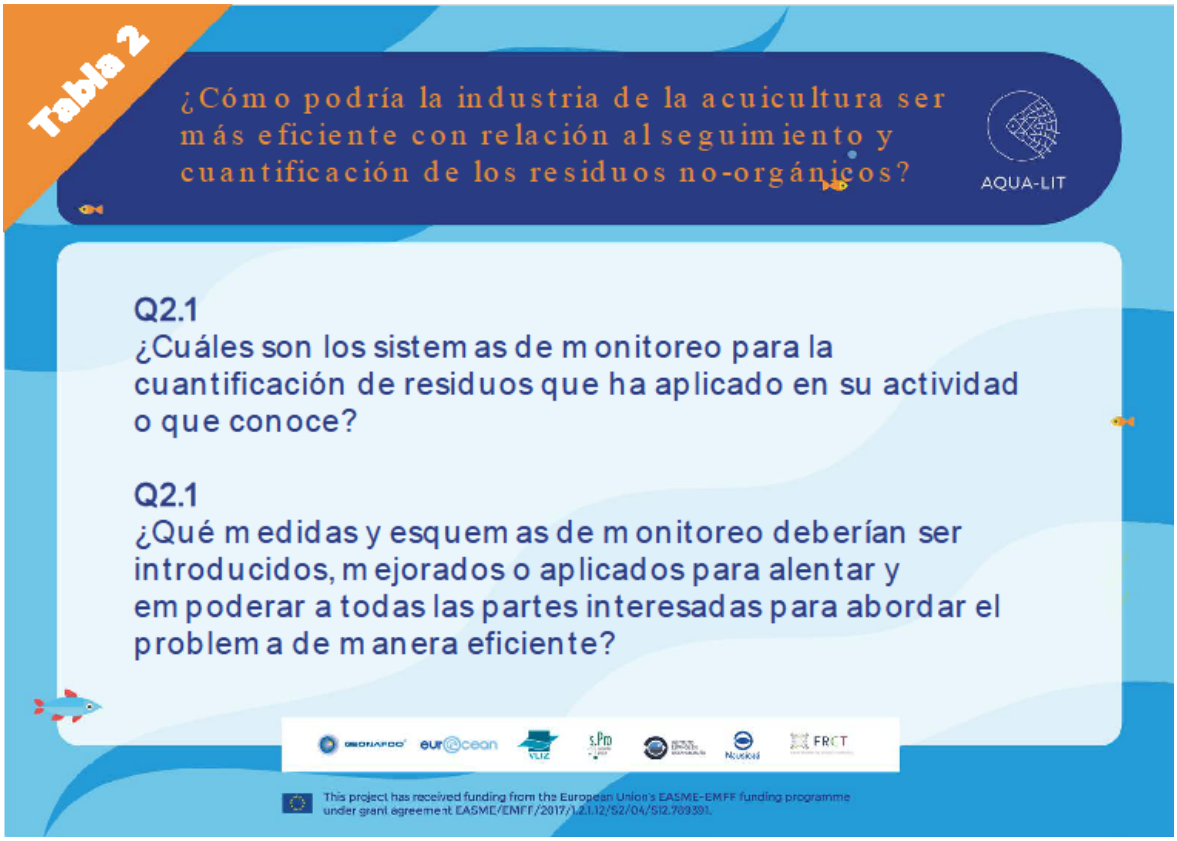

Preguntas de apoyo que el facilitador puede usar para estimular la discusión:

1. Frecuencia de seguimiento: en su empresa / organización, ¿hay algún tipo de seguimiento después de las tormentas? o es un monitoreo estacional?

2. Tipo de monitoreo / cuantificación: ¿se realiza categorizando productos o materiales o tipo de aparejos/equipamiento?

3. ¿Su empresa está reportando a algún organismo / institución? En caso afirmativo, ¿recibe alguna respuesta de esta institución?

4. ¿Su empresa / institución mantiene esa información en una base de datos / excel / ...? ¿Hace algún análisis al respecto?

5. ¿Está estandarizado su sistema de seguimiento / cuantificación? (¿usando indicadores internacionales / nacionales?) En caso afirmativo, ¿cree que armonizar el alcance (regional /

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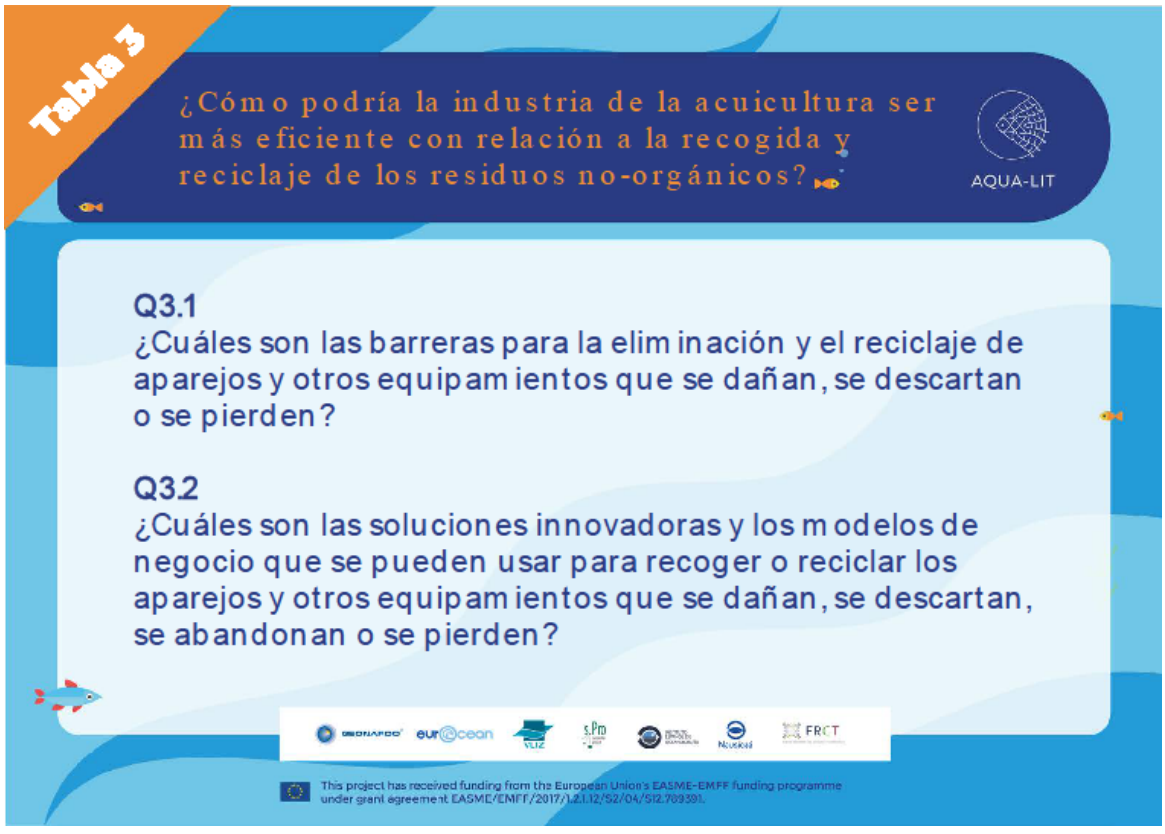
cuenca marina / nacional) y las metodologías de monitoreo / cuantificación ayudaría a mejorar el sistema / lo haría más útil / sería más útil para fines ambientales?

6. ¿Está monitoreando la huella de carbono- y/o huella del agua con respecto a la energía utilizada?

7. ¿Existe alguna regulación nacional / a nivel de cuenca marítima / internacional que esté siendo aplicada por su empresa / institución con respecto a las tareas de seguimiento / cuantificación? ¿Necesitaría algún tipo de apoyo para ponerlo en marcha?

8. ¿Qué mejores prácticas son las más eficientes para su negocio?

REMOVAL & RECYCLING
OF MARINE LITTER



Preguntas de apoyo que el facilitador puede usar para estimular la discusión:

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1. ¿Dónde ve la necesidad de mejorar sus procesos internos o procedimientos administrativos?

2. ¿Qué impacto tiene la nueva Directiva de instalaciones portuarias (La Directiva 2000/59 / CE del PRF exige que los buques desembarquen los residuos que producen durante los viajes hacia y entre los puertos de la UE a las instalaciones portuarias de recepción. También requiere que los puertos desarrollen Planes de Manejo de Residuos y proporcionen Instalaciones Portuarias de Recepción a los barcos que usan su puerto)

en su interés en recuperar los aparejos y otros equipamientos dañados, descartados, abandonados o transportados por el mar?

3. ¿Cuál es su opinión sobre la inclusión de la acuicultura en la Directiva de responsabilidad extendida del productor (EPR)?

4. ¿Cuáles son las instalaciones o plantas de reciclaje en su área? Por favor enumérelos.

5. ¿Qué opina de un fondo de seguro para los acuicultores?

6. ¿Qué mejores prácticas son las más eficientes para su negocio?

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Annex d: Questions used for targeted stakeholder interviews

1. **Perfil del entrevistado**

Para una mejor interpretación de sus respuestas, nos gustaría hacerle una serie de preguntas sobre las actividades que su institución/compañía lleva a cabo.

- ¿Con qué tipo de acuicultura está usted conectado (costa-en alta mar, especies, etc.)
- ¿Cuáles son las tecnologías que se usan en su organización?
- ¿En qué partes del ciclo de producción acuícola están ustedes involucrados?
- ¿En qué países desarrollan su actividad?

2. **Aquellos que proporcionan autorizaciones para las instalaciones acuícolas?** (como, por ejemplo, autoridades públicas).

El objetivo de este set de preguntas es describir la estructura de gobernanza de la acuicultura y los actores principales involucrados en sus diferentes niveles.

- ¿Quién/Qué organismo es responsable de la **autorización de las infraestructuras acuícolas**, incluyendo los Estudios de Impacto Ambiental?
    - ¿Se trata de **un sistema centralizado** o su aprobación requiere de la acción de **múltiples autoridades**?
    - ¿Existe una **autoridad para cada tipo de acuicultura** (por ejemplo sistemas alimentados vs sistemas extractivos o cultivo de algas/cultivo de moluscos/peces)?
    - ¿Existen **diferencias en relación a los procedimientos y guías disponibles** respecto a los **diferentes tipos de acuicultura** (peces, moluscos, etc)?
    - Describa el **rol de las autoridades acuícolas** en los diferentes niveles administrativos/de gestión, dependiendo del sistema de gobernanza aplicado en el país.

      Tenga en cuenta que en algunos casos hay diferencias en el sistema de gobernanza en función de la distancia a la costa como, por ejemplo, acuicultura de costa vs acuicultura localizada en la Zona de Exclusividad Económica (EEZ). Mientras que es probable que no haya instalaciones acuícolas en la EEZ, es relevante tenerlo en cuenta, dado que existe una tendencia futura próxima a nivel europeo que implica localizar las instalaciones en áreas más alejadas de la costa.
- ¿Están las **medidas de prevención/mitigación/monitoreo** de los residuos incluidas de alguna forma en los **procedimientos de autorización**?

3. **Producción y operatividad acuícolas.**
    - En general, ¿**cuántos productores** acuícolas hay en su país?

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  - ¿Qué **tipo** de organizaciones son? (**pequeñas empresas familiares** que poseen un negocio artesanal, **producción a escala industrial** o compañías internacionales grandes)
  - ¿Hay **asociaciones** que las representen?
- ¿**Qué elemento**, en **su experiencia** en relación al **equipamiento acuícola,** se suele **perder** más frecuentemente?
- ¿Han diseñado o **aplicado alguna solución inventiva** en relación a esta problemática? ¿Cuál podría **recomendar**?
- ¿Existe **equipamiento** para el cuál es necesario que haya **alternativas sostenibles**? ¿**Cuáles serían esos elementos**?
- ¿Existen **procedimientos/técnicas sostenibles/medidas** para prevenir y controlar los residuos acuícolas?
  - ¿Son voluntarios o vinculantes?
  - ¿Cuáles usan ustedes?
- ¿Han puesto en funcionamiento sistemas que integren las **tres R (Reducción, Reúso y Reciclaje)** en su organización?
- ¿Cree usted que **su organización** podría **mejorar la gestión de los residuos**?
- ¿Qué tipo de **apoyo falta en relación a la gestión de residuos** (por ejemplo, procedimientos y requerimientos claros por parte de las autoridades relevantes, guías de buenas prácticas, financiación u otras iniciativas para llevar a cabo tales actividades)?
- ¿Cree que las **actividades acuícolas** también experimentan **impactos negativos derivados de la presencia de basuras marinas**? Por ejemplo, pérdidas en producción debido a los elementos de plástico flotantes.

4. **Equipamiento acuícola, instalación y diseño de sistemas y compañías ingenieras:**
   - En general, ¿**cuántas empresas dedicadas al diseño de sistemas acuícolas/ingeniería acuícola** hay en su país?
     - ¿Son corporaciones **internacionales grandes o nacionales y pequeñas**?
     - ¿Hay alguna **asociación** que las represente?
     - ¿**Trabajan ustedes directamente** con alguna de ellas?
   - ¿La problemática relacionada con los **residuos acuícolas** es tomada en consideración **durante las fases de diseño**?
   - ¿Esas compañías trabajan también en el desarrollo de **soluciones técnicas/diseño sostenible** relacionadas con el **desmantelamiento, la reutilización o el cambio de finalidad** de las infraestructuras acuícolas? Por ejemplo, la propuesta técnica de una granja acuícola podría incluir sugerencias o planes para el momento en que ésta deje de ser funcional (desmantelamiento, re-uso, adaptación de finalidad).
   - ¿Se aplican los siguientes principios/aproximaciones de diseño? ¿Cómo?
     - ***Diseño circular***

       El diseño circular tiene como objetivo la circulación de los materiales usados en las instalaciones acuícolas en bucles cerrados. Estos bucles, como **re-uso, reparación, re-**

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manufacturación, re-amueble o reciclado permite extender el ciclo de vida de las instalaciones acuícolas y mejorar la productividad de los recursos[4].

- ***Diseño de la Evaluación del Ciclo de Vida.***

  El objetivo del diseño de Evaluación del Ciclo de Vida[5] (LCA) **es minimizar los impactos ambientales agregados asociados con el sistema productivo**. La aplicación de LCA en fases tempranas de la toma de decisiones puede informar a los diseñadores sobre la importancia del impacto ambiental relacionado con la elección de materiales a usar y las dimensiones de las instalaciones.

- ¿Conoce usted algún **producto reutilizable alternativo** para las jaulas, equipamientos varios, etc (como por ejemplo redes, redes para molúscos o líneas asociadas a bateas)? Por favor, aporte detalles.
- Se debería **concienciar** a los productores **sobre la existencia de alternativas sostenibles** para determinados elementos**. ¿Está usted de acuerdo?**
- ¿Cuál es o podría ser el **rol de los productores** en la tarea de prevenir los residuos acuícolas?
- ¿Existen diferencias en cuanto a las **cantidades de residuos** en función del **tipo de acuicultura** (peces, moluscos, cultivo de algas, etc), tecnología o sistema de producción usado?

5. **Conformidad con las tecnologías y metodologías usadas en acuicultura** (por ejemplo, por parte de órganos clasificadores o certificadores):
   - ¿Cuál es el rol de los **organismos que trabajan en clasificación** como **DNV GL, Bureau Veritas**?
   - ¿Existen guías **nacionales específicas o requerimientos** de otros organismos que desarrollan la **clasificación/certificación**?

6. **Construcción, logística, montaje de la granja:**
   - ¿En general, **cuántas** hay en su país?
   - ¿Hay alguna **asociación** que las represente?
   - ¿Con que **metodologías** trabajan para gestionar los residuos que se pueden producir durante sus actividades?

7. **Preguntas relacionadas con la Responsabilidad Ampliada del Productor (RAP):**
   - **¿Qué productores y usuarios** del equipamiento acuícola deberían incluirse en la directiva RAP?

     - ¿Cómo debería ser tratado el equipamiento importado de países de fuera de Europa?

[4] https://www.researchgate.net/publication/313771263_Circular_Design_-_Design_for_Circular_Economy
[5] https://www.sciencedirect.com/science/article/pii/095965269390004U

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- ¿Cómo se deberían tratar las plantas acuícolas que forman parte de compañías de fuera de Europa?
  - ¿Es **injusto culpabilizar a todos los productores de la misma forma**, porque algunos están localizados en países sin salida al mar y no contribuyen a la problemática de la basura marina con la misma intensidad que los productores de las zonas costeras?

8. **Monitoreo del la generación de residuos acuícolas (por ejemplo, refuerzo de medidas para una correcta disposición de residuos).**
   - **¿Quién** realiza el **monitoreo** de las actividades acuícolas**?**
   - ¿Se enfrentan también a la problemática de **la basura/los residuos**[6]?
   - ¿Qué **metodologías** están implementadas? Son voluntarias o vinculantes?
   - ¿Qué **tipo de apoyo se necesita** para mejorar el monitoreo?
   - ¿Existen buenas **prácticas nacionales o internacionales** en relación al monitoreo de las actividades acuícolas que podrían prevenir la generación de residuos acuícolas?
   - ¿Qué entiende usted por **monitoreo**?
   - **¿Su compañía ha** desarrollado alguna actividad de monitoreo de este tipo?

9. **Gobernanza de la gestión de residuos de la acuicultura (no orgánicos):**
   - **¿Quién** está gestionando **los residuos marinos**[7] en su país, quién es responsable de gestionar los residuos que provienen de las granjas acuícolas?
   - ¿Qué **medidas/buenas prácticas de gestión de residuos** hay en funcionamiento? ¿Son voluntarias o vinculantes?
   - ¿Cree que añadir una **tasa sobre los productos acuícolas de un solo uso** en el punto de venta podría ser más útil que el sistema RAP?
   - ¿Daría apoyo a la idea (voluntaria o vinculante) de crear un **esquema de depósitos para jaulas y equipamiento acuícola pasivo para aumentar la tasa de retorno** de estos productos? Por favor, explique.

10. **Proceso de desmantelamiento:**

[6] *Basura* – definida como residuos que no han sido recogidos ni dispuestos de forma apropiada, o cualquier elemento que haya sido perdido (como por ejemplo instalaciones o equipamientos que vayan a la deriva), *Restos marinos* – Basura flotante (generalmente no generada de forma intencionada, como por ejemplo después de un desastre).
Los residuos pueden ser gestionados; la basura se correspondería con residuos no gestionados, que sólo pueden ser recogidos.

[7] *Gestión de residuos se refiere a su correcta recolección y disposición, de forma que se previene la aparición de basuras y restos no deseados*
La recuperación de restos o la recolección de basura se podrían definir como medidas correctivas a aplicar a la disposición incorrecta (no intencional o intencional) de basuras.

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- **¿Quién** está al cargo de los procesos de **desmantelamiento** en su país?
- ¿Qué procedimientos se siguen? ¿Son voluntarios o vinculantes?

11. **Procesando los residuos acuícolas (no orgánicos) (recolección, reciclaje, limpieza):**
    - ¿Quién es responsable del **procesamiento de residuos acuícolas** en su país?
    - ¿Qué **procedimientos** se siguen? Son voluntarios o vinculantes?
    - **¿Cuándo es viable el reciclaje de redes**? ¿Qué cantidades de material serían necesarios?
    - Qué rutas de materiales se podrían usar para facilitar el reciclado del equipamiento recuperado? (por ejemplo, que tipo de productos se podrían fabricar con restos de redes).
    - ¿Podría una **mezcla** de redes (al fin de su ciclo de vida), equipamiento abandonado/perdido y basura marinas, siguiendo iniciativas similares Fishing-For-Litter, facilitar las rutas de reciclaje para los restos de materiales depositados a mano o abandonados? ¿o la mezcla de diferentes tipos de materiales es contra-productivo?
    - Pregunta relacionada con la Responsabilidad Ampliada del Productor (RAP):
        - ¿De qué forma debería ser **registrado** el **equipamiento acuícola** que es vendido o recolectado?
        - ¿En lugar de **la RAP, cree que existen medidas alternativas** más adecuadas para reducir los residuos acuícolas como podrían ser a) aplicar una penalización a las personas que ensucien b) financiar las medidas públicamente con tasas?

12. **Concienciación:**
    - ¿Estaría de acuerdo con la idea de que la clave de la concienciación podría ser **marcar/etiquetar los productos**? Los requerimientos para marcar los productos relacionados con el Art. 7 SUP podrían focalizarse en la disposición apropiada de los residuos acuícolas para prevenir que fueran depositados y gestionados de forma incorrecta. Esto podría requerir incluir un mensaje en los productos acuícolas (en packs o en los productos individuales) incluyendo imágenes de los impactos e iconos para facilitar la disposición adecuada.
    - ¿Cree que los talleres de concienciación para trabajadores y gestores son útiles? ¿Participaría usted en alguno de ellos?

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