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Mª Dolores Garza-Gil
Corresponding author
University of Vigo,
Department of Applied Economics,
Vigo,
Spain
✉ dgarza@uvigo.es

Manuel M. Varela-Lafuente
University of Vigo,
Department of Applied Economics,
Vigo,
Spain
✉ mmvarela@uvigo.es

Marcos I. Pérez-Pérez
University of Vigo,
Department of Applied Economics,
Vigo,
Spain
✉ marcos.perez@uvigo.es

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The Blue Economy in the European Union: Valuation of Spanish Small-Scale Fishers' Perceptions on Environmental and Socioeconomic Effects

Summary: European coastline has undergone a transformation in becoming a significant sector of the economy. The economic importance of aquaculture, coastal and maritime tourism, and industry based on oceanic energy is crucial for explaining that transformation. The European "blue growth" generates employment and economic opportunities but could have major environmental effects on coastal zones. This could become inimical to small-scale fishing and those communities that depend heavily on fishing. This paper studies the Spanish fishers' perceptions to the linkages between the Blue Growth and small-scale fishing. Results show a significantly positive attitude toward potential contribution of blue growth to socioeconomic development and a significantly negative perception on environmental impact of such activities. Interactions are identified as well as possible opportunities that Blue Growth could offer to small-scale fishing. Recommendations for Blue Growth strategy are provided.

Keywords: Perceptions and attitudes, Environmental-economic synergies, Blue economy, Small-scale fishing, Coastal management.

JEL: C13, Q01, Q56.

The negative effect of human activity on the environment has encouraged the green economy for the last decades. This green economy is based on green energy, technologies, business and industries; and is expanding in the European Union and at global level through clean technologies, with green energy produced, for example, through wind turbines and biofuels (Alexandru Bogdan et al. 2014). The Earth is a blue planet, with more than seventy per cent of its surface covered by marine waters. This makes the marine biosphere the largest ecosystem on Earth, though with remarkably diverse abundance of life, from being virtually barren to productivity hot-spots, and playing an important role to mitigate the impact of climate change. However, human activity is causing a dramatic loss of marine biodiversity and biomass and is damaging its ability to recovery. In this framework, the Blue Economy (BE) refers to the new system of ocean-based Green Economy that implies a new growth engine by promoting both the sustainable use and preservation of the oceans, ensuring the Earth's continued survival (Nicholas Kathijotes 2013).

In recent years the European coastline has undergone a transformation in becoming a significant sector of the economy. The economic importance of certain activities - including marine aquaculture, coastal and maritime tourism (especially in the Mediterranean), and industry based on wind and tidal energy - is crucial for explaining that transformation. The growth of this "blue economy" - meaning marine aquaculture, coastal and maritime tourism, marine biotechnology, oceanic energy and deep-sea mining (European Commission 2012) - in Europe has generated many employment and economic opportunities, which have helped to mitigate the continuing economic crisis as well as the slower than desired recovery from its effects. For European Commission (EC) the "blue growth" (BG) is part of its long-term strategy, the so-called "Europe 2020 strategy for smart, sustainable and inclusive growth" (European Commission 2012). However, the environmental effects of BG industries on coastal and oceanic zones could become inimical to small-scale fishing (SSF) and be extremely adverse effects on those communities that depend heavily on artisanal fishing, yet it could also create opportunities for SSF.

This paper studies the perceptions of Spanish fishers to the linkages between BG and SSF trying to identify opportunities and challenges for this fleet segment. To do so, and after this introduction section, Section 1 introduces the review of literature of this field. Section 2 shows the main socio-economic data of European BG and SSF activities. Section 3 describes the case study. Section 4 presents the views of Spanish fishermen on the linkages between BG and SSF. Section 5 poses discussion on BG strategy. Section 6 concludes the paper.

1. Literature Review

Research on the views of fishers has focused mostly for the last years on increasing their levels of participation in decision making or analysing fishers' opinions about the (dis)incentives that aim to improve compliance with fisheries rules and their perception on different environmental effects. The empirical literature has evidenced that greater participation of agents in the decision-making process should render regulatory measures more effective (Stephan Gelcich et al. 2009; Cristina Pita, Graham J. Piarce, and Ioannis Theodossiou 2010), reduce conflicts involving fishers and increase compliance levels (Sverker C. Jagers, Daniel Berlin, and Svein Jentoff 2012; M. Dolores Garza-Gil et al. 2015; Garza-Gil and Manuel M. Varela-Lafuente 2015). Likewise, recent literature has shown that fishers have detected climate-related changes in their environment particularly those in developing countries that are highly dependent on marine activities for food and economic security, as well as for the maintenance of traditional cultures (Melissa Nursey-Bray et al. 2012; Junjie Zhang, Jason Fleming, and Ralf Georicke 2012; C. J. Da Silva, Ruth Albernaz-Silveira, and Pedro S. Nogueira 2014; Munshi K. Rahman and Thomas W. Schmidlin 2014; Sonia R. C. Seixas et al. 2014; Edward H. Allison and Hannah R. Basset 2015; Israt Jahan, Dewan Ahsan, and Hasan Faruque 2015; Sebastián Villasante et al. 2016; Ivan Machado Martins and Maria A. Gasalla 2018).

Not many references there are about Blue Economy (BE). Awni Behnam (2007) first raised the idea of "Living with the ocean and from the ocean and in a sustainable relationship". And, since then, a few studies pose a new approach to the new system of ocean-based Green Economy that interweaves creative neo-science and technologies with the ocean. Kathijotes (2013) proposes the introduction of more innovative technologies to the market based on BE Concept, such activities will generate new cash flow, and in consequence create jobs and build social capital. This author suggests BE as the mainstream of national development which can integrate socioeconomic development based on land and sea in a sustainable manner, and an integrated spatial planning is also required for it (Kathijotes 2014). Bogdan et al. (2014) pose a practical approach through the bridges between green economy and blue economy, with practical examples about the rural eco-bio-economy, for the agro-food green power, innovative eco-biotechnologies, and the management of complex systems, among others. This approach would avoid the increase of ecological debt of current generations form accounts of natural resources for the sustainable survival of future generations.

Regarding on the particular case of each one of the BG activities, *aquaculture* has the potential to improve food security and alleviate poverty and technological advances have opened up new avenues for the development of this activity (Food and Agriculture Organization 2015). Although the environmental effects of a marine fish farm depend on species being raised, cultivation method, stock density, power supply, and hydrographic conditions, the factors driving this BG segment's environmental impact can be focused on generation of waste products, escape of farmed species, and use of chemicals and antibiotics (Joao G. Ferreira, Camille Saurel, and José M. Ferreira 2012; Xinxin Wang et al. 2012; Kathijotes 2013; Irja Vormedal 2017).

Coastal and maritime tourism is one of the most economically significant maritime activities in the EU (European Commission 2016). The EC identified several actions that could build on the sector's capacity to contribute to a smart, sustainable, and inclusive economy that would stimulate development in coastal zones. Environmental protection is vital for nautical tourism in particular, since for boaters the main attraction of such tourism is a beautiful, clean, and well-preserved area. However, the development of such activities increases environmental pressures on the littoral coastal (FAO 2015) and the greater population and urban occupation of the territory produce alterations in the coastal dynamic and may well degrade the coast and marine environment (Ross A. Klein 2011; Roberta Lasagna et al. 2011; Hrvoje Caric and Peter Mackelworth 2014; Alexandra Polido, Elsa Joao, and Tomás B. Ramos 2014; Caric 2016; Marilena Papageorgiou 2016).

Marine biotechnology (a.k.a. blue biotech) can be defined as "efforts that involve marine bio-resources, either as the source or the target of biotechnology applications" (Joël Querellou et al. 2010). The progress being made in gene transfer technology indicates that it may be possible to manipulate the growth patterns of fish and shellfish via growth hormone genes (Ian Joint, Martin Mühling, and Querellou 2010; Antonio Figueras, M. M. Costa, and Beatriz Novoa 2012; Alejandro P. Gutierrez et al. 2012; Muhammad Y. Laghari et al. 2014; Joshua Weitz et al. 2015). Yet the possible benefits of blue biotech include reducing greenhouse gas (GHG) emissions as well as both the recycling costs and the energy and water requirements of manufacturing chemical products.

Like other renewable energies, harvested *oceanic energy* could help reduce GHG emissions. European seas and oceans are crucial for the EU's energy security and for diversifying its sources of energy and their supply routes (European Commission 2012, 2014a). The most frequently cited environmental effects are the destruction of habitats and the killing of fish through direct blade strikes, underwater noise, and electromagnetic waves (George W. Boehlert and Andrew B. Gill 2010; Andreas Uilhein and Davide Magagna 2016).

Lastly, on *deep-sea mining*, many countries have shown increased interest in deep-sea mining as a response to surges in the price of raw materials, concerns about securing a supply of critical minerals, technological developments, and new discoveries of mineral deposits (European Commission 2014b). A large number of studies have addressed the possible environmental impact of deep-sea mining highlighting loss of substrate, effects on the seabed of the operational plume and re-sedimentation, and effects of the discharge plume on pelagic or - depending on the plume's depth - benthic organisms (Malcom R. Clark et al. 2012; Rachel E. Boschen et al. 2013, 2016; Jennifer M. Durden et al. 2017).

2. European BG and SSF Activities

According to data from Eurostat (2017)[1], BG activities represent more than 1% of the gross value added (GVA) and some 2.5% of the employment throughout European coastal regions in 2013 (the only year for which BG industry data are available). The figures reported in Tables 1 and 2 reveal the importance, in terms of GVA and number of jobs (positions, not necessarily full-time), of the blue economy for each country in that year. The greater significance of these activities for France, Greece, Italy, Slovenia, Spain, and the United Kingdom mainly reflects the contribution of coastal and maritime tourism. The economies of France and Spain derive considerable benefit also from the aquaculture sector, and in Germany there are a relatively high number of jobs due to ocean energy activity. There is a much shorter history of minerals exploitation and marine biotechnology, so these sectors are active in only a few countries. In fact, the information available indicates that only Ireland and Spain host companies for which "blue technology" is the main focus. Yet all major pharmaceutical firms have marine biology divisions, and their economic importance is likely greater than Table 1 suggests. Only seven countries are known to engage in the economic exploitation of minerals in their territorial waters; most such activity occurs in France, Germany, and the Netherlands.

Table 3 report the main socioeconomic indicators, by country, for the European small-scale fishing segment during 2008-2014. France, Italy, Portugal, Spain, and the United Kingdom are the major fishing countries in terms of GVA, and they have already become invested in some blue growth activities. SSF is important from an employment standpoint in France, Greece, Italy, Portugal, Spain, and the United Kingdom. Likewise, SSF accounts for 60% of the European fleet's vessels and by 30% of full-time employment (FTE) - although nearly half of the jobs according to STECF (2016).

[1] **Eurostat.** 2017. Maritime Policy Indicators. http://epp.eurostat.ec.europa.eu (accessed October 19, 2017).

Table 1 European Blue Economy, 2013 - GVA

	Aquaculture	Coastal and maritime tourism	Marine biotechnology	Oceanic energy	Deep-sea mining	Total blue economy
Belgium	3.00	531		35	10	**579**
Bulgaria	0.20	771				**771**
Croatia	29.00	710				**739**
Cyprus	10.00	632				**642**
Denmark	10.00	1,016		70	10	**1,106**
Estonia		134				**134**
Finland	10.00	290				**300**
France	516.00	5,648			58	**6,222**
Germany	3.00	2,660		1,530	20	**4,213**
Greece	450.00	8,710				**9,160**
Ireland	37.00	498	9	5		**549**
Italy	150.00	7,170				**7,320**
Latvia		53				**53**
Lithuania		16				**16**
Malta	12.00	273				**285**
Netherlands	43.00	3,727		999	115	**4,884**
Poland	10.00	330			5	**345**
Portugal	6.00	943				**949**
Romania		402				**402**
Slovenia	0.07	54				**54**
Spain	246.00	12,986	12			**13,232**
Sweden	3.00	1,400		2		**1,405**
UK	95.00	2,280			10	**2,385**
Total EU	1,633.00	**51,234**	**21**	**2,641**	**228**	55,745

Notes: GVA (gross value added) in millions of euros; UK = United Kingdom.

Source: Authors' compilation from European Commission (2014c).

Table 2 European Blue Economy, 2013 - Employment

	Aquaculture	Coastal and maritime tourism	Marine biotechnology	Oceanic energy	Deep-sea mining	Total blue economy
Belgium	80	9,738		1,200	100	**11,118**
Bulgaria	218	112,794				**113,012**
Croatia	105	33,677				**33,782**
Cyprus	120	84,800				**84,920**
Denmark	190	20,835		330	100	**21,455**
Estonia		4,720				**4,720**
Finland	279	8,930				**9,209**
France	30,672	149,316			646	**180,634**
Germany	10	98,460		16,510	270	**115,250**
Greece	3,600	98,000				**101,600**
Ireland	1,705	6,636	185	151		**8,677**
Italy	4,200	206,580				**210,780**
Latvia		5,370				**5,370**
Lithuania		341				**341**
Malta	173	14,525				**14,698**
Netherlands	2,580	91,800		2,208	462	**97,050**
Poland	60	22,390			20	**22,470**
Portugal	2,085	44,913				**46,998**
Romania		47,730				**47,730**
Slovenia	30	2,150				**2,180**
Spain	43,222	351,304	287			**394,526**
Sweden	147	26,950		46		**27,143**
UK	988	173,009			436	**174,433**
Total EU	**90,464**	**1,614,968**	**472**	**20,445**	**2,034**	**1,728,096**

Notes: Jobs in number of persons; UK = United Kingdom.

Source: Authors' compilation from European Commission (2014c).

Table 3 Main Socioeconomic Indicators: Small-Scale Fishing Fleet, 2008-2014

Country	Number of vessels			Full-time employment (persons)			Gross value added (€ millions)		
	2008	2011	2014	2008	2011	2014	2008	2011	2014
Belgium									
Bulgaria	747	926	999	1,096	1,423	343	0.7	–0.8	1.9
Croatia	n.a.	n.a.	1,665	n.a.	n.a.	537	n.a.	n.a.	10.0
Cyprus	500	931	827	697	740	616	4.3	0.7	0.2
Denmark	1,228	1,102	1,004	379	276	225	16.6	12.8	10.9
Estonia	880	876	1,475	444	320	333	2.4	2.4	2.8
Finland	1,486	1,589	1,699	177	229	251	5.9	6.7	6.6
France	4,589	4,480	4,198	2,931	2,789	2,481	164.8	175.4	137.0
Germany	961	883	817	790	664	608	4.9	3.1	3.8
Greece	15,834	15,268	14,642	n.a.	19,396	n.a.	n.a.	n.a.	–85.0*
Ireland	1,030	786	898	1,667	1,067	763	9.1	11.6	19.0
Italy	7,885	7,866	7,611	9,385	1,036	9,379	188.2	199.7	142.3
Latvia	736	245	221	373	202	214	0.7	1.2	1.7
Lithuania	89	69	64	208	37	46	0.3	0.3	0.3
Malta	621	532	648	695	592	804	–0.1	2.2	1.2
Netherlands	155	163	178	132	73	99	5.6	2.9	2.6
Poland	563	518	595	1,201	1,163	1,420	6.4	7.5	6.9
Portugal	3,792	3,338	3,097	3,246	3,370	2,967	77.3	58.5	65.3
Romania	395	197	111	31	26	24	0.3	0.9	0.7
Slovenia	60	62	77	48	42	60	0.2	1.2	1.2
Spain	6,420	4,214	4,156	7,059	6,695	5,546	75.7	81.4	86.7
Sweden	819	754	731	470	367	332	12.1	9.4	7.0
UK	3,256	3,325	3,138	1,745	2,066	1,954	73.6	58.0	65.8
Total EU	**52,046**	**47,198**	**48,851**	**32,774**	**42,573**	**29,002**	**649**	**635**	**489**
Total EU fishing	**87,805**	**82,356**	**82,517**	**100,788**	**120,700**	**90,360**	**3,242**	**3,580**	**3,573**

Notes: The small-scale fishing fleet includes vessels less than 12 meters in length (of which Belgium has none); n.a. = not available; UK = United Kingdom; * = 2013.

Source: Authors' compilation from Carvalho, Keatinge, and Guillen (2016).

The revenues and GVA generated by this segment represent 15% of that generated by the total European fleet. In relative terms, and according to Natacha Carvalho, Michael Keatinge, and Jordi Guillen (2016) the participation of SSF in the national fleet is especially significant (in terms of employment and number of vessels) for Cyprus, Estonia, Greece, Poland, and Romania, countries in which it accounts for 70% of the respective national totals; that figure is close to 60% in France, Italy, Latvia, and Malta. The total European fleet and the SSF fleet exhibit a similar trend over 2008-2014, both variables decreasing by 1% overall but with a slight increase from 2011 to 2014. Full-time employment in the SSF segment, after increasing in the immediate aftermath of the economic crisis, declined by nearly 3% overall; and GVA decreased by nearly 4% during this period.

Thus when all of Europe is considered, the socioeconomic importance of BG industries is both substantial and dramatically greater than that of fishing. Of critical importance, however, is that further growth in these activities could have major environmental effects on coastal and oceanic zones, and especially in those grounds where SSF operates (Kathijotes 2012).

3. Method

3.1 Case Study

The rapid growth of blue industries could well accelerate degradation of the ocean environment, and any alteration in the ecosystems of coastal zones will have a negative effect on the species caught by the SSF fleet. At the same time, BG activities offer socioeconomic benefits in terms of GVA, employment, and food security. Another positive effect is that aquaculture and blue technology should provide significant benefits to European society in terms of achieving greater security of food and nutrition. Table 4 summarizes these positive impacts and the environmental effects.

Table 4 Effects of the Blue Economy

	Aqua-culture	Coastal and maritime tourism	Marine bio-technology	Oceanic energy	Deep-sea mining
Socioeconomic effects					
Production	+	+	+	+	+
Income (gross value added)	+	+	+	+	+
Job creation	+	+	+	+	+
Food safety	+	N.A.	+	N.A.	N.A.
Nutrition	+	N.A.	+	N.A.	N.A.
Environmental effects					
Marine pollution	−	−	0	−	−
Eutrophication	−	−	0	−	−
Habitats/ecosystems/biodiversity	−	−	−	−	−
Marine mammals and birds	N.A.	N.A.	N.A.	−	−
Climate change mitigation	0	−	+	+	−
Improved monitoring and understanding of marine ecosystems	+	+	+	+	+

Notes: +: positive effect; −: negative effect; 0: no or small effect; N.A.: not applicable (or unable to assess).

Source: Authors' compilation.

Stakeholder interactions are viewed as an important factor of research for sustainable development (Flurina Schneider and Tobias Buser 2018). In this particular case study, accommodating the perspective of small-scale fishing - one of the sectors probably most affected by and thus most concerned with the development of BG industries - increases the likelihood that maritime policies will be effective. Toward this end, a survey of Spanish small-scale fishers was conducted.

3.2 Survey

The survey included questions about coastal problems, the contribution of BG industries to economic development, the effect of BG activities on the ocean environment, the interaction between BG and SSF, and socioeconomic data. The list of coastal problems regarding which these assessments were elicited was based on the European Environment Agency (European Environment Agency 2016): loss of habitats, erosion, pollution, waste water discharge, declining stocks and urbanisation. The second section of questionnaires refers to the fishers' perceptions on contribution to socioeconomic development and environmental effects of BG activities. Since questions on perceptions elicit responses that indicate degrees of importance to statements each respondent was asked to respond to a set of statements regarding the topics under investigation using a five-point Likert scale ranging from "very unimportant" to "very important". In particular, fishers were asked to classify how they viewed the importance of these topics using the scale: 1 (very unimportant), 2 (unimportant), 3 (neutral), 4 (important), or 5 (very important). Likert-type scales are frequently used in the behavioural sciences (Charles Judd, Eliot R. Smith, and Louise H. Kidder 1991; Louis Cohen, Lawrence Manion, and Keith Morrison 2013) and have been increasingly used to measure fishers' attitudes and perception towards their fishery, conservation, policy and management measures (Nadine Marshall 2007). For the interaction BG and SSF section, no response scale was employed; for these questions, results reflect subjects' spontaneous responses.

Research to date suggests that fishers' perceptions can be influenced by a wide variety of factors. Attitudes and perceptions can vary depending on characteristics of boats, fishing ground, if fisher is owner of boat, or skipper, among other factors. Information for these variables and other socioeconomic characteristics were collected and used in the analysis in order to investigate which personal characteristics influenced fishers' perceptions. In particular, Spanish SSF were asked by age, education level (basic level or more), income level (<15, 15-18, and >18 thousands of euros), technical characteristic of vessel, business characteristics (owner, skipper), and fishing zone (Northwest Atlantic, rest of Atlantic, and Mediterranean Sea). The Table 5 shows the descriptive statistics and the description of the variables used in the statistical analysis and other relevant characteristics.

Table 5 Descriptive Statistics of the Sample

Description of variables	Average	Standard deviation
Socioeconomic characteristics		
Age = age of person surveyed (years)	40	12.63
Education level = 1, if respondent has the obligatory education level or more, 0 if respondent has less than obligatory level	0.2	0.4
Income level = total annual income range (thousand €)[a]	15-18	71
Capacity = vessel capacity in terms of gross tonnage	4.3	1.7
Length = length of vessel in meters	6.5	2.3
Engine power = vessel power in terms of horsepower	29.3	7.4
Skipper = 1, if respondent is employed as skipper, 0 otherwise	0.8	0.3
Owner = 1, if respondent is owner of the vessel, 0 otherwise	0.7	0.4
Geographic zone		
Norwest Atlantic = 1, 0 otherwise	0.51	0.36
Rest of Atlantic =1, 0 otherwise	0.17	0.29
Mediterranean Sea =1, 0 otherwise	0.32	0.38
Fishers' perceptions towards socioeconomic effects of BE activities		
ACQ = 1, if respondent perceive aquaculture to contribute to socioeconomic development, 0 otherwise	0.65	0.45

CMT = 1, if respondent perceive tourism to contribute to socioeconomic development, 0 otherwise	0.91	0.28
OE = 1, if respondent perceive energy to contribute to socioeconomic development, 0 otherwise	0.45	0.50
BT = 1, if respondent perceive blue technology to contribute to socioeconomic development, 0 otherwise	0.56	0.50
DM = 1, if respondent perceive mining to contribute to socioeconomic development, 0 otherwise	0.33	0.21
Fishers' perceptions towards environmental impacts of BE activities on SSF grounds		
ACQ = 1, if respondent perceive aquaculture to generate impact, 0 otherwise	0.69	0.43
CMT = 1, if respondent perceive tourism to generate impact, 0 otherwise	0.85	0.34
OE = 1, if respondent perceive energy to generate impact, 0 otherwise	0.26	0.44
BT = 1, if respondent perceive blue technology to generate impact, 0 otherwise	0.68	0.47
DM = 1, if respondent perceive mining to generate impact, 0 otherwise	0.95	0.21

Notes: [a] majority range and frequency of occurrence (%); ACQ = aquaculture; CMT= coastal and maritime tourism; OE = ocean energy; BT= blue technology; DM = deep-sea mining.

Source: Authors' compilation.

In order to develop the pilot questionnaire, different fishers' guilds were contacted with the aim of presenting the proposed survey and securing their collaboration. Next, the questionnaire was pre-tested and adjusted. In the end, 861 questionnaires were completed (over 10% of employed persons in Spanish SSF, see Table 3), a response rate of about 59%.

3.3 Analysis

The study aims evaluate the SSF fishers' perceptions towards socioeconomic and environmental effects of the BE. For it, a survey was conducted. The choice of variables is based on European Commission (2012) and incorporating the usual socioeconomic and geographical variables in studies about fishers' attitude analysis (Gelcich et al. 2009; Jagers, Berlin, and Jentoff 2012; Garza-Gil et al. 2015). In order to identify which of fishers' individual characteristics (socioeconomic, size, fishing zone, perceptions and attitudes) influence such ranked responses, ordinal logistic regression models were fitted, using Huber-White robust standard errors (Alan Agresti 1984; J. Scott Long and Simon Cheng 2004). The ordered regression models are the most commonly used models for ordinal outcomes in the social sciences. These models assume proportional odds (or parallel regression assumption), i.e. they assume that the coefficients describing the relationship between each pair of outcome groups are the same. As such, the proportional odds assumption needs to be tested and this is done through the Brant's Wald test (Brant test) and the Likelihood-ratio test for ordinal responses.

First a reliability analysis, using the Cronbach's alpha coefficient, was carried out to test the internal consistency of the scale for the several Likert-scale items. The Cronbach's alpha coefficient is the most frequently used estimate of internal consistency and is used to measure how well a set of items measure a single unidimensional latent construct; alpha coefficients range in value from 0 to 1 and scales with a Cronbach's alpha of 0.7 or greater are considered to be acceptable. In addition, the explanatory variables were tested for collinearity, and when independent variables exhibited a bivariate correlation above 0.7 one of the variables was omitted (Barbara G.

Tabachnick and Linda S. Fidell 1996). For these cases, the variables used in the analysis were chosen according to relevance to the study (Gelcich et al. 2009). Post-estimation analysis for multicollinearity was also calculated, with tolerance and variance inflation factor (VIF) and no multicollinearity was found amongst the explanatory variables. Reliability tests were also performed for the estimated response ranges by using both likelihood and Wilcoxon tests to quantify fishers' preferences regarding the different proposed options:

$$Z = \left[\left(T - \left(N(N+1)\right)/4\right)\right] / \left[\sqrt{\left(\left(N(N+1)(2N+1)\right)/24\right)}\right], \qquad (1)$$

where T denotes number of pairs where difference is not 0 and N is the smallest of absolute values of the sums.

The logistic regression for cases with multiple response categories ($Y = (y_1, y_2, \dots, y_k)$ for $k \geq 3$) seeks to explain the probability of each response category related to a set of explanatory variables $X = (x_1, x_2, \dots, x_m)$. The formulation of model to predict the probabilities of the different possible outcomes of the categorically distributed dependent variable is as follows:

$$f\left(\gamma_j(X)\right) = log\left[\frac{\gamma_j(X)}{1-\gamma_j(X)}\right] = log\left[\frac{P\left(Y \leq y_j \middle| X\right)}{P\left(Y > y_j \middle| X\right)}\right] \; \forall\, j = 1, \dots, k-1, \qquad (2)$$

where $\gamma_j(X)$ is the logit link function and is expressed as:

$$\gamma_j(X) = P\left(Y \leq y_j \middle| X\right). \qquad (3)$$

Expression (2) estimates, for this case study, the probability of fishers' perception level towards socioeconomic and/or environmental impacts from each BE activities related to several characteristics. The goodness of fit is measured using *Pseudo-*R^2 as the likelihood ratio R^2, representing the proportional reduction in the deviance wherein the deviance is treated as a measure of variation analogous, but not identical, to the variance in linear regression analysis (Scott W. Menard 2002). Likewise, the robust standard errors were estimated via the Huber-White method.

On other hand, the development of SSF exerts a positive impact on BE activities, and the development of BE can also generate a positive impact on SSF. This potential endogeneity problem has been analysed by Ramsey Reset test; if p-value of F-statistic is greater than 0.05, the not endogeneity assumption is accepted.

4. Perceptions of Spanish SSF

The average age of respondents was 40, most of them has basic education, earns between fifteen and eighteen thousand euros, is owner and skipper of the boat, and the average length of the vessel was 6.5 meters (Table 5). Regarding on coastal problems, declining fish stocks, marine pollution, loss or destruction of coastal habitats and urbanization of coastal zones are considered by respondents to be the most important problems. Most of these fishers are neutral about the discharge of wastewater, and coastal erosion is viewed as being relatively unimportant. Results for remaining questions are shown in Tables 6-9. With regard to the contribution of BG sectors to the socioeconomic development of coastal zones (Table 6), respondents believe that the activities related to coastal and maritime tourism are very important for such development. At the same time, however, they are concerned about water and soil pollution, tourism's pressure on the environment, and how these factors could affect the natural habitats and fishing grounds located in coastal areas. Aquaculture and blue technology are viewed as important activities owing to their potential contribution to direct and indirect employment. Most interviewees believed that oceanic energy and deep-sea mining would be unimportant for the socioeconomic development of coastal areas. The reasons they gave were that those activities generate few jobs, their environmental effects could deter tourists from visiting the area, and - in the case of deep-sea mining - the benefits of exploitation would accrue mostly to the industrial enterprises undertaking that activity.

Table 6 Spanish Small-Scale Fishers' Views on Blue Economy: Contribution to Socio-Economic Development

Statement	(% response)					Mean (SD)	Wilcoxon signed-rank test
	Very unimportant	Unimportant	Neutral	Important	Very important		
Aquaculture	13	22	11	45	9	3.224 (1.228)	$Z = 6.21$, $p < 0.001$
Coastal and maritime tourism	4	5	8	38	45	4.113 (1.084)	$Z = 6.08$, $p < 0.001$
Ocean energy	11	44	12	22	11	2.781 (1.229)	$Z = 4.65$, $p < 0.001$
Blue technology	21	23	13	33	10	2.884 (1.370)	$Z = 5.93$, $p < 0.001$
Deep-sea mining	33	34	11	22	0	2.225 (1.134)	$Z = 1.82$, $p = 0.287$

Notes: Neutral = neither unimportant nor important; SD: standard deviation. Reliability analysis by Cronbach's alpha to Likert-type statements designed to quantify fishers' perceptions (α = 0.89). Individual statements were tested for departure from neutrality with Wilcoxon signed-rank test.

Source: Authors' compilation.

Table 7 Spanish Small-Scale Fishers' Views on Blue Economy: Ocean Environment Impacts

Statement	(% response)					Mean (SD)	Wilcoxon signed-rank test
	Very unimportant	Unimportant	Neutral	Important	Very important		
Aquaculture	12	19	11	45	13	3.229 (1.228)	$Z = 1.12$, $p = 0.521$
Coastal and maritime tourism	2	13	12	41	32	3.873 (1.068)	$Z = 1.98$, $p = 0.402$
Ocean energy	34	40	11	13	2	2.108 (1.079)	$Z = 1.03$, $p = 0.074$
Blue technology	11	21	33	23	12	3.003 (1.158)	$Z = 5.80$, $p < 0.001$
Deep-sea mining	0	5	5	34	56	4.396 (0.828)	$Z = 7.85$, $p < 0.001$

Notes: Neutral = neither unimportant nor important; SD: standard deviation. Reliability analysis by Cronbach's alpha to Likert-type statements designed to quantify fishers' perceptions (α = 0.84). Individual statements were tested for departure from neutrality with Wilcoxon signed-rank test.

Source: Authors' compilation.

These small-scale fishers rate the impact of deep-sea mining could be very important (see Table 7). The reasons given are that this activity could damage the seabed and alter the entire marine ecosystem. Likewise, the surveyed fishers viewed the aquaculture's impact as somewhat important due to its associated chemical waste and the possibility that farmed fish could escape and compete with wild stocks. Most interviewees were essentially neutral about the exploitation of marine organisms by blue technology firms, although some mentioned that genetically modified fish could reduce marine biodiversity and possibly compromise human health. Few respondents considered activities of the oceanic energy sector to be important. However, some acknowledged that sea-based infrastructures could damage marine habitats and thus have a negative effect on their targeted fish stocks.

Tables 8 and 9 show the results of logistic regressions. No socioeconomic characteristics and length had apparent effect on fishers' perceptions on blue economy effects. Regarding on the geographic zone, the results show, generally in all zones, a significantly positive attitude toward potential contribution of blue growth to socioeconomic development and a significantly negative perception on environmental impact of such activities, except for Northwest, rest of Atlantic and Mediterranean coast fishers' perceptions on the environmental impact of the coastal tourism, aquaculture, and energy, respectively, which do not result statistically significant.

Finally, fishers were asked about their views on the possible effects of interactions between BG industries and SSF. Thus survey respondents were asked: "Do you think that there could be interaction between the BG sectors and small-scale fishing?" Interviewees who responded "Yes" were then asked to specify such interaction and classify it as positive or negative. The effects identified by fishers - who were not prompted with possible responses - are reported in Table 10. Respondents generally believe that there is some interaction between BG activities and SSF. The interaction effects identified include environmental impact, use of shared space, complementary activities, and infrastructure building. Opinions about the use of space differed depending on whether it was land facilities or maritime areas being shared.

Table 8 Results of the Logistic Regression Model on Spanish Small-Scale Fishers' Views on Blue Economy: Socioeconomic Effects

	ACQ		CMT		OE		BT		DM	
	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value
Socioeconomic characteristics										
Age	0.025	0.886	0.001	0.597	0.008	0.925	0.002	0.492	0.098	0.437
Education level	0.564	0.292	0.125	0.355	0.221	0.301	0.013	0.254	0.010	0.818
Income level	0.226*	0.064	0.399	0.226	0.121	0.196	0.019	0.600	0.048	0.512
Boat length	0.003	0.998	0.204*	0.092	0.089	0.655	0.112*	0.076	0.017	0.447
Geographic zone										
Northwest Atlantic	0.162*	0.070	0.415**	0.000	0.262*	0.068	0.668*	0.058	0.280*	0.090
Rest of Atlantic	0.141*	0.082	0.409**	0.008	0.060*	0.089	0.486*	0.080	0.155*	0.081
Mediterranean Sea	0.128*	0.085	0.588**	0.000	0.155*	0.081	0.298*	0.073	0.276*	0.052
Pseudo *R*-squared	0.255		0.080		0.090		0.122		0.106	

Notes: ACQ = aquaculture; CMT = coastal and maritime tourism; OE = ocean energy, BT= blue technology; DM = deep-sea mining. * and ** indicate significance at the 10 and 5% levels, respectively. Robust standard error were estimated by Huber-White method; Brant ($\chi^2(7) = 8.59$, $p = 0.377$) and Likelihood-ratio ($\chi^2(7) = 11.31$, $p = 0.190$) tests, showing that the parallel regression assumption has not been violated. Ramsey Reset test ($F(7, 853) = 0.701$, $p = 0.5924$) showed not endogeneity in the model.

Source: Authors' compilation.

Table 9 Results of the Logistic Regression Model on Spanish Small-Scale Fishers' Views on Blue Economy: Environmental Effects

	ACQ		CMT		OE		BT		DM	
	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value	Coef.	*p*-value
Socioeconomic characteristics										
Age	0.027	0.774	0.026	0.512	0.012	0.459	0.107	0.254	0.141	0.385
Education level	0.020	0.260	0.052	0.441	0.423	0.370	0.203	0.208	0.356*	0.051
Income level	0.797*	0.086	0.196	0.494	0.432	0.109	0.398	0.473	0.140	0.729
Boat length	0.013	0.923	0.010	0.922	0.021*	0.038	0.130	0.120	0.009	0.855
Geographic zone										
Northwest Atlantic	0.102*	0.051	0.043	0.219	0.302*	0.091	0.287**	0.001	0.410**	0.000
Rest of Atlantic	0.355	0.208	0.460*	0.059	0.327*	0.051	0.105*	0.082	0.661**	0.000
Mediterranean Sea	0.246*	0.091	0.423*	0.064	0.139	0.481	0.181*	0.072	0.610**	0.010
Pseudo *R*-squared	0.181		0.194		0.280		0.097		0.118	

Notes: ACQ = aquaculture; CMT = coastal and maritime tourism; OE = ocean energy; BT = blue technology; DM = deep-sea mining. * and ** indicate significance at the 10 and 5% levels, respectively. Robust standard error were estimated by Huber-White method; Brant ($\chi^2(7) = 9.81$, $p = 0.270$) and Likelihood-ratio ($\chi^2(7) = 11.63$, $p = 0.172$) tests, showing that the parallel regression assumption has not been violated. Ramsey Reset test ($F(7, 853) = 1.854$, $p = 0.0741$) showed no endogeneity in the model.

Source: Authors' compilation.

Table 10 Views on Potential Effects of Interaction between BG Industries and SSF

	Aqua-culture	Coastal and maritime tourism	Marine bio-technology	Oceanic energy	Deep-sea mining
Environmental effects	−	−	−	0	−
Land space use	0	−	0	−	0
Maritime space use	−	−/+	0	−	−
Synergies	+	+	+	0	0
Construction of infrastructures	+	+	+	+	+

Notes: −: negative interaction; +: positive interaction; −/+: interaction could be negative and/or positive; 0: no interaction.

Source: Authors' compilation.

The interaction with aquaculture was mainly viewed as a negative one because of possible effects on wild stocks and because of competition for maritime space with spawning and nursery zones. Yet some fishers note that shellfishing aquaculture could share marketing and distribution costs with SSF and thus achieve economies of scale in both sectors - and some pioneering, seasonal efforts along those lines were mentioned. As for coastal and maritime tourism, fishers report a generally negative interaction driven by the ill environmental effects of maritime traffic, marina building, and competition for the use of land- and sea-based infrastructure. In contrast, most fishers identify a positive interaction with seafaring tourism; such activities are viewed as being complementary to fishing - although some of them declare that the current experiences in this topic are showing problems basically regarding compatibility of fishing hours and tourism time.

Respondents identified no significant interaction between marine biotechnology and SSF, though some fishers indicate a possible complementary fishing activity: the collection of seaweeds for pharmaceutical products and unwanted bycatches and discarding could be used for biotechnological research. Interviewees have a negative view of oceanic energy; it increases competition for space use, especially when wind- and wave-power installations are close to the coast (within their fishing zones) and when maritime traffic (to support those installations) subsequently increases. Interviewees look askance on deep-sea mining for similar reasons, and are concerned also about its potential for having strongly negative ecological effects on their fishing grounds. However, some respondents view the creation of facilities related to mining activities in a positive light because such infrastructure could boost the area's building sector in the short and medium term. Finally, most of them highlight the improvement of port infrastructures and construction of new infrastructures - linked with BG activities - as a positive interaction.

5. Discussion

Taking into account the results of this study and that the EC wants to enhance the BG activities (European Comission 2017), the aims of an overarching BG strategy could be: (i) to assess ways and means of minimizing the cumulative impact of those sectors on living aquatic resources, biodiversity, small-scale fishers, and ecosystem services; and (ii) to develop synergies between BG and SSF sectors (and other activity branches). Given the sector's interconnectivity with and reliance on aquatic ecosystems as well as the potential for those it employs to act not only as resource users but also as stewards of precious natural resources along coastline, the SSF may have a key role to play in the transition toward a European BG policy. In particular, the crucial and interrelated elements of a successful European BG strategy may be described as follows:

- It is necessary to acknowledge, respect, and protect the various forms of legitimate tenure rights to aquatic resources currently enjoyed by SSF communities. Implementation of a BG strategy should proceed only through cooperation with regional advisory councils, regional/national governments, fishing sector - with wide participation from SSF sector for this proposal - and other stakeholders. Thus governance and consider the perceptions of SSF are a critical issue that any BG strategy must address. Outcomes beneficial to SSF would include improved fisheries management, a reduced proportion of overfished stocks, reduced bycatch, and improved aquatic ecosystems with habitats preserved for the species harvested by SSF. Of course, this might extended to other distinct SSF fleet segments.
- Policy could strive to earn public support for the development of science-based standards for fish and fishery products as well as the support of member states and the private sector for adopting and implementing these standards, including market standards on eco-labelling, sustainability, and traceability.
- Activities that promote ecotourism and recreational fishing in coastal areas could be also targeted. Fisheries' local action groups could help on this score by devising strategies tailored to a given area and proposing collective plans. Besides using SSF ships for sport fishing, other remunerative possibilities include boat trips to protected natural areas or other excursions, offering instruction on fishing activity and fishing gear, game fishing, "discovery" expeditions to explore the marine environment and its biodiversity, and providing guided visits to first-sale markets or to aquaculture

and canning facilities. Other eco-friendly activities include managing museums, shops of sailor items, gastronomical spots, and so forth. This approach has been taken by several European countries, although the primary focus so far is on recreational fishing.

- The upgrading of fishing boats is essential for diversification into tourism activities, as older vessels must find a way to comply with modern guidelines for passenger safety and comfort. Investment in capacity building is also urgently needed so that SSF households and other local villagers can acquire the necessary skills and knowledge.

- A decent transport infrastructure and proper hospitality facilities are needed, and public spaces (parks and coastal zones) should be scrupulously maintained and free of litter. Such efforts will enjoy greater success if residents are educated about the importance of environmental conservation. It is essential to implement programs in order to increase the visibility and awareness of the threats to ecosystems.

- A plan to establish an integrated coastal management in the BG context should be interdisciplinary, inclusive, and cooperative. It should seek to minimize negative effects on the coastal communities that depend heavily on SSF. Not only fisheries and other maritime activities but also the BG industries themselves should be included in maritime spatial planning; there is perhaps no more reliable way to reduce the possibility of conflict over use of maritime space.

In any case, the marine environment must have strong protection if communities are to realize the full economic and social potential of oceans and seas and special attention must be paid to the possible effects of BG activities, especially with regard to those risks most pertinent to SSF. Adoption of a well-designed BG strategy could lead to greater and more widely distributed knowledge, which in turn would have the effect of promoting agreed-upon BG initiatives and policies, low-carbon technologies, and best practices while reconciling environmental conservation with the interests of economic development, community resilience, and decent livelihoods for small-scale fishers. Consider the fishers' perceptions on it may contribute to the quality and acceptance of BG strategy.

6. Conclusion

Small-scale fishing makes a significant contribution to the food security and livelihoods of many people in European maritime regions, especially in communities that are highly dependent on this activity. The SSF segment represents more than half of total fishing employment in more than half of the EU coastal countries. In addition, the fishing harbours, landing sites, and associated processing facilities provide employment in and significant economic benefits to those regions. However, the rapid economic growth of fisheries in recent decades has proceeded via the unsustainable exploitation of many aquatic resources showing at the same time the limits of the fishing activity. In this context, the EU is promoting the development of other activities related to the exploitation of seas and oceans than fishing. The rapid growth of the blue activities could contribute to deteriorate the marine ecosystems in SSF grounds.

Although Spanish small-scale fishers believe that BG may exacerbate environmental imbalances in those fishing grounds where SSF operates and competition for the use of shared spaces, the empirical results also show that a significantly positive perception on potential contribution to the socioeconomic development of coastal zone. Fishers are also aware that there could be synergies between SSF and some BG industries such as aquaculture, sea-based tourism, and blue technology. Our study examined the attitude of the fishermen to the effects of BG economy. Further research is needed to quantify the importance of each of the environmental and economic factors of BG activities for fishers.

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