FARNET Support Unit

TECHNICAL REPORT

FLAG Support to Algae Production

September 2020

Authors: **Janne Posti, Urszula Budzich-Tabor, Richard Freeman, Margot van Soetendael, Ewan Geffroy**

FARNET Support Unit

Rue Belliard 40

B 1040, Bruxelles

Tel: +32 2 613 26 50

info@farnet.eu

www.farnet.eu

Executive Summary

The recently launched European Green Deal acknowledges the important role of algae as a source of alternative protein for a sustainable food system and global food security. However, local data on algae-based initiatives have been relatively limited across the EU. This study aims to provide quantitative and qualitative information on algae-related projects funded by the European Maritime and Fisheries Fund (EMFF) via Fisheries Local Action Groups (FLAGs) and outline their levels of knowledge and interest in working further on this subject contributing to their areas' local development. In addition, the study aims to improve understanding of the challenges that FLAGs perceive in supporting algae-related activities in their areas.

Key findings

- 35 **(17%)** out of 208 FLAGs that submitted the survey are supporting algae-related projects, **27%** of them are aware of other algae-based activities in their areas and **49%** believe in future opportunities to develop algae sector in the FLAG areas.
- At the sea basin level, the results were more prominent for the **Atlantic**, where **55%** of the FLAGs are supporting algae projects, **61%** are aware of other algae-based activities in their areas and **75%** of them believe in future opportunities to develop local algae sector.
- For other sea basins, despite a relatively positive perception towards the future potential of algae **(41%)**, only **6%** of the FLAGs have funded algae-related projects yet and their knowledge of other local or regional algae initiatives remains limited **(14%)**.
- Two countries clearly stand out in terms of number of projects funded per FLAG: **10 Spanish FLAGs have supported 23** and **11 French FLAGs 22 algae-related projects.** Other FLAG-funded algae projects have been implemented in Portugal (7), Ireland (6), Latvia (3), Denmark (2), Estonia (2), Sweden (2), and Bulgaria (1).
- At sea basin level, the vast majority **(76%)** of FLAG-funded algae projects are implemented in the **Atlantic**, and to a much lesser extent in the **Baltic Sea (13%),** the **Mediterranean (9%)** and the **Black Sea (1.5%)**
- The most prominent project categories were 'Supply chain / product development' **(32%)**, followed by 'Research' **(22%)**, 'Wild harvesting' **(20%)** and 'Cultivation' **(15%)**.
- The most frequent challenges identified by the FLAGs to support algae-related activities were: 'the lack of local know-how or culture of exploiting algae**' (28%)** and 'lack of consumer awareness and acceptance for algae products' **(18%).** In the **Atlantic**, 'conflicts over space / access to water/ licensing' **(33%)** was identified being the most notable challenge.
- In terms of FLAG perceptions towards the potential of algae exploitation by different sectors and industries, the key most sectors identified were cosmetic products (**70%**), food source (**62%**), food supplement (**58%**), pharmaceutical industry (**58%**), fertiliser (**57%),** and animal and fish feed (**52%**).
- Only **seven** out of 208 FLAGs that answered the survey indicated that the COVID-19 outbreak impacted on algae-based activities.

Contents

Tables and Figures

Acronyms

CLLD   Community-Led Local Development

DG MARE   Directorate-General for Maritime Affairs and Fisheries

EU   European Union

EMFF   European Maritime and Fisheries Fund (2014-2020)

FARNET   Fisheries Areas Network

FAO   Food and Agriculture Organisation

FLAG   Fisheries Local Action Group

FSU   FARNET Support Unit

MS   Member State

1. Introduction

According to the FAO (*The global status of seaweed production trade and utilisation, 2018*), there are 221 species of algae that have commercial value. Algae production has grown globally from 14.7 million tonnes in 2005 to 30.4 million tonnes in 2015 (29.4 tonnes cultivated, and 1.1 million tonnes wild capture)[1]. However, the vast majority of the algae production is concentrated outside the EU, most notably in South-East Asia. The EU share of global macroalgae biomass production is low (0.28%), with France, Denmark and Ireland being the largest EU producers. In contrast to the global trend, EU macroalgae production is primarily based on wild harvesting (98%) as opposed to aquaculture[2]. According to the Annual Report on the EU Blue Economy 2018, the data provided by the industry claims that the EU algae biomass sector currently employs approximately 14 000 people and is worth 1.69 B €[3].[4]

In the context of various initiatives under the European Green Deal, such as the Farm to Fork and the Bioeconomy Strategies, the Blue Bioeconomy Forum, the Renewable Energy Directive and the upcoming revised Sustainable EU Aquaculture Guidelines call on community action to better exploit the potential of algae.

Enhanced production and use of algae could help ensure sustainable food and farming systems, circular economy, and bio-based products. In addition, as part of the Green Deal, the European Commission expects to introduce a comprehensive action on algae in 2021 which aims to make the EU algae sector more sustainable, reduce the aquaculture sector's dependency on feed derived from wild capture fisheries, reduce bioplastics and other waste, and improve circular economy services.

However, in the context of algae exploitation and its potential around the EU, the data availability remains limited. So far the data on algae production appears to be limited to data collected by the Joint Research Centre (JRC)[5], and partly visualised in EMODNET[6], Eurostat, the FAO as well as industry data from the European Algae Biomass Association. At the request of DG MARE, the FARNET Support Unit (FSU) carried out a study on the potential of algae production and use in EU fisheries areas.

The FARNET Support Unit is the technical assistance team supporting DG MARE in the implementation of Community-Led Local Development (CLLD) under the European Maritime and Fisheries Fund (EMFF). The decision-making on the use of CLLD funding is delegated to local partnerships that bring together the private sector, local authorities, and civil society organizations. Known as Fisheries Local Action Groups (FLAGs), these partnerships take decisions within the framework of a local strategy, developed in response to specific needs and opportunities identified locally. In July 2020 there were 348 FLAGs operating across 19 EU Member States.

The FSU has been aware of a few projects funded by the FLAGs under CLLD to harvest, cultivate and/or process algae, but no overall picture existed in terms of the extent to which the FLAGs have supported the sector or how they see its potential to contribute to their local economies and food systems.

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[1] Ferdouse, F., et al. (2018) '*The global status of seaweed production, trade and utilization*' FAO Globefish, Rome.
[2] The European Commission: Science and Knowledge Service. (2020) '*Algae biomass production for the bioeconomy*'.
[3] The figure includes research and development, equipment production and jobs in the larger supply chain that depend on output from the algae sector.
[4] European Commission. (2019) '*The EU Blue Economy Report*', Publications Office of the European Union, Luxembourg.
[5] The Joint Research Centre is the Commission's science and knowledge service. The JRC employs scientists to carry out research in order to provide independent scientific advice and support to EU policy.
[6] The European Marine Observation and Data Network (EMODnet) consists of more than 150 organisations assembling marine data, products, and metadata to make these fragmented resources more available to public and private users.

2. Methodology

A survey, consisting of eight questions, was designed to ascertain FLAG knowledge and information on algae production in their areas, and to identify algae initiatives which they have supported. The survey design was concise and focused on a limited number of questions to maximise the response rate. The questionnaire was developed using the online surveying software, JotForm, and was distributed by email to FLAG managers in the following six languages: English, French, German, Italian, Polish and Spanish. In addition, the FSU team contacted certain FLAG managers by telephone or additional email to increase the response rate (See Appendix B for a full version of the survey). 'Algae' and 'algae-based' products are defined quite broadly in the EU legislation[7], but in order to ensure the comprehensibility of the questionnaire, the definition was simplified in the JotForm by classifying the algae into three main categories (seaweed/macro-algae, blue-green algae/cyanobacteria and other micro-algae) as respondents could not be expected to be experts in this field.

A total of 219 responses were obtained. Following the deletion of multiple answers from the same FLAG (11), a final sample of 208 FLAGs was established, i.e. an overall response rate of 60%. However, since the questionnaire was sent to all 348 EU FLAGs, it is important to underline that the total sample of 208 FLAGs also contains 34 responses submitted by the FLAGs operating in inland areas.[8] The inclusion of inland FLAGs in this analysis was essential in order to obtain information on their potential engagement in algae projects (e.g. inland cultivation, processing or product development).

By country (Figure 1), the response rate varied from 17% (LT) to 91% (FR). The table below also shows the response rate as well as the number of FLAGs and FLAG submissions by MS.
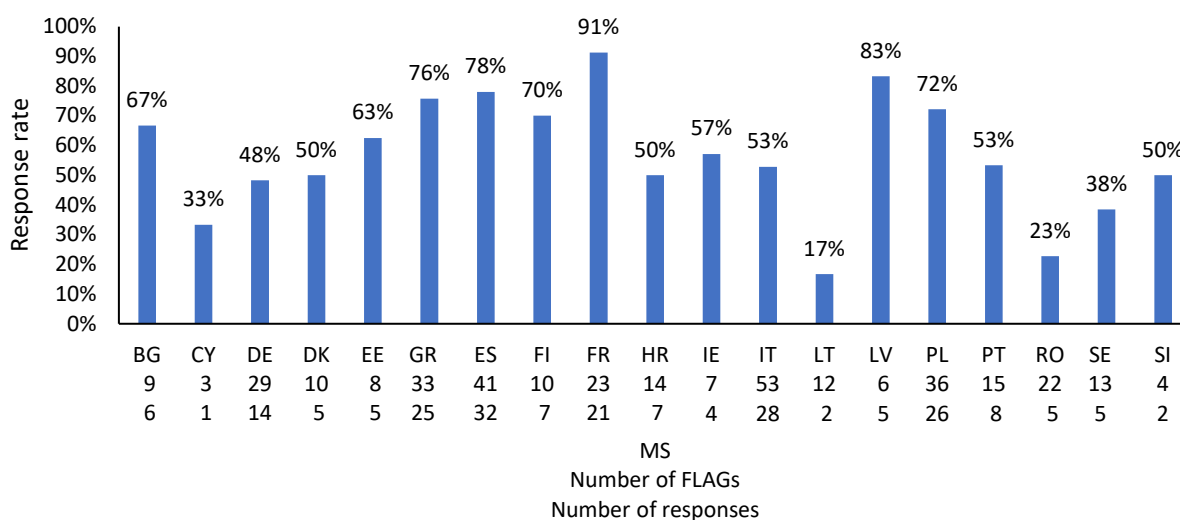
Figure 1: Response rates by MS

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[7] According to the European Committee for Standardisation (CEN), algae and algae-based products (and their intermediates) are defined as algal biomass, algae extracts or purified compounds from algae, including photoautotrophic, autotrophic, mixotrophic and heterotrophic algae, harvested in the wild, or produced in open cultivation systems, as for example raceway ponds, lagoons and natural environment, and produced in closed systems (CEN 454). However, this definition was not used in the survey, of which one of the purposes was to obtain information on FLAG perceptions of algae.

[8] The number of inland FLAG's submissions by MSs: Poland 16, Germany 7, Finland 3, Romania 3, Estonia 1, Bulgaria 1, Lithuania 1, Slovenia 1, Sweden 1.

Figure 2 shows the response rate, number of FLAGs and FLAG responses at sea basin level. A high response rate was received in the Atlantic (72%), North Sea (67%), Baltic (55%), and Mediterranean (63%), while only 35% of FLAGs in Black Sea responded to the survey. It should also be noted that the proportion of responses provided by the inland FLAGs was high in the Baltic (44%) and Black Sea (36%) regions.[9] Although a high response rate was received from the North Sea basin, it should be kept in mind that there are only 15 FLAGs on the North Sea coast (and no FLAGs at all in the Netherlands or Belgium).

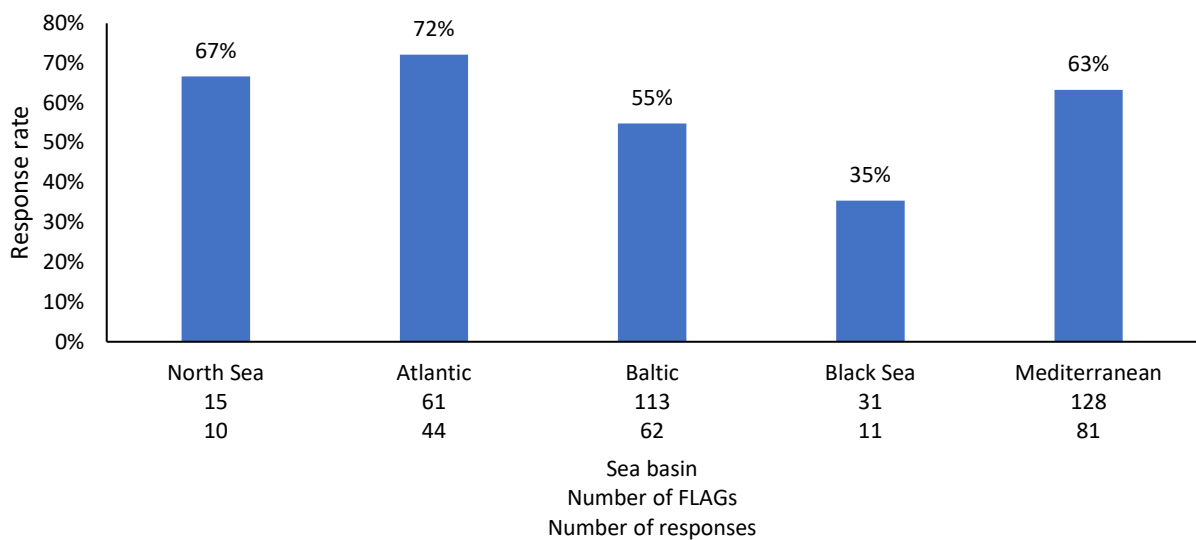| Sea basin	North Sea	Atlantic	Baltic	Black Sea	Mediterranean
Response rate	67%	72%	55%	35%	63%
Number of FLAGs	15	61	113	31	128
Number of responses	10	44	62	11	81

Figure 2: Response rates by sea basins

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[9] The number of inland FLAG's submissions by sea basins: Baltic Sea 27, Black Sea 4, North Sea 2, Mediterranean 1.

3. Results

3.1 Prevalence of algae observed by the FLAGs

Regarding the question whether FLAGs are aware if algae naturally occur in their area, 66% of the total sample of 208 FLAGS responded 'Yes', while 21% responded 'No' and the remaining 13% responded 'I don't know'. When analysing this question, it is also important to take into account the responses received from the 34 inland FLAGs, as majority of them answered 'No' (59%) or 'I don't know' (3%), while many inland FLAGs in the Baltic Sea region (notably in Germany, Finland, Estonia and Sweden) answered 'Yes' referring to 'Blue-green algae/cyanobacteria', which occur not only in the Baltic Sea but also in the lake areas of the region. It is also possible that some of the respondents understood the question within the context of the Baltic Sea, and not just the inland waters where they operate.

Looking at the FLAG awareness of the algae prevalence at sea basin level (Figure 3), it can be concluded that the FLAGs are observing relatively significant prevalence of macroalgae in all sea basins, with the exception of the Black Sea, where the blue-green algae/cyanobacteria seems to be the most observed phylum, followed by the 'other micro-algae'. 32% of respondents provided more detailed descriptions of the species observed, but due to the diversity of responses (some used scientific names for algae species, while some described species in their native language), no clear conclusions can be drawn from these responses.
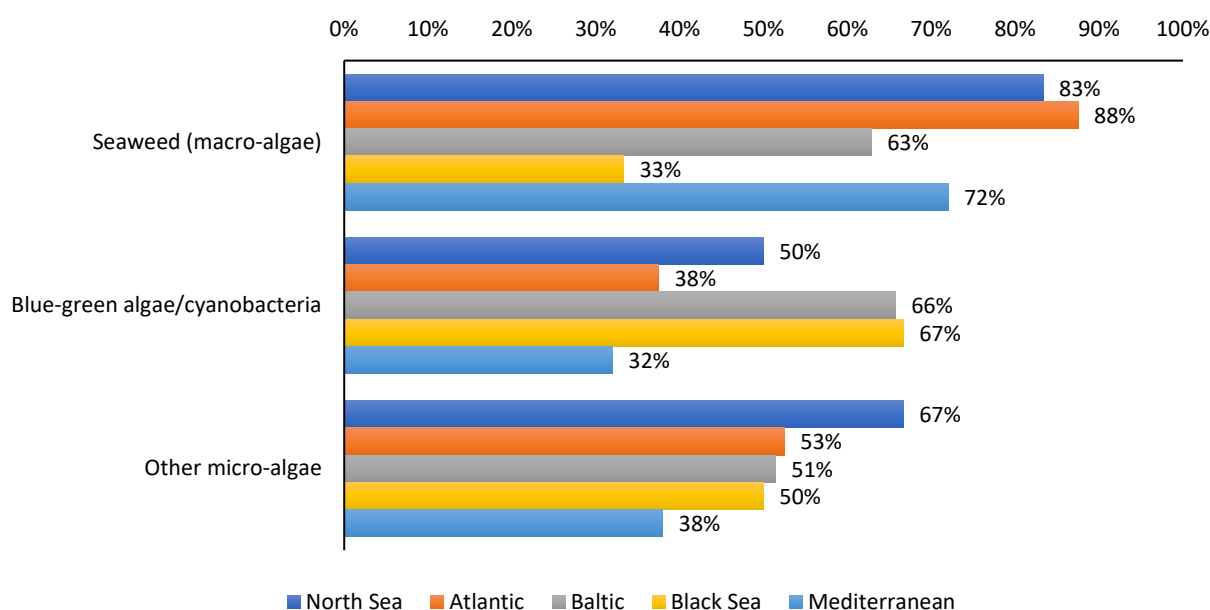

Figure 3: Types of algae species identified by the FLAGs at sea basin level

3.2 Quantitative information on algae-related projects supported by the FLAGs

Based on the information provided by 208 FLAGs, during the previous (2007-2013) and current (2014-2020) programme periods 35 FLAGs in nine MSs have supported 68 algae projects in total. The MSs are illustrated in the map below (Figure 4) and two of them clearly stand out in terms of number of projects supported per FLAG: 10 Spanish FLAGs have funded 23 and 11 French FLAGs 22 algae-related projects. Other FLAGs involved in supporting algae projects are based in Portugal, Ireland, Latvia, Denmark, Estonia, Sweden, and Bulgaria. In terms of individual FLAGs, the Ría de Vigo - A Guarda FLAG in Spain has the highest number (6) of algae projects followed by the Oeste FLAG in Portugal (5),

Galpemur FLAG in Spain (4) and Brest FLAG in France (4). 34 responses received from inland FLAGs indicate that they have not supported algae-related activities. [10,11]

Legend:
- 1 project (BG)
- 2 projects (DK, EE, SE)
- 3 projects (LV)
- 6 projects (IE)
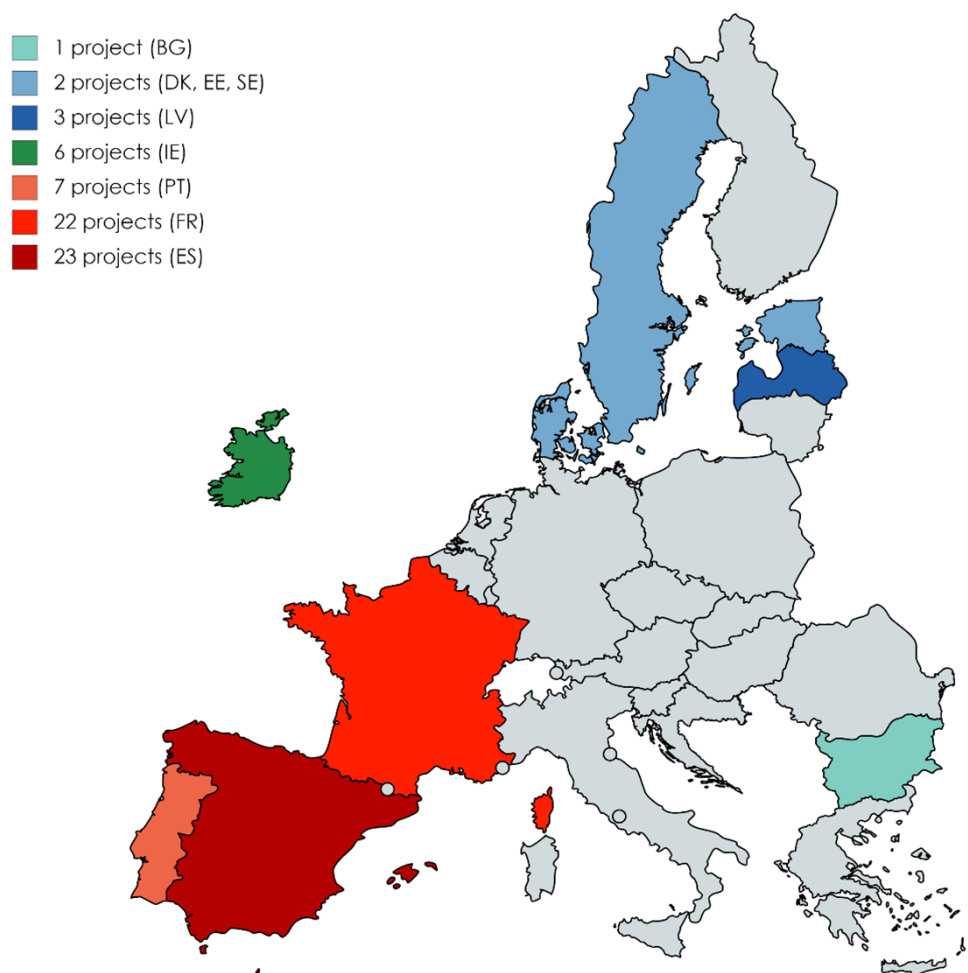- 7 projects (PT)
- 22 projects (FR)
- 23 projects (ES)

Figure 4: FLAG-funded algae projects by country

Breaking down the survey results by sea basins (Table 1), the vast majority (76%) of FLAG-funded algae-related projects are implemented in the Atlantic, and to a lesser extent in the Baltic Sea (13%), Mediterranean (9%) and the Black Sea (1.5%). The North Sea is the only sea basin where the FLAGS have not been involved in supporting algae-related projects. However, this low engagement can be partly explained by the fact of having only 15 FLAGs operating in the North Sea basin of which 10 submitted the survey.

Table 1: FLAG-funded algae projects by sea basin

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[10] The Finnish Kainuu-Koilismaa FLAG has funded a duckweed (*lemna minor*) cultivation project in Finnish lake areas, with the objective to investigate its potential in fish feed production and nutrient removal from wastewater and recycling. Nevertheless, the Finnish example has not been taken into account in the analysis since the FLAG is operating in inland waters and the duckweed belongs to the botanical family of Lemnaceae (aquatic plant) instead of to the group of algae.

[11] In 2020, there are 348 active FLAGs implementing CLLD across 19 EU Member States (MSs). For example, there are no FLAGs operating in NL although this MS has many initiatives related to algae.

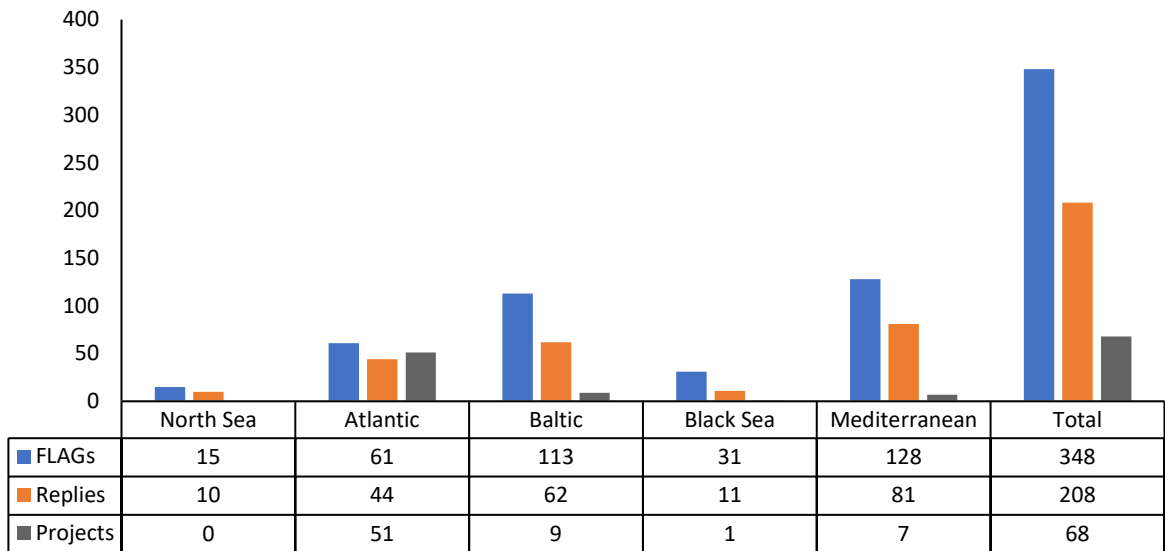|	North Sea	Atlantic	Baltic	Black Sea	Mediterranean	Total
FLAGs	15	61	113	31	128	348
Replies	10	44	62	11	81	208
Projects	0	51	9	1	7	68

Figure 5 provides information on the costs of algae-related projects funded by the FLAGs. The total costs range from €29 000 (IE) to €220 000 (BG), with an average cost of €84 000 per project. The average FLAG support level is 59%, i.e. approximately €50 000 per project, ranging from €14 000 (IE) to € 100 000 (BG) respectively.
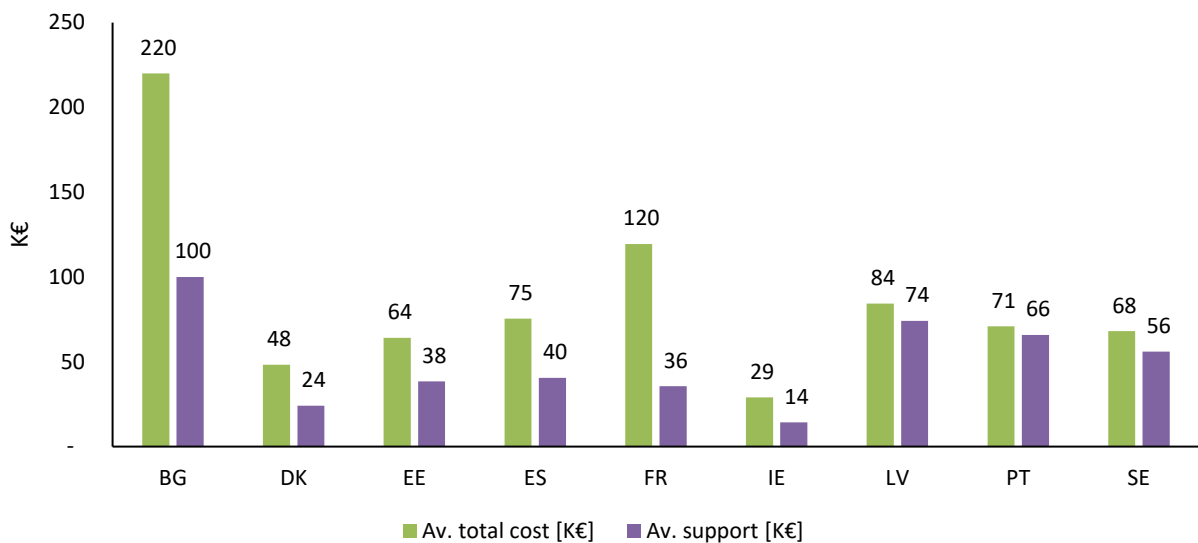

Figure 5: The average cost of algae-related projects and FLAG support by MS

3.3 Qualitative information on algae-related projects supported by the FLAGs

As well as providing quantitative information on algae-related projects in their area, FLAGs also provided qualitative information on these initiatives. Based on short project descriptions provided by

35 FLAGs, funding a total of 68 algae-related projects, the following *'project categories'* were identified:

1) **Wild harvesting** ▪ Projects related to the development of macroalgae harvesting including the acquisition of equipment and machinery used for wild macroalgae harvesting, and the harvesting of wild macroalgae for environmental reasons.
2) **Cultivation** ▪ Projects related to the development of algae cultivation, and the procurement of cultivation equipment.
3) **Supply chain/product development** ▪ Projects aimed at improving algae supply chains and the marketing of algae products.
4) **Education** ▪ Projects focused on the exploitation of algae in relation to the environment, sustainability, and health and wellbeing.
5) **Research** ▪ Projects related to the scientific research of algae.
6) **Cooperation** ▪ Projects aimed at bringing together different sectors/actors to enhance the potential of algae exploitation.

26 of the project descriptions fell under more than one category. For example, projects related to both the *'Wild harvesting'* of algae and *'Education'* or *'Research'*. The other 42 projects were identified as relating to just one category. Overall, the most prominent project categories were *'Supply chain / product development'* (with 31% of all projects assigned to this category), followed by '*Wild harvesting*' (22%), '*Research*' (21%), and '*Cultivation*' (15%) (see Figure 6). Examples of specific projects related to each of the project categories are provided in Table 2.
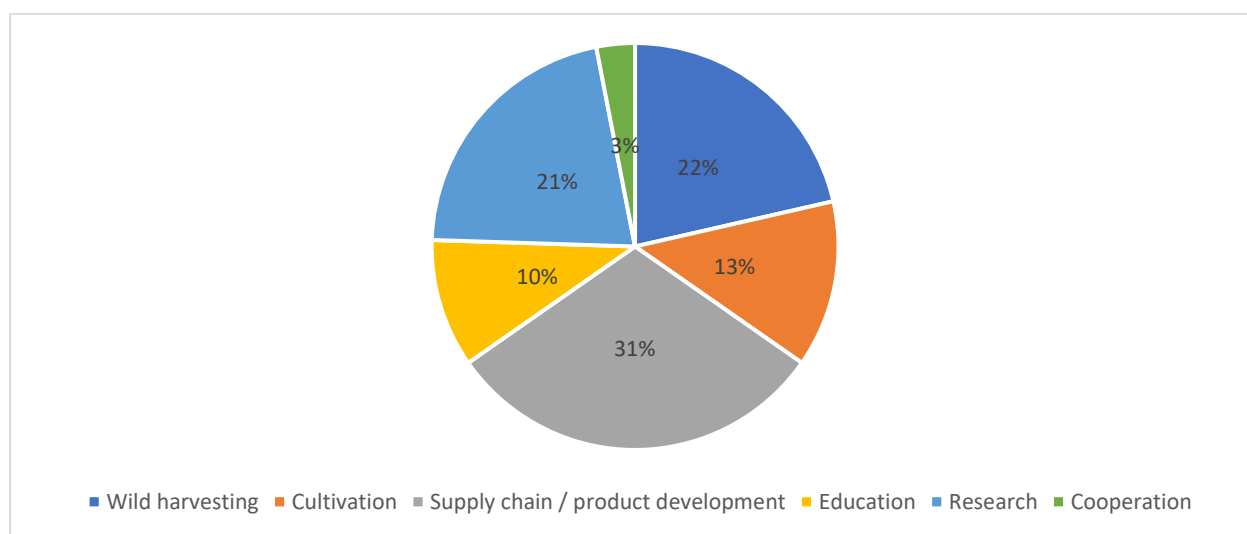

Figure 6: The division of algae project categories

Figure 7 shows the number and type of FLAG-funded algae project across the nine MSs. Again, it is important to bear in mind the total number of FLAG-funded algae projects carried out in each MS. For example, while projects under the category of 'cultivation' represent 100% of all algae-related initiatives in Bulgaria, this only represents one singular project. In MSs with a higher total number of projects related to algae, such as France and Spain, there is a greater dispersion across the categories due to their lower relative percentages.
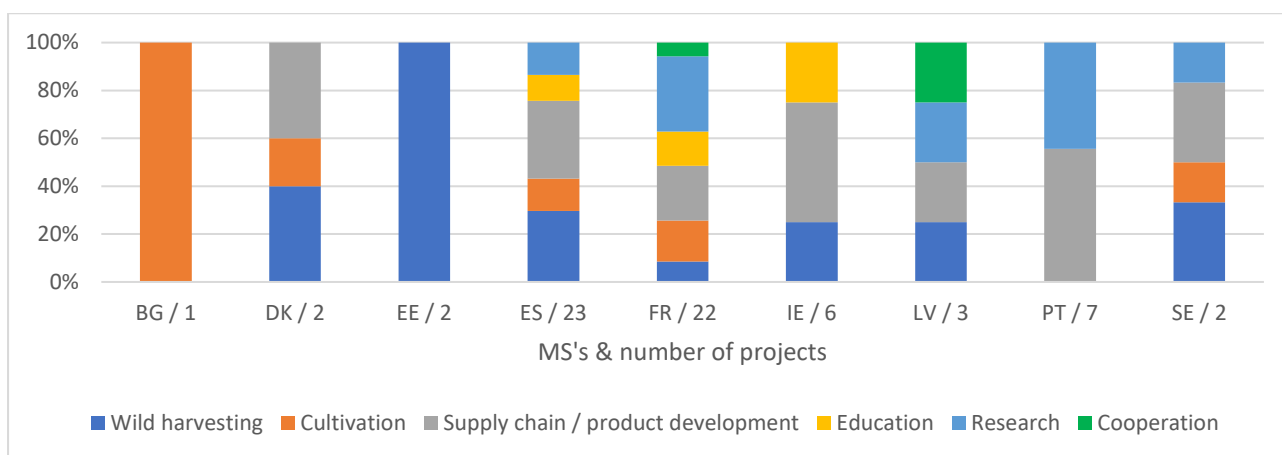
Figure 7: The division of algae project categories by MS

Table 2 illustrates four different types of FLAG-funded algae-related projects implemented in Spain, Ireland, France, and Portugal during the 2014-2020 program period.

Table 2: Examples of FLAG projects related to algae

SPAIN: Algas La Patrona	**IRELAND:** Irish Seaweed
🟦 Wild harvesting The Spanish Ría de Arousa FLAG has supported the establishment of a new company *Algas La Patrona* which began collecting, processing, and marketing premium quality seaweed from the Galician estuaries. These fresh, dried, and preserved seaweed products are sold in 26 different outlets in Spain. • Total project cost: € 71 200 • FLAG support: € 35 600 • Project duration: 8/2019 – 11/2019 • https://algaslapatrona.com/en/	🟨 Education The Irish South West FLAG has supported a *Seaweed Knife and Spoon Handle Project* implemented by the Atlantic Irish Seaweed microenterprise that has been running seaweed discovery courses & workshops since 2009. The company also offers seaweed talks, tastings and foraging trips for schools, colleges, and clubs. • Total project cost: € 1000 • FLAG support: € 500 • Project duration: 2/2019 – 10/2019 https://www.atlanticirishseaweed.com/
FRANCE: Algae cluster of Pays de Brest	**PORTUGAL:** AlgaDepur
🟩 Cooperation The French Brest FLAG has supported the creation of algae cluster in Pays de Brest. *The Seaweed Cluster*, launched in September 2018 by the Technopôle Brest-Iroise and the CCI MBO Brest, is aiming at accelerating the structuring and economic development of the seaweed sector in the Brest. • Total project cost: € 270 000 • FLAG support: € 102 542 • Project duration: 2018 - 2021 • https://www.clusteralgues-brest.bzh/	🟦 Research Portuguese Mondego Mar FLAG has supported *ALGADEPUR* project carried out by MARE - Centre for Marine and Environmental Sciences of the University of Coimbra to investigate the use of macroalgae in reducing the environmental impacts of aquaculture practiced in coastal areas (estuaries). • Total project cost: € 208 835 • FLAG support: € 177 511 • Project duration: 2018 - 2020 • https://algadepur.com/

Figure 8 shows the division of project categories at sea basin level. 51 projects carried out in Atlantic and 9 projects in the Baltic Sea region mostly supported the *'Supply chain / product development'*,

'Research' and 'Wild harvesting', whereas seven projects in the Mediterranean and one project in the Black Sea indicate high percentages in 'Cultivation' category. Again, the data obtained from Mediterranean and Black Sea should be used cautiously due to low number of projects implemented in these sea basins.
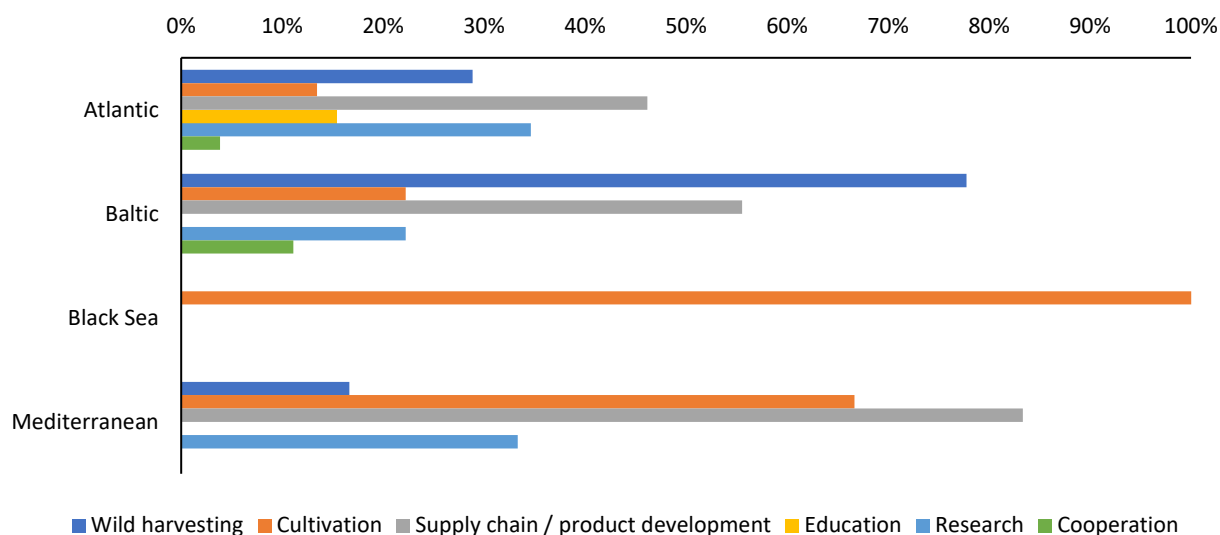

Figure 8: The division of algae project categories at sea basin level

3.4 Description of challenges that FLAGs perceive to support algae related activities

Looking at the challenges (Figure 9) faced by the EU FLAGs in supporting algae-related activities, based on the 208 submissions received, the most prominent obstacles identified were: '*the lack of local know-how or culture of exploiting algae*' (28%) and '*lack of consumer awareness and acceptance for algae products*' (18%). Indeed, the consumer behaviour is often cited as a reason for slow rate of change in sectors where change is needed for improved use of resources.[12]
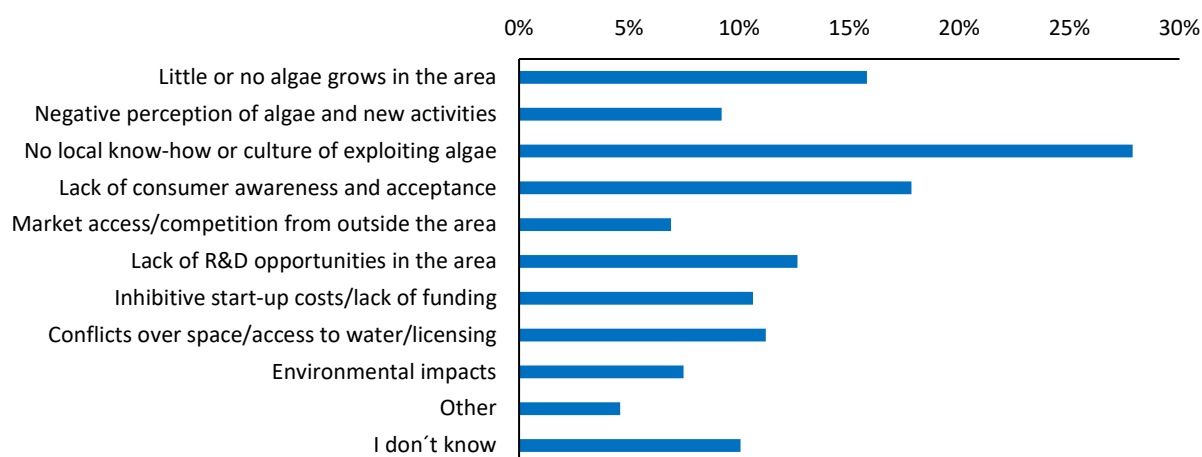

Figure 9: Challenges that FLAGs perceive to support algae related activities

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It can be observed that these results varied at the sea basin level (Figure 10). For instance, 33% of the FLAGs in the Atlantic identified *'Conflicts over space / access to water / licensing'* being the most prominent challenge in the area, followed by the lack of *'local know-how or culture exploiting algae'* and *'consumer awareness and acceptance'.* In contrast, in the North Sea '*I don't know'* was the most common response followed by the '*lack of natural occurrence of the algae'*.

Despite of the challenges and uncertainties related to the technical, economic and environmental feasibility of algae industry in the North Sea, the responses provided by the North Sea FLAGs are rather surprising since there are several endemic seaweed species occurring in the North Sea as well as a large number of algae-related SME's that have been established in the region over the past decade[13]. Regarding the challenges identified by the Atlantic FLAGs on '*Conflicts over space / Access to water/ licensing'* are consistent with scientific studies since many areas in the Atlantic region suitable for algae cultivation are covered by the Natura 2000 directive. In addition, currently only six companies have licenses for algae cultivation and lastly the cultivation is regarded to be challenging in the Atlantic sea basin due to natural geography, competitive activities on potential sites, conflicts over maritime space and regulations.[14]

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[13] Soma, K. *et al.* (2019) 'Assessing social innovation across offshore sectors in the Dutch North Sea', *Ocean and Coastal Management*, 167, pp. 42–51.

[14] Monagail, M. and Morrison, L. (2020) 'The seaweed resources of Ireland: A twenty-first century perspective', *Journal of Applied Phycology,* 32, pp. 1287–1300.
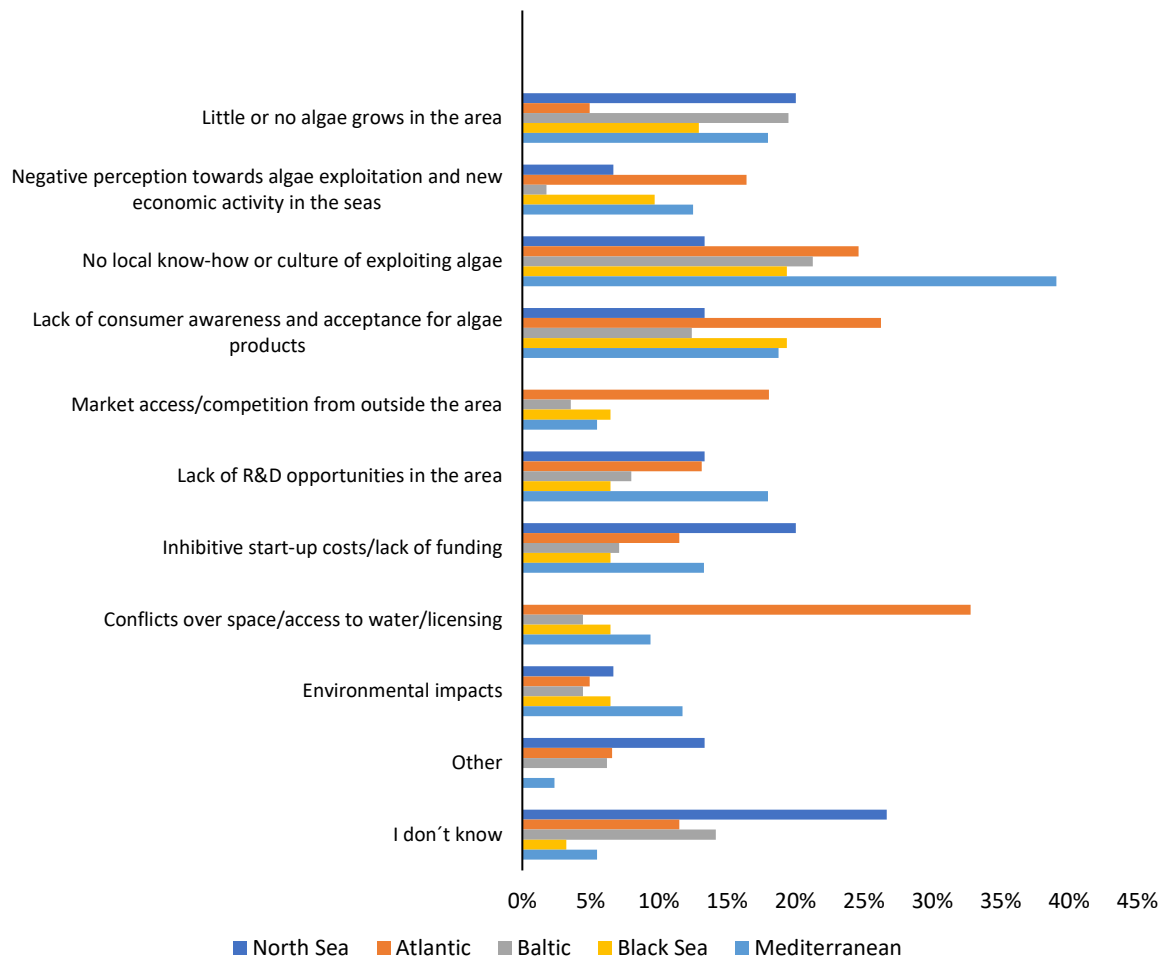
Figure 10: Challenges that FLAGs perceive to support algae-related activities by sea basin level

3.5 Opportunities and interest of FLAGs to work further on algae

In terms of future opportunities to benefit from algae-related activities, the general perception of FLAGs was relatively positive. Nearly half (49%) of the 208 FLAGs envisage potential opportunities to work further with algae-based activities by sea basin (Figure 11), the FLAGs in the Atlantic coast had the most positive perception (75%) towards these activities. The least future potential for algae activities was perceived by the Baltic Sea (35%) and North Sea (40%) FLAGs.
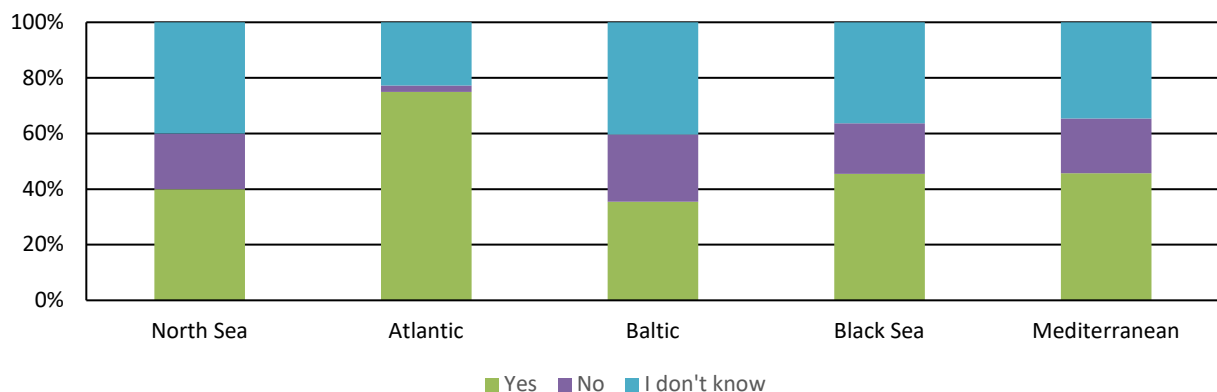

Figure 11: FLAG perceptions of algae potential per sea basin

In terms of FLAGs perceptions towards the potential of algae exploitation by different sectors and industries (Figure 12), based on the 101 positive responses (49%) received, the most promising sectors identified were cosmetic products 70%, food source 62%, food supplement 58%, pharmaceutical industry 58%, fertiliser 57% and animal and fish feed ingredient 52%.
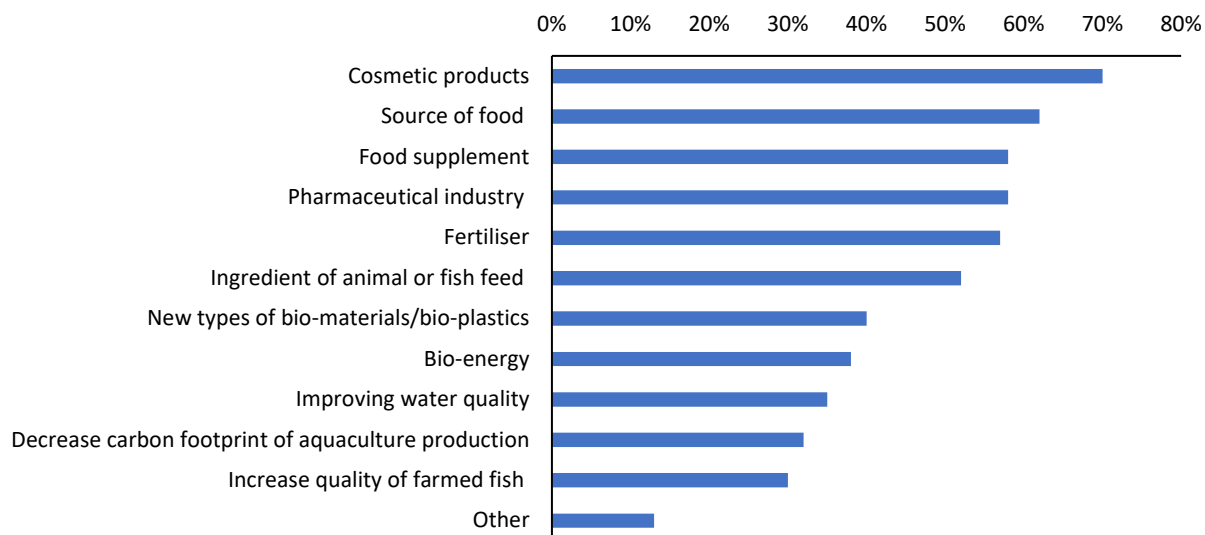

Figure 12: FLAGs perceptions towards the potential of algae exploitation by different sectors and industries

Figure 13 indicates the FLAG perceptions towards the future opportunities of algae exploitation by different sectors and industries at the sea basin level. Again, the FLAGs in the Atlantic stand out positively, highlighting algae's potential specifically as a food source, in cosmetics, in food supplements, in animal feed production and in pharmaceutical industry. On the other hand, the FLAGs in the Baltic Sea and Black Sea perceive the strong potential for algae in '*Improving the water quality*', which correlates well with the FLAG observations regarding the toxic '*Blue-green algae/cyanobacteria*' in these sea basins.
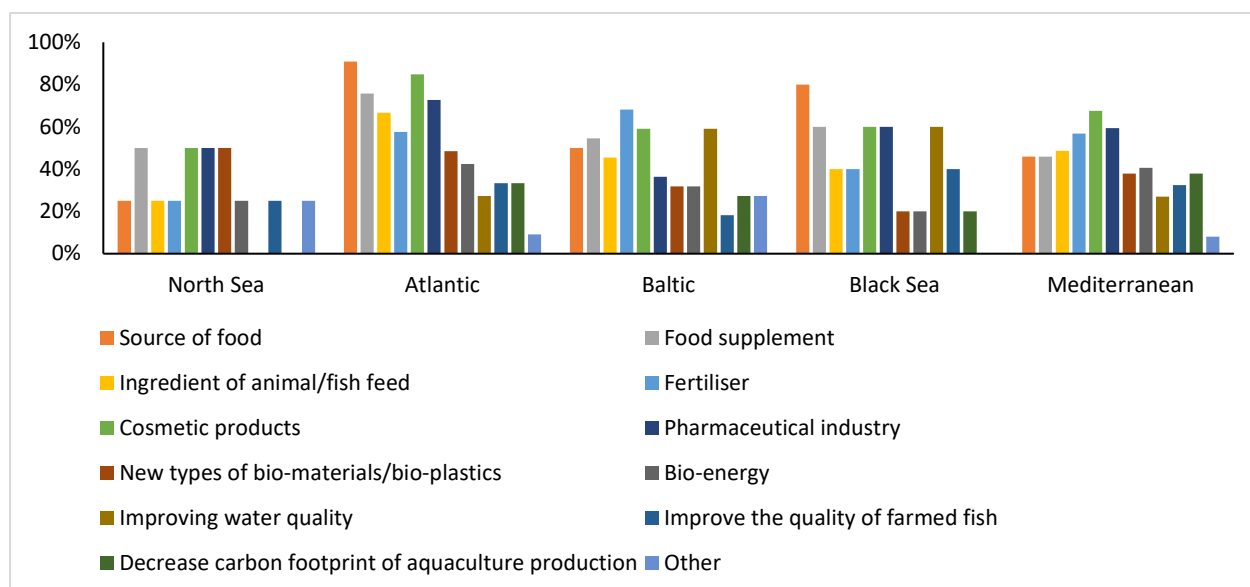

Figure 13: FLAG responses indicating algae potential in different sectors

In addition, the FLAGs were asked whether FARNET should include an algae session in their next FLAG seminar and whether the FLAGs are interested in combining opportunities to initiate or support algae-related activities. Once again, these proposals were most welcomed by the Atlantic FLAGs, while those in the Baltic and North Sea regions did not find such initiatives so useful. The responses provided by the Black Sea FLAGs were quite evenly distributed between different response options, showing a slightly more positive perception towards these proposals (see Figures 14 and 15).
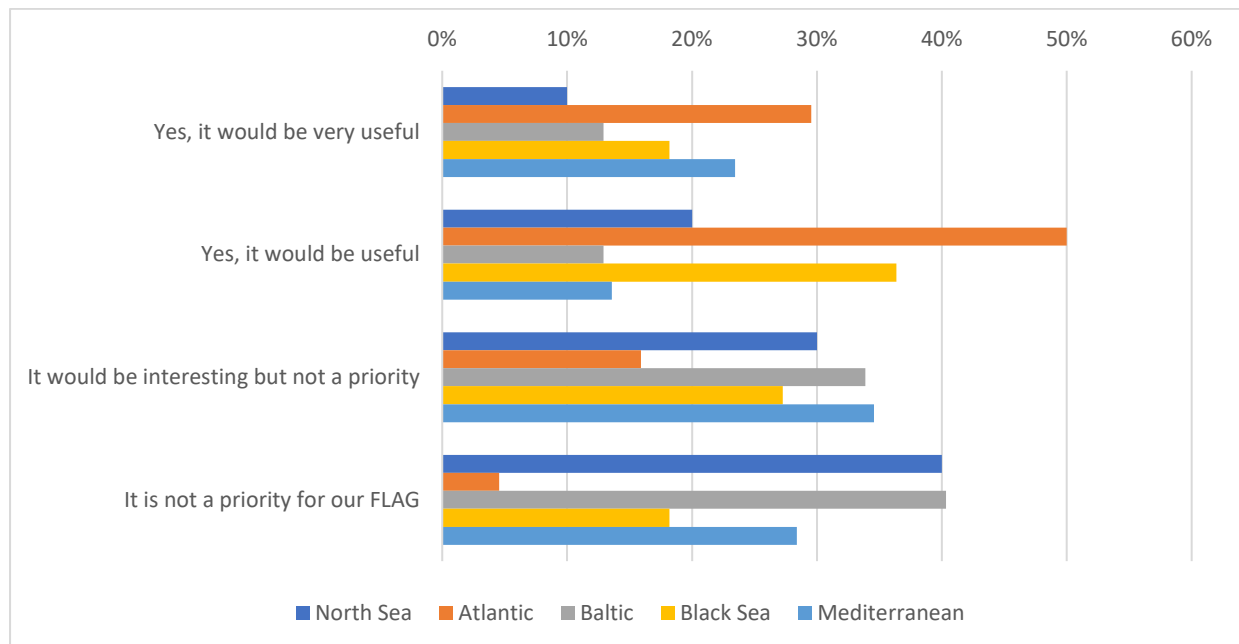

Figure 14: FLAG response to 'would it be useful for FARNET to include a session on algae at its next FLAG seminar?'
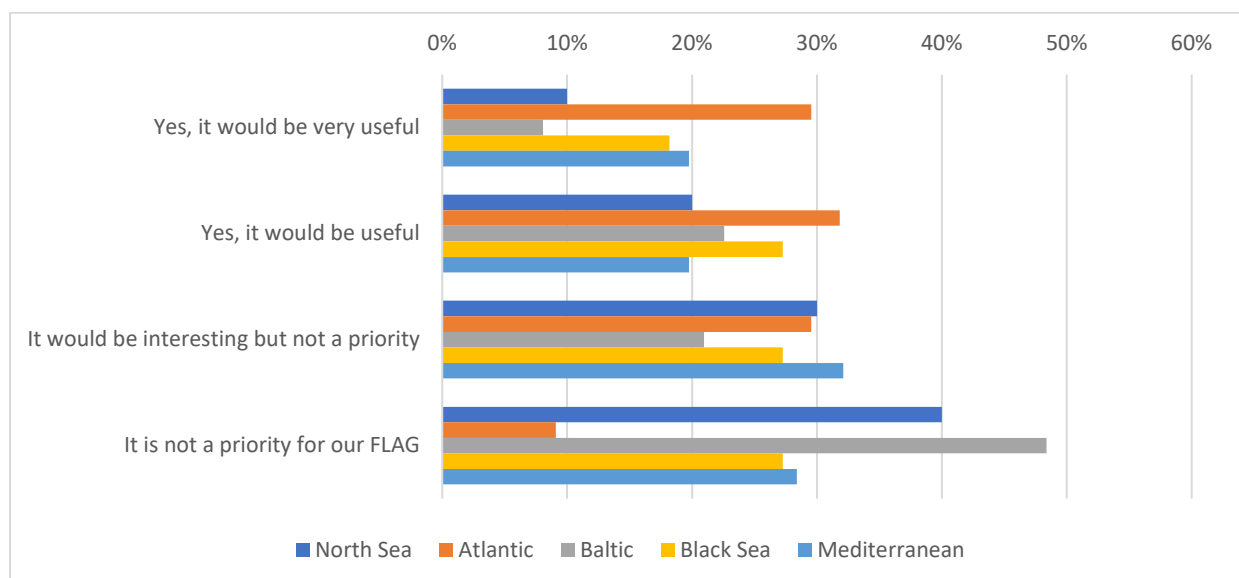

Figure 15: FLAG response to 'would you be interested in linking up with other FLAGS and/or LAGS to exchange on the potential of launching or supporting activities related to algae?'

3.6 COVID-19

Regarding the question on the impacts of the COVID-19 pandemic on algae activities, out of FLAG 208 responses, only 7 indicated that the pandemic has had some impacts on these activities. One of submission was provided by the Polish FLAG, which did not contain any detailed description of these impacts. Since there are no FLAG-funded algae projects recorded in Poland, it is highly likely that an error has occurred in the PL submission. Other written descriptions were provided by three Irish, two French and one Spanish FLAGs.

One French FLAG highlighted the *'immediate impacts of the COVID-19 on business activity and cash flows as well as a potential medium sales decrease of algae products aimed for human consumption'*, while one of the Irish FLAGs emphasised the negative impacts of '*social distancing requirements'* and *'general market disruptions caused by the COVID-19'.* According to the Spanish FLAG, '*the COVID-19 has limited the positive developments of companies and fishing organisations working with algae'.*

In conclusion, it appears that the spread of COVID-19 did not have a significant impact on FLAG-funded algae projects and activities in a short term. However, at the time the survey was carried out, the economic consequences of COVID-19 were largely unknown, so no conclusions can be drawn on the long-term impacts.

4. Conclusions

The study provides an overview of the EU FLAG's engagement in and perceptions towards algae-related activities during the CLLD 2014-2020 and Axis 4 2007-2013 programming periods. Information gathered from 208 FLAGs (60% of the FLAG population), points to 68 algae projects supported by 35 FLAGs in 9 member states, with French and Spanish FLAGs in the Atlantic coast being the forerunners in providing this type of support. It can also be observed that there is a strong correlation between the response rates and algae related activities, as higher response rates were obtained from those Member States and sea basins (notably Atlantic) where the FLAGs had been most involved in supporting algae projects.

Evidently, the overall level of FLAG's engagement in algae activities cannot be considered substantial compared to the total number of FLAG projects implemented during the and 2014-2020 (6922 projects by June 2020) and 2007-2013 programming periods.

When analysing the FLAG responses about the *'algae occurrence'* in different sea basins and FLAG areas, it is important to bear in mind that these estimates are based on assumptions and the level of awareness by FLAG managers, so no conclusions can be drawn from the submissions regarding the actual prevalence of algae in different sea basins or FLAG areas. However, e.g. the significant blue-green algae and cyanobacteria observations by the Baltic Sea FLAGs come as no surprise since the amount of blue-green algae has increased in open sea areas particularly in the Northern parts of the Baltic Sea over the last 40 years.[15]

These FLAG survey results are relatively consistent with the latest available data (JRC algae database 2019), which indicates that there are 126 algae-producing companies in the EU operating a total of 144 production plants and 57% of these companies produce macroalgae, and 43% microalgae. The vast majority of these companies are based in France, Spain, and Ireland. In France, Spain, and Portugal there are approximately equal numbers of macro- and microalgae producers while the German, Italian and Austrian production is focused on microalgae, and Irish and Danish production on macroalgae. Despite the insufficient data available on the European production of seaweed cultivation[16], the JRC database indicates that most of the aquaculture systems for macroalgae are mainly developed in the Atlantic, although currently only six companies have licences for large scale sea cultivation in the area, due to environmental restrictions (i.e. Natura 2000).[17] In the other sea basins, the algae cultivation is currently limited or in experimental phase due to lack of adequate infrastructure for seaweed mass cultivation, suboptimal geographic conditions, inconsistent legislation and low profitability.[18] Despite the similar challenges faced by the Atlantic coast, today the Atlantic seems to be the most prominent sea basin for algae activities from both, FLAG's and general point of view. Indeed, France, Spain, Ireland, and Portugal have relatively well-established seaweed

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[15] The Finnish Environment Institute. (2019) 'Press release: Warming in the Baltic Sea area increases blue-green algae blooms'.

[16] Barbier, M, et al. (2019) 'PEGASUS - Phycomorph European Guidelines for a Sustainable Aquaculture of Seaweeds', *COST Action FA1406 (2015-2019)*.

[17] European Commission. (2019) '*Brief on algae biomass production'*, Joint Research Centre, Uitgever, Publications Office of the European Union.

[18] Weinberger, F., *et al.* (2019) 'Seaweed resources of the Baltic Sea, Kattegat and German and Danish North Sea coasts', *Botanica Marina,* 63(1). pp. 61-69.

industry in place, a large number of 'algae SME's' have been set up over the last decades and the collaboration between RTDs and algae sector is increasing.[19]

While the scope of this study does not allow us to develop a set of clear recommendations for CLLD stakeholders, certain proposals as to the future role of FLAGs in supporting the algae sector moving forward can be formulated, namely:

✓ FLAGs can be instrumental in overcoming many of the challenges, which may act as barriers to developing algae-related activities at local level. In recognising and building upon the opportunities associate with algae, FLAGs via the EMFF can support diversification into the algae sector in much the same way that they do for developing new opportunities for fisheries communities in other industries such as tourism and gastronomy.

✓ By promoting algae as an area's untapped natural resource, FLAGs can nurture interest in the industry, build capacity among project promotors and stakeholders using similar methods as for fisheries and aquaculture. A starting point for FLAGs could be the encouragement of research and development into an area's algae potential through feasibility studies.

✓ A lack of know-how, consumer awareness, knowledge and skills related to algae were cited by many FLAGs as a key barrier to the development of the sector in their respective areas. If opportunities are presented, FLAGs are well placed to balance interests among local stakeholders and mediate conflicts with other industries, thus addressing some of the most frequently mentioned barriers to the development and uptake of algae-related activities in FLAG areas.

✓ Given the nature of algae production and its potential uses, cooperation between FLAGs and Leader LAGs may prove fruitful in the growing sector (e.g. the creation and development of supply chains for fertilisers and animal feeds).

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[19]Michèle Barbier, Bénédicte Charrier, Rita Araujo, Susan L. Holdt, Bertrand Jacquemin & Céline Rebours *'PEGASUS - PHYCOMORPH European Guidelines for a Sustainable Aquaculture of Seaweeds'*, Roscoff, France, 2019, https://doi.org/10.21411/2c3w-yc73 pp. 42-43