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Characterization of fisheries dependence in Galicia (Spain)

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Abstract

The management of marine ecosystems requires adequate knowledge of both environmental and human dimensions, as well as their interrelationships. In this study, the aquaculture and fisheries activities are analyzed in one of most important fishing regions in Europe, Galicia (NW Spain). In particular, the intensity and characteristics of the fishing dependence are evaluated in terms of income and employment. Thus, nine marine economic activities for nine Maritime Zones have been defined, considering the social and economic relevance of the provided ecosystem services to these communities. This paper highlights the entire Galician coast as fishing-dependent, independently of the urbanization level. Furthermore, the contribution of the different fishery segments to the income and employment of these coastal communities is reviewed, including fluctuations on whether the activity is small or large-scale. Finally, this study establishes a strong relationship among the marine activities, which generate most employment, and the regulatory framework of the Regional Government. Therefore, the conclusions are relevant to design and implement policies that affect Galicia's Region and all its related marine ecosystems.

Keywords

Fishing dependency; Galicia's coastal communities; ecosystem-based management

1. Introduction

A clear trend for natural resources management recognizes the adequacy of adopting ecosystem-based approaches on decision-making, particularly for fisheries activities [1-4]. This management approach emphasizes the need to comprehend both; the natural dynamics of the species and their interactions, as well as the socioeconomic aspects involved [5-6]. The consideration of the social and economic dimension is a challenge and a requirement if an ecosystem-based approach is to be applied for managing sustainable fisheries [1]. Numerous authors [7-11] consider the interactions between ecological and socioeconomic dimensions as fundamental. However, uncertainties exist on what and how long the socioeconomic impacts will be [8]. Thus, the use of precise indicators, e.g. employment or income, provides necessary information to evaluate fisheries sustainability and its impact on society [12-14].

In this context, the Code of Conduct for Responsible Fisheries [15] agreed on developing data collection, analysis and research into social, economic and institutional aspects in order to reach sustainable fishery management. Since then, the SOFIA biannual reports on the state of world fisheries and aquaculture [16] as well as several global studies on fishing's socioeconomic aspects have been carried out. In addition, recent studies review the contribution to employment [17], the impact on output and income [18] and the vulnerability of certain economies in the face of the consequences that climate change and other natural disasters might have for fishing activity [19-20]. There has also been an increase in analyses on the socioeconomic importance of fishing, especially in developing Asian countries, where a certain level of fishing dependency on the part of rural populations exists [21-27].

In 2000 the European Council, based on considerations made by the FAO, decided to establish a Data Collection Framework to evaluate the situation of the fisheries sector under the Common Fisheries Policy (CFP). This decision was concluded eight years later, adopting a multi-annual program for the collection, management and use of data in the fisheries sector [28]. These programs are making it easier to obtain homogenous information and helping to improve knowledge of the social and economic reality of fishing in Europe [29]. In this regard, some studies have been published in recent years on the role of marine activities in different European economies [30-33] and on the characteristics and effect of fishing activity in some fishing-dependent communities [34-39].

Moreover, in spite of the fact that a significant part of the CFP's structural component has been focused on measures linked to fishing effort adjustment measures (fishing vessels decommissioning), fleet modernization, or initiatives concerning aquaculture, ports and the processing and trade of fish products, other sustainable development measures aimed at promoting local projects in fishing-dependent zones are becoming increasingly important [40-41]. Axis 4 of the current European Fisheries Fund (EFF, 2007-2013) and the forthcoming European Marine and Fisheries Fund (EMFF, 2014-2020), contemplate the possibility of implementing specific measures aimed at avoiding or mitigating negative impacts on fishing-dependent communities. For this reason, it is also essential to identify the European coastal areas whose local economies are highly dependent on fishing activity [42].

The basic aim of this study is to analyze and quantify the direct impact (in terms of income and employment) that fishing activity has on the economy and coastal communities in Galicia (NW Spain), one of the most important European Union (EU) fishing region (Salz and Macfadyen [43] point out that Galicia is the region with the highest employment and dependence on income from fishing sectors, in a study of 128 European coastal regions). In particular, the goal is to evaluate the intensity of the socioeconomic dependency on regional, national and international fishing in nine different coastal zones in Galicia, distinguishing between each type of fishing activity and its associated ecosystems.

Frequently, fishing activity is identified and analyzed in base on the fleet activity and their related landings [35; 29; 42], including the Data Collection Framework approach [28].

However, in Galicia, there is a huge diversity of fishing activities, which require neither a vessel, nor a port for landing the catches (such as shellfish harvesting on foot). Evermore, fishing activity does not exist uniformly throughout Galicia's coast and its current administrative divisions (which serve as a territorial reference for collecting statistical information) do not always respond to criteria base on geographical or socioeconomic homogeneity (indeed, analyses at EU level are usually carried out at EU NUTS 2 level [43]). For instance, there are regions at the same administrative division (NUT 2 or NUT 3) where combine urban and rural zones, i.e., communities with very diverse socioeconomic dynamics. Therefore, the boundaries of the coastal communities were delimited using a specific territorial criterion that allows to distinguish the zones with precision, facilitating the characterization and quantification of the fishing dependency. The data sources, the estimation methods of the socioeconomic variables and the allocation of each activity and zone are made explicit in the section on material and methods.

In the section on results and discussion, the estimated values for the main socioeconomic variables are presented: the value of fishery output at basic prices (Output bp), Gross Value Added at basic prices (GVA bp), Gross Primary Income and total employment generated, both with regard to the number of people as well as full-time equivalent employment (FTE). Due to the volume of generated results, it was decided to summarize the relevant information as follows. First, the results obtained for Galicia as a whole are reviewed, separating the nine activity segments considered, and, later, the disaggregated information on each coastal zones. Finally, the main conclusions are summarized in the last section.

2. Material and methods

2.1. The definition of aquaculture and fishery activities

Different types of activities linked to marine aquaculture and fishing can be found along the Galician coast. In spite of the evident synergies that already exist between the primary fishing activity (extraction and production) and fish processing and trade, only those encompassed in the marine fishery and aquaculture sectors are considered (codes 03.11 and 03.21, respectively, of the statistical classification of economic activities NACE Rev.2, [44-45]). The primary activity is closely linked to the maritime coastline (there cannot be any fishing communities without fishermen) and, in consequence, it is considered the determining factor for defining the level and intensity of the fishing dependency of a zone or region. Then, activities associated to fish processing and trade (NACE codes 10.20 and 46.38, respectively) are not considered because they can also take place away from the coast.

The qualitative information and statistical data about fishing and aquaculture activities are widely dispersed among different sources [46-54]. From them, the most relevant information of each activity is detailed in this section.

Three important groups of fishing activities are distinguished in Table 1 (Aquaculture, Shellfish harvesting on foot and Sea fishing), including each differentiated segments. Marine Aquaculture and Shellfish harvesting take place in coastal facilities on land or in marine zones considered inland waters and named *Rías*. The regional Government (Xunta de Galicia) has the regulatory authority over these activities. Otherwise, Sea fishing is developed in different waters according to each fleet segment. Nevertheless, regulation relays on; (i) the regional government (for small-scale fisheries), (ii) the Spanish government and other EU member states together with EU institutions (for coastal and distant-water fisheries), and (iii) International organizations or non-EU Countries (for long-distance fisheries).

Table 1 about here.

Within the first activity, the aquaculture, three segments can be distinguished: rafts,

aquaculture farms and fish farms. The rafts are floating structures, placed in the middle of the inland waters or *Rías*, which are used to produce mussels. They need auxiliary vessels with specialist equipment to carry out their activities. Their business structure is midway through a family enterprise and an industrialized company. On the other hand, the aquaculture farms are public land concessions at inter-tidal, shallow areas in the *Rías*, used for bivalve mollusks farming (mainly clams). They are operated artisanal by companies with a familiar business model. Finally, the fish farm and nursery segment is made up of businesses with a high level of industrial development with onshore facilities engaged mainly in the breeding and fattening of turbot and sole.

The second group is the shellfish harvesting on foot that is an artisanal and traditional fishing activity of catching seafood, which does not usually require the use of vessels. Two segments can be distinguished: goose barnacle harvesting and shellfish harvesting aimed mainly at the production of bivalve mollusks. These activities lie halfway between harvesting and extensive aquaculture. The most of the activity takes place on rocky coasts in the case of the goose barnacle (*Pollicipes pollicipes*) and on the sandbanks of inter-tidal zones for bivalve shellfish. Additionally, they are carried out with elementary production methods and most of employment is at part-time.

Within the third group, sea fishing, four segments can be distinguished: the small-scale fleet, the coastal fleet, the distant water fleet and the long-distance fleet. These segments are related to the size of the vessels and its associated ecosystems.

The small-scale or artisanal fleet is made up mainly of family companies. It comprises the smallest sized fleet, with an average length of 6 meters, with a low tonnage, low-power engines and only one or two crewmen (in many cases self-employed). These vessels are able to catch mixed-species and change their gears according to the period of year and the ecosystem characteristics. Normally, they operate in the *Rías*, catching high-value species (mainly crustaceans, mollusks and ground fish), which are sold fresh in the fish markets of each zone at daily auctions.

The coastal fleet segment includes larger and more complex firms than the artisanal ones, although a familiar model is also involved usually. The vessels in this fleet will have an average length of around 20 meters and an average capacity of 84 GT, necessary for fishing in waters outside the *Rías*, in the fishing grounds of the Galician-Portuguese coastline. They will have an average crew of 8, although this will vary depending on the type of fishing gear used (hooks, trawl nets, purse seine gear or gill nets). Their products are varied (hake, sardine, horse mackerel, mackerel, Norway lobster, blue whiting, etc.) and are sold fresh using the numerous first-sale facilities located along the Galician coastline.

The distant-water segment is made up of companies that are industrial in nature. Vessels will measure an average 33 meters in length and will have an average capacity of almost 700 GT per vessel. This capacity enables them to operate in wider areas and, therefore, their main fishing grounds are placed in EU Celtic Sea waters. Two groups can be distinguished in this segment according to the type of fishing; trawlers (with average crews of 10), and long-liners (with average crews of 12). In the majority of cases, they land their catches in port facilities in Galicia, although, given the remoteness of their habitual fishing grounds, they can also land their catches in other ports (in France, Ireland and the UK) and transport their products across land to the fish markets in Galicia. This reinforces the argument regarding the link among fishing firms with their place of origin.

Finally, the largest and most industrialized fishing companies are included in the long-distance fleet segment. The average size of the vessels varies considerably according to the type of fishing activity, from the 35 meters in length and 465 GT of the long-line vessels, to the 60 meters in length and 1250 GT of the freezer trawlers and the 90 meters in length and 2700 GT of the freezer seiners. The average number of crewmen ranges from 9 in the long-liners to 16 in the freezer trawlers and seiners. They fish in very remote areas, both in international and third country waters (non-EU). The majority of their products are processed and frozen on board and landed in different countries throughout

the world. On many occasions, these products are later transported in refrigerated containers by merchant vessels which land them in Galician ports, mainly in the port of Vigo [39], which once again confirms in this case the link between fishermen (and fishing companies) and their place of origin.

2.2. Defining fishing zone boundaries

Galicia, with a surface area of 29,574.4 Km^2, has some 1,498 Km of coastline along which numerous activities associated with the sea are established, making it one of Europe's most important fishing regions [43]. Table 2 describes the main areas that provide the ecosystem services linked to fishing, classified in accordance with the abovementioned activity groups and assuming that Ecosystem services are the benefits people obtain from ecosystems (including provision of services, such as food, water, and recreation; regulatory services, such as flood and disease control; cultural services, such as spiritual benefits; and support services, such as nutrient cycling [58-59]).

Table 2 about here.

Most of the socioeconomic information (population censuses, employment, Gross Value Added, etc) is available at regional (NUTS 2), provincial (NUTS 3) and municipal levels. More disaggregated economic information is scant; therefore, it is necessary to use statistical data at municipal level in order to characterize and quantify fishing activity.

For its part, the regional administration distinguishes nine maritime zones (see Figure 1) for organizing fishing information (fleet censuses, employment in the activity, volume and value of landings, etc.). The boundaries are drawn based on a dual criterion. On the one hand, the division responds to criteria involving geographical continuity, so that the physical environment of each zone shows many similarities. On the other hand, the socioeconomic aspects are also considered, as each zone is a space (a *Ría* or a stretch of coastline) in which ports and first points of sale are common to the majority of fleets and fishing activities linked to this coastline. In this way, the possible internal flows of the fleets (to and from different ports) and their landings (at different first sale points) are extensively gathered within each of the defined zones.

Figure 1 about here.

In order to define the boundaries of the fishing zones, it is necessary to combine the municipal territorial boundaries with the zone division of the coast carried out by the regional administration (see Table 3). In this study, all of the municipalities with a maritime coastline were considered. In these coastal municipalities, there are a total of 71 fishing ports for landings and 62 facilities for auction of fishing products. Within this body of 73 municipalities, those that have various ports and first sale facilities are combined with others that lack these services (17 do not have fishing ports in their territory and 19 do not have sales facilities). The consideration of all the coastal municipalities is based on the fact that a large majority of the companies and agents that participate directly in fishing activity are domiciled in these municipalities, regardless of whether or not they have port or fish market facilities. The coastal municipalities, taken in different Maritime Zones, are assigned to the zone in which their main port facilities are located (vessel bases and first sale facilities). The combination of the spatial analysis of Galicia's administrative units and the estimation of the fishery sector's contribution to the local economies' income and employment is one of this study's novel contributions.

Table 3 about here.

Based on the abovementioned maritime zone boundaries, Table 4 shows some of each zone's main socioeconomic indicators. As can be seen, the majority of inhabitants and employed population (around 53% in both cases) are concentrated in the 73 coastal municipalities (23% of the total number in Galicia). The area has a relatively high average population density, where predominantly urban maritime zones (Vigo, A Coruña-Ferrol and Pontevedra) coexist with others that are predominantly rural (A Mariña, Fisterra and

Cedeira). The overall primary income generated in the 73 coastal municipalities amounts to around 56% of the total figure for Galicia. This primary income is concentrated in three urban zones (Zones I, II and VII), which together represents almost 77% of the total amount of primary income from the nine maritime Zones.

Table 4 about here.

2.3. Data and criteria regarding allocation to segments and zones

The economic data available is provided by Galicia's official statistical service, the Galician Statistics Institute [63] for the Fisheries and Agriculture sector (sector 03 of the statistical nomenclature for economic activities, known as NACE Rev. 2), and its disaggregation in Aquaculture (code 03.2) and Fishing (code 03.1). In Table 5, it is shown that fishing activity is quantitatively relevant in the Galician economy, as it represents around 1.3% of the GDP and a little more than 2% of employment, in contrast to 0.10% and 0.23%, respectively, for Spain overall and 0.06% and 0.13%, respectively, for the EU-27 (according to information from the Eurostat [64]).

Table 5 about here.

In order to obtain a more precise view, it is necessary to qualify the data and disaggregate the information according to activity segments and zones. The estimations of all the disaggregated information will be carried out using official information sources, both the regional government (Xunta de Galicia) and the national government (Spanish government). The first difficulty regarding the information shown was that, under code 03, marine aquaculture and fishing was grouped together with inland fishing. Inland fishing as a productive activity is barely significant in Galicia, although the same cannot be said for inland salmon and trout farming. In order to find out the importance of marine aquaculture, it was necessary to resort to regional government sources which, through a study based on surveys, provide data on production and employment in 2010 for the three differentiated segments: rafts, aquaculture farms and fish farms [65].

In order to estimate the output value (at basic prices) of Shellfish harvesting on foot, the regional government's database on the first-sale value of fishery output for the year 2010 was used [66]. In the case of the Goose barnacle (*Pollicipes pollicipes*) sector, the whole value of the sale of this species in Galicia's fish markets was taken into account which, as it is registered before the application of taxes or subsidies, can be considered an output value at basic prices. For the segment of Bivalves and others, the first sale values (also at basic prices) reached for the main species produced by this segment were considered: different types of clams (*Ruditapes decussatus* and *Ruditapes philippinarum*); cockles (*Cerastoderma edule*); other bivalves (*Ensis siliqua*, *Ensis arcuatus*, *Ostrea edulis* and *Crassostrea gigas*); echinoderms (urchins and starfish); gastropods (winkles) and polychaetes (marine worms).

The output value of Sea Fishing is calculated as the difference between the value estimated for the entire 3.1 Fisheries sector and the value estimated for the Shellfish harvesting on foot activity. The distribution among the different Sea Fishery segments was carried out assuming a similar distribution to the one estimated in the regional government's study [65]: 12.80% for Small-scale segment, 27.40% for Coastal, 22.65% for Distant Water and 37.14% for Long Distance Fleet.

For the case of Aquaculture and Sea Fishing, the distribution of the level of employment among the different segments was carried out assuming the distribution estimated in [65]. For Shellfish harvesting on foot, it was assumed that the employment generated is equivalent to the number of licenses that the regional government granted in 2010 for the harvesting of mussels and bivalves and others [50]. The employment generated by vessels not registered in the official register of the fishing fleet or by shellfish poachers working without an official license were not considered in any case.

Once the output value (at basic prices) of each segment was calculated, Intermediate Consumption was estimated in each case. To do so, the results obtained in two studies based on samples stratified per type of aquaculture activity, size and type of fishing vessels and fishing region were used [67-68]. For the aquaculture and fisheries segments, first of all they were identified with the sample strata used in both of the Spanish Government's studies. Then, similar behavior, insofar as intermediate consumption was concerned, between Galicia's fishing agents and the Spanish agents operating in the zone and similar fishing or production method as a whole was assumed. Due to the studies developed by the Spanish Government did not include sample strata that could be equated to the Shellfish harvesting on foot segment of activity, for these two segments (Goose barnacles and Bivalves and others), it is assumed other similar intermediate consumptions to those estimated for the artisanal fleet, subtracting, however, consumptions linked to the vessels (fuel, repairs and maintenance, etc.), as they do not require boats to carry out these activities.

Once these estimations were carried out, the Gross Value Added at basic prices (GVA bp) for each activity segment was calculated directly, subtracting the value of the Intermediate Consumptions from the Output bp. The Primary Gross Income was calculated by subtracting the estimated Net Taxes on output (Taxes less Subsidies) from the GVA bp.

The distribution of the values estimated for each segment of aquaculture and fishery activity among the nine Maritime Zones considered was carried out following a simple principle: the location of the output units and agents. That is, the results from the activity of Aquaculture were assigned to the zones where the mussel rafts, the aquaculture farms or the breeding and fattening farms are located. The results from Shellfish harvesting were assigned to the Zones for which official licenses are issued for harvesting goose barnacles or Shellfish harvesting on foot. In addition, the results from Sea Fishing were assigned to the Zones in accordance with the location of the fleet's base port (the port that appears on the Official Register of Fishing Vessels). This criterion is based on the assumption that output, income and employment generated by the activity should be assigned to the municipality and zone where the economic agents actually reside. In spite of the fact that an important part of each Zone's fishing output can be marketed via a single first sale port or facility, the income and employment generated in fact affect all of the municipalities which make up that Zone, as they are where the companies and people involved in fishing activities live. Nevertheless, this selected criterion may incorporate difficulties for the statistical analysis (associated to the Modifiable Areal Unit Problem [69]). Therefore, it is necessary to consider this fact for interpreting the results obtained.

3. Results and discussion

3.1. Results per segments of activity

After defining the different fishing activities and assuming the criteria for assignation to each segment, from the data available the results shown in Table 6 for Galicia overall were obtained. These results seem compatible and coherent with the official estimations shown in Table 5. The 663 million Euros generated by the Maritime Aquaculture and Fishing sectors of activity (Codes 03.21 and 03.11) in 2010 represent around 1.29% of the Galician economy's GDP. The 20,220 FTE jobs represent around 1.95% of Galicia's total employment. Within Maritime Aquaculture and Fishing overall, the sector of activity with the greatest relative importance in terms of income and employment is the Sea Fishing sector (73% of the GVA bp and almost 60% of FTE Employment), followed by Maritime Aquaculture (almost 20% of GVA bp and 23% of Employment) and Shellfish harvesting on foot (7% of GVA bp and 17% of Employment).

Table 6 about here.

Per segments of activity, there is a significant difference between those which show a higher degree of industrial and business development and those which are more artisanal

in nature and comprised of family businesses. In Table 7, the more industrial segments (Fish farms and nurseries, Distant waters fishing and the Long distance fleet) generate a greater volume of Primary Income than Employment, whereas the opposite occurs with the more artisanal and traditional segments (Nurseries and fish breeding farms, Goose barnacle and Bivalve shellfish and Small-scale fisheries). The activities with an intermediate level of industrial and business development (Mussel raft aquaculture and Coastal fishing), show a certain equilibrium insofar as their contribution to income and employment is concerned. Consequently, if the operational objectives of ecosystem management consist of increasing or protecting employment in the Galician aquaculture and fisheries sector, the measures ought to be focused on intervention and aid for the more artisanal segments. On the contrary, if the priority aims consist of generating income, the measures adopted ought to be aimed at the more industrialized sectors with higher average outputs.

Table 7 about here.

It is also interesting to carry out an analysis of the generation of income and employment in the different aquaculture and fishery segments in terms of the Public Administration with a higher level of management and regulatory authority over such activities. As can be seen in Table 8, the regional government (Xunta de Galicia) has broad regulatory and management authority over the segments of activity that generate the most employment (almost 70% of the total amount) and provide a significant part of fishing income (almost 38%). In consequence, given the diversity of aquaculture and fishing activities in Galicia, the social and economic interests of the agents involved are distributed among practically all of the CFP's possible spheres of action. The significant social relevance (in terms of contribution to employment) of the activity segments under the jurisdiction of the regional government makes it advisable to take into account coordination with such government in relation with any measure that might be adopted by the European and/or Member State administrations regarding the CFP, especially those included in axis 4 of the structural funds applicable to fisheries.

Table 8 about here.

The application of the CFP through the States affects to a greater extent the segments that provide more income than employment. Furthermore, the Income generated by the Distant Water fleet is significant (higher than 21% of the total), which is why this segment depends to some extent on the decisions adopted within the EU's external fisheries policy (both in International Fisheries Organizations as well as in relations with Third non-EU Countries).

3.2. Results by Maritime Zones

The results estimated for Galicia's different Maritime Zones are shown in Table 9. The three most relevant fishing Zones are Vigo (Zone I), Arousa (Zone III) and A Mariña (Zone IX), as together they represent 70% of Galicia's total fisheries GVA bp and somewhat more than 67% of Employment (in FTE terms). Zone IX, Arousa, is the most important insofar as aquaculture and Shellfish harvesting activities are concerned, as it represents almost 60% of Galicia's total Marine Aquaculture GVA bp and almost 40% in the case of Shellfish harvesting on foot. In the Sea Fishing segment, the contribution of 33% to the total GVA bp by Zone I, Vigo, and the contributions of approximately 18% of the total by A Mariña (Zone IX) and Arousa (Zone III) stand out.

Table 9 about here.

Combining the data on income and employment from the socioeconomic indicators of Galicia's Maritime Zones (Table 3) with the previous data estimated for aquaculture and fishing activity by Zones, the results shown in Table 10 are obtained. As can be seen, for the municipalities that make up Galicia's Maritime Zones as a whole, the primary activity of Aquaculture and Fishing (branches 03.21 and 03.11 of NACE Rev.2) represent a slightly increase than 3% of their Primary Income and Employment.

Table 10 about here.

With the results obtained, it is not difficult to determine which of Galicia's Maritime Zones can be classified as fishing-dependent regions. Nevertheless, no consensus exits as to the minimum figures regarding the contribution of the region to income or employment to make it possible to talk of dependency on fishing. While some authors place these figures at 5% of the total (for example, [43] and [70]), others propose raising it to 10% [71] and others consider it necessary to take into consideration cultural factors [72-73] or a combination of diverse factors [34]. Furthermore, any figure would be conditioned by the amplitude of the activities considered (in this study, the processing and trade of marine products are not taken into consideration) and by the greater or lesser population size and characteristics of the territories defined (in this study municipalities are considered and those that are predominantly urban are not excluded from the Maritime Zones). Thus, for merely illustrative purposes, in this study a Maritime Zone is classified as highly dependent on fishing when in one of the variables (income or employment) the primary activities of marine aquaculture and fishing as a whole represent more than 5% of the total of said region. Dependence on fishing will be moderate when the contribution stands at under 5% but over 1%. Dependence will be low when this figure does not reach 1%, but is higher than 0.1% of the total. There is no dependence on fishing if the figure does not reach 0.1% (approximately the contribution that fishing represents to income and employment in the EU-27 as a whole).

In accordance with the conventional criterion described, all of Galicia's Maritime Zones would be fishing-dependent (See Figure 2). Five Zones could be classified as highly dependent on fishing (Arousa, Muros, Fisterra, Cedeira and A Mariña), three Zones would be moderately dependent (Vigo, Pontevedra and Costa da Morte) and only one Zone would have a low level of dependency (A Coruña-Ferrol). As was to be expected, the level of dependency on fishing seems to be lower in the urban Zones. However, the correlation between population density (data from Table 3) and the contribution of fishing to the income and employment of each Zone (data from Table 9) is not particularly high, obtaining correlation coefficients of -0.70 in the case of income and scarcely -0.44 in the case of employment. Indeed, zones with intermediate population densities (such as Muros and Arousa) belong to the group of zones that are more heavily dependent on fishing. These results contradict the somewhat general belief that the fishing-dependent communities of developed countries are located in predominantly rural areas [25]. This aspect can be somewhat relevant when designing and applying fishery policies associated with the structural funds for local development (EFF axis 4 measures), often designed to be preferentially applied in rural communities.

Figure 2 about here.

The significant differences that are observed in some Zones with regard to contribution to income and employment are due to the different presence or importance of each segment of fishing activity in such Zones. Thus, for example, in A Mariña the relative importance of fishing decline in terms of employment due to the existence of a high relative presence of the more industrialized and highly productive fishery and aquaculture segments (the most industrialized fishing segments provides almost the 76% of the primary income in the Zone, but less than 65% of employment, see Table 11). The opposite occurs with Arousa, which is more specialized in traditional and artisanal segments of aquaculture, shellfishing and fishing, which provide significant employment but are less capable of generating income (the artisanal and traditional fishing segments provides more than 56% of the employment in the Zone, whilst only the 33% of the primary income, see Table 11). Therefore, the close marine ecosystems provide more employment than those settled wide apart to Galicia, which provides more primary income.

Table 11 about here.

Furthermore, the fishing-dependent Zones may have very different characteristics, regardless of whether or not their populations are more or less urban. On the one hand, Galician Maritime Zones that depend on the fishing activity of the more artisanal segments

exist, segments over which the regional government has extensive regulatory powers. On the other hand, fishing-dependent Zones, but of segments with a greater level of industrial development, can also be detected, regulated by State and EU or even Third Country administrations. Obviously, the dynamics of the fisheries sector and fisheries policies applicable in each case will necessarily be different.

4. Conclusions

The basic objectives of this study were to analyze primary aquaculture and fishing activity in Galicia's coastal communities (Galicia being one of the EU's most important fishing regions), to quantify its impact on income and employment and to evaluate the intensity and characteristics of socio-economic dependency on fishing in coastal zones.

In order to carry out this analysis, first of all nine segments of aquaculture and fishing activity were distinguished according to the natural resources on which they act and in which way. Secondly, nine Maritime Zone boundaries were defined under the criteria of geographical continuity, socio-economic homogeneity and in accordance with the statistical information available. In addition, thirdly, the starting data and the criteria regarding allocation to activity segments and Maritime Zones according to official information sources were made explicit.

On this basis, some interesting results and conclusions were obtained and can be summed up as follows:

- Ecosystem approach for fisheries management requires the extensive knowledge and definition of the different aquaculture and fishing activities. In Galicia, a significant variety of primary fishing activities exists, each with different levels of technological and business development, associated with numerous ecosystems and with different socioeconomic impacts. As was to be expected, the activity segments of a more industrial nature (Fish farms and nurseries, Distant-water fishing and Long-distance fleet) generate a greater volume of Income than of Employment, the opposite occurring with the more artisanal and traditional segments (Aquaculture farms, Goose barnacle and Bivalve shellfish and Small-scale fishing). Depending on the operational objectives established in ecosystem-based management (generation of income or promotion of employment), the measures adopted should be applied differently and with different intensities according to the characteristics of each segment of fishing activity.
- At institutional level, the aquaculture and fishery segments are conditioned by the different public administrations with the legal authority to regulate their activities. In the case of Galicia, the regional government has extensive management and regulatory authority over the activity segments which generate the most employment (almost 70% of the total), while the decisions adopted in other institutional frames (Spanish Government, EU institutions and, even, other States) have a greater impact on the capacity to generate income. The diversity of aquaculture and fishery activities in Galicia means that the social and economic interests of the agents involved are distributed across all of the CFP's possible spheres of action. Moreover, the significant social relevance of the activity segments that fall under the jurisdiction of the regional government makes it advisable to consider coordinating with such government when adopting any fisheries policy measure.
- For the municipalities that make up Galicia's nine Maritime Zones as a whole, the primary activity of Aquaculture and Fishing represents just over 3% of their Primary Income and Employment. No consensus exists with regard to minimum figures which make it possible to determine whether it is a fishing-dependent region or not. However, given that in this study the activities associated with the processing and trade of marine products were not taken into account, and the predominantly urban coastal municipalities were not excluded, it can be concluded that Galicia's coastal territory can be considered as fishing-dependent.

- Adopting a conventional classification, five of Galicia's nine Maritime Zones could be classified as highly dependent on fishing (fishing accounts for more than 5% of income or employment), three Zones would be moderately dependent (accounting for between 1 and 5% of income or employment) and only one Zone would have a low dependency on fishing (lower than 1% but higher than 0.1%, which is the approximate figure for the EU-27 as a whole). In general, the level of socioeconomic dependency on fishing falls in the more urban Zones. However, this correlation is not very high, as semi-urban Zones show a high dependency. This aspect should be considered when designing and planning the fishing policies associated with the structural funds for local development, often designed to be preferentially applied in rural communities.
- In some of Galicia's Maritime Zones, significant differences between contribution to income and employment have been observed, on account of the varying relative presence of each activity segment. The Zones with a greater presence of artisanal and traditional segments are shown to be more highly dependent in terms of employment than in terms of income, whereas the opposite occurs for Zones with a significant presence of more industrialized activity segments. In consequence, the fishing-dependent Zones can have significantly different characteristics, regardless of whether its population is more or less rural. Therefore, the dynamics of the fisheries sector and the fishery policies applicable in each case must necessarily be different.

In order to gain a more complete perspective of Galicia's aquaculture and fishery activities, it would be desirable to rely on studies that incorporate other activities associated with or derived from fishing, as well as analyses on the direct, indirect and induced effects that fishing activities have on the rest of the economy. These are aspects which could be discussed in future studies.

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Tables

Table 1
Fishery activities in Galicia.

Activity	Segment	Basic characteristics	Main target species
Marine Aquaculture	Rafts	3337 floating rafts in the Rías, with 1667 auxiliary vessels	Mussels
	Culture farms	639 culture farms in the Rías' coastal sandbanks	Clams
	Farms and nurseries	19 fish breeding and on-growing farms on land	Turbot
Shell-fishing on foot	Goose barnacle	368 licenses for the harvesting of crustaceans in rock coastal areas	Goose barnacles
	Bivalves and others	3586 for the harvesting on foot of bivalves and polychaetes on beaches and intertidal sandbanks	Bivalves
Sea fishing	Small-scale or Artisanal	3873 vessels under 12 m in length fish with different types of gear in inner maritime waters (in the Rías)	Broad range of fish, crustaceans and mollusks
	Coastal	518 vessels with an average length of some 20 m fish in waters near to the coast with purse-seine, trawl, hook and gill-net gears	Broad range of fish and crustaceans
	Distant waters	90 vessels with an average length of 30 m, fish in the Celtic Sea with trawl and hook gears	Hake, Megrim, Anglerfish and Norway Nephrops
	Long-distance waters	119 freezer vessels with an average length of over 40 m fish in international waters and waters of non-EU countries with hook, trawl and purse seine gears.	Tuna, Swordfish, Hake, Halibut and Argentine shortfin squid

Source: Compiled by the authors based on [49-51].

Table 2
Main areas providing ecosystem services to Galicia.

Activity		FAO Area	Large Marine Ecosystem	ICES		Marine Ecoregions
				ECOREGION	DIVISION	
Marine aquaculture **Shell-fishing on foot** **Sea fishing** (Artisanal)		NE Atlantic (FAO 27)	Iberian Coastal	South European Atlantic Shelf	VIII C IXa	Temperate Northern Atlantic; 3. Lusitanian 27. South European Atlantic Shelf
Sea fishing	Coastal	NE Atlantic (FAO 27)	Iberian Coastal	South European Atlantic Shelf	VIII C IXa	Temperate Northern Atlantic; 3. Lusitanian 27. South European Atlantic Shelf
	Distant waters	NE Atlantic (FAO 27)	Celtic-Biscay Shelf	Celtic Sea	ICES VII	Temperate Northern Atlantic; 2. Northern European Seas 26. Celtic Seas
	Long-distance waters*	NW Atlantic (FAO 21)	Newfoundland-Labrador Shelf	n.a.	n.a.	Temperate Northern Atlantic; 38. Southern Grand Banks–South Newfoundland
		SW Atlantic (FAO 41)	Patagonian Shelf	n.a.	n.a.	Temperate South America; 48. Magellanic 186. Malvinas/Falklands
		E Central Atlantic (FAO 34)	Canary Current	n.a.	n.a.	Temperate Northern Atlantic; 3. Lusitanian 28. Saharan Upwelling 29. Azores Canaries Madeira
		SE Atlantic (FAO 47)	Benguela Current	n.a.	n.a.	Temperate Southern Africa 50. Benguela 190. Namib

* The fishing fleet that catch highly migratory species (e.g. tuna, swordfish, etc.) are not included.

Source: Compiled by the authors based on [55-57].

Table 3
Coastal municipalities, fishing ports and first sale facilities.

Maritime Zones	Geographical boundaries *	Coastal municipalities	Fishing ports	First sale facilities
Zone I - Vigo	From the River Miño to Punta Soavela	11	12	9
Zone II - Pontevedra	To Punta Faxilda	5	9	6
Zone III - Arousa	To Punta Sieira	12	14	12
Zone IV - Muros	To Punta Insua	4	4	4
Zone V - Fisterra	To Cabo Touriñán	5	4	4
Zone VI - Costa da Morte	To Punta Langosteira	9	7	9
Zone VII – A Coruña-Ferrol	To Cabo Prioriño	14	10	8
Zone VIII - Cedeira	To Cabo de Bares	4	3	3
Zone IX – A Mariña	To Rio Eo	9	8	7
TOTAL 9 Zones		**73**	**71**	**62**

* The zones are defined according to coastal stretches, Zone 1 beginning in the Rio Miño (border with Portugal), Zone IX ending at the mouth of the River Eo (boundary with the Region of Asturias). Shown in the table are the geographical points which define the end of each coastal stretch, constituting a geographical point where the next Zone begins.

Source: Compiled by the authors based on [49-51].

Table 4
Socioeconomic indicators of Galicia's Maritime Zones (2009-2010).

Maritime Zones	No. of Municipalities	Population (1000 inhabitants)	Population density (inhab./km^2)	Working population * (1000 people)	Primary gross incomes ** (millions €)
Zone I - Vigo	11	435.5	560	167.4	7,189.9
Zone II - Pontevedra	5	153.7	340	59.1	2,604.4
Zone III - Arousa	12	160.5	201	63.7	2.209.1
Zone IV - Muros	4	41.9	164	17.3	493.6
Zone V - Fisterra	5	23.2	85	9.6	257.9
Zone VI - Costa da Morte	9	104.8	141	43.3	1,384.8
Zone VII – A Coruña-Ferrol	14	463.7	424	191.8	8,719.1
Zone VIII - Cedeira	4	26.0	54	10.8	333.2
Zone IX – A Mariña	9	60.6	46	24.2	935.3
Total of 9 Maritime Zones	**73**	**1,470.1**	**237**	**587.2**	**24,127.3**
GALICIA	**315**	**2,797.0**	**95**	**1100.4**	**43,119.7**

* The working population has been estimated by applying to each municipality the average Rate of Employment for the year 2010 and the Province to which they belong (NUTS 3 Region).

** Primary Gross Incomes are comprised of the incomes from the Remuneration of Employees, the Gross Operating Surplus, Mixed Income and the Property Income Balance Sheet.

Source: Compiled by the authors based on [60-62].

Table 5
Economic data on the fisheries and aquaculture sector in Galicia 2010.

NACE Rev.2 Codes	Sectors	Output bp (1000 €)	Intermediate consumption (1000 €)	GVA bp (1000 €)	Primary Gross Income (1000 €)	Total Employment (No.)	Total Employment (FTE*)
03	**Fishing and Aquaculture**	**1,240,119**	**570,697**	**669,422**	**731,654**	**24,044**	**20,852**
03.2	- Aquaculture	313,343	177,884	135,459	139,187	5,976	5,354
03.1	- Fishing	926,776	392,813	533,963	592,467	18,068	15,498
	% 03 s/ Galicia	**1.14%**	**1.00%**	**1.30%**	**1.43%**	**2.06%**	**2.01%**

* The FTEs are Full Time Equivalent units. In the case of this sector, 1,800 hours work a year is considered an FTE.

Source: IGE, [63].

Table 6
Estimated data for Marine Aquaculture and Fishing in Galicia per segments. 2010.

CNAE Code	Activity segments	Population No.*	Output bp (1000 €)	GVA bp (1000 €)	Primary Gross Income (1000 €)	Total Employment (No.)	Total Employment (FTE)
03.21	**Marine aquaculture**	**3,995**	**276,376**	**129,045**	**132,596**	**5,271**	**4,722**
	Rafts	3,337	159,131	83,134	85,422	4,069	3,645
	Culture farms	639	10,531	6,652	6,835	625	560
	Farms and nurseries	19	106,714	39,259	40,339	577	517
03.11	**Shell-fishing on foot**	**4,123**	**58,138**	**46,965**	**48,988**	**4,535**	**3,488**
	Goose barnacle	400	10,030	8,102	8,451	440	338
	Bivalves and others	3,723	48,108	38,863	40,536	4,095	3,150
03.11	**Sea fishing**	**4,600**	**868,638**	**486,998**	**543,479**	**13,533**	**12,010**
	Artisanal fishing	3,873	111,195	83,396	93,068	7,416	5,917
	Coastal fishing	518	238,027	154,717	172,662	3,339	2,838
	Distant waters	90	196,771	108,224	120,776	1,446	1,590
	Long-distance waters	119	322,646	140,660	156,974	1,331	1,664
	TOTAL		**1,203,152**	**663,008**	**725,063**	**23,339**	**20,220**

*In the case of Marine Aquaculture, the data on population refers to the number of rafts, number of farms and number of fish harvesting facilities on land. With regard to Shell-fishing, it refers to the number of official shell-fishing licenses. In the case of Sea fishing, it refers to the number of fishing vessels registered in the official registers.

Source: Compiled by the authors.

Table 7
Distribution of fishing income and employment according to the level of industrial development.

Type of activity*	Generation of Primary Income	Generation of Employment (in FTE)
Artisanal and traditional	20.5%	49.3%
Intermediate activities	35.6%	32.1%
Highly industrialized	43.9%	18.6%

* Culture Farms, Artisanal fishing and both Shellfishery segments are aggregated in the Artisanal and traditional activities; Rafts and Coastal Fishing are aggregated in the Intermediate activities; and finally, Farms and Hatcheries, Distant-water fishing and Long-distance water fishing are aggregated in the Highly Industrialized activities.

Source: Compiled by the authors.

Table 8
Distribution of fishing income and employment according to management authority.

Administrations with greater regulatory and management authority*	Generation of Primary Income	Generation of Employment (in FTE)
Regional government	37.9%	69.9%
National authorities and EU institutions	40.5%	21.9%
International bodies and Third countries**	21.6%	8.2%

* The Regional Government (Xunta de Galicia) has almost exclusive powers over the segments of Aquaculture, Shell-fishing on foot and the Artisanal Fleet. The Coastal and Distant-water fleets are regulated by Member States and EU Institutions. The Long-distance water fleet is subject to the regulations of International Fishery Bodies or of non-EU member countries, in accordance with the vessels' habitual fishing grounds.

** Non-EU members

Source: Compiled by the authors.

Table 9
Estimated data for Marine Aquaculture and Fishing in Galicia by Zones. 2010.

Zones	Output bp (1000 €)	GVA bp (1000 €)	Primary Gross Income (1000 €)	Total Employment (No.)	Total Employment (FTE)
Zone I – Vigo	**382,596**	**188,891**	**208,658**	**4,243**	**3,997**
Marine Aquaculture	39,644	18,107	18,605	674	604
Shell-fishing on foot	9,144	7,387	7,705	660	508
Sea fishing	333,807	163,396	182,347	2,909	2,886
Zone II – Pontevedra	**77,113**	**43,899**	**47,911**	**1,872**	**1,599**
Marine Aquaculture	16,500	8,620	8,857	422	378
Shell-fishing on foot	5,388	4,353	4,540	459	353
Sea fishing	55,225	30,926	34,513	991	868
Zone III – Arousa	**313,112**	**180,649**	**193,513**	**9,526**	**8,014**
Marine Aquaculture	153,528	76,150	78,246	3,602	3,227
Shell-fishing on foot	22,948	18,538	19,336	1,939	1,491
Sea fishing	136,635	85,961	95,931	3,984	3,295
Zone IV - Muros	**54,086**	**35,552**	**38,835**	**2,094**	**1,687**
Marine Aquaculture	11,244	5,006	5,144	174	156
Shell-fishing on foot	6,747	5,451	5,685	553	426
Sea fishing	36,095	25,095	28,006	1,367	1,105
Zone V - Fisterra	**32,283**	**18,213**	**19,849**	**594**	**491**
Marine Aquaculture	11,233	4,132	4,246	61	54
Shell-fishing on foot	1,891	1,528	1,593	111	85
Sea fishing	19,159	12,553	14,009	422	352
Zone VI - Costa da Morte	**59,215**	**36,735**	**40,332**	**1,279**	**1,045**
Marine Aquaculture	11,233	4,132	4,246	61	54
Shell-fishing on foot	5,048	4,078	4,254	290	223
Sea fishing	42,934	28,524	31,832	927	767
Zone VII – A Coruña-Ferrol	**77,094**	**44,769**	**49,281**	**1,541**	**1,315**
Marine Aquaculture	10,528	4,632	4,760	156	140
Shell-fishing on foot	4,590	3,708	3,868	348	267
Sea fishing	61,976	36,429	40,654	1,037	908
Zone VIII - Cedeira	**29,685**	**17,690**	**19,503**	**546**	**458**
Marine Aquaculture	5,617	2,066	2,123	30	27
Shell-fishing on foot	943	762	795	80	62
Sea fishing	23,126	14,861	16,585	436	369
Zone IX – A Mariña	**177,969**	**96,610**	**107,182**	**1,645**	**1,614**
Marine Aquaculture	16,850	6,199	6,369	91	82
Shell-fishing on foot	1,437	1,161	1,211	95	73
Sea fishing	159,682	89,251	99,602	1,459	1,460

Source: Compiled by the authors from the sources quoted.

Table 10
Contribution of Marine Aquaculture and Fishing to the Income and Employment of Galicia's Maritime Zones. 2010.

Maritime Zones	Contribution to Primary Gross Income*	Contribution to Employment**
Zone I – Vigo	2.90%	2.39%
Zone II - Pontevedra	1.84%	2.71%
Zone III – Arousa	8.76%	12.58%
Zone IV – Muros	7.87%	9.72%
Zone V – Fisterra	7.70%	5.12%
Zone VI - Costa da Morte	2.91%	2.41%
Zone VII – A Coruña-Ferrol	0.57%	0.69%
Zone VIII – Cedeira	5.85%	4.26%
Zone IX – A Mariña	11.46%	6.67%
Total 9 Maritime Zones	**3.01%**	**3.44%**

* Calculated as Primary Gross Income generated in the activity of Maritime Aquaculture and Fishing in relation with the total Primary Gross Income of each Maritime Zone's Municipalities.

** Calculated as Employment (in FTE) generated in the activity of Maritime Aquaculture and fishing in relation with the Employed Population estimated for all of the Municipalities of each Maritime Zone.

Source: Compiled by the authors from the sources quoted.

Table 11

Distribution of fishing income and employment according to the level of industrial development by Maritime Zones.

	Generation of Primary Income			Generation of Employment (in FTE)		
Maritime Zones	**Artisanal**	**Intermed.**	**Industrial**	**Artisanal**	**Intermed.**	**Industrial.**
I - Vigo	10.3%	18.8%	70.9%	34.6%	24.2%	41.2%
II - Pontevedra	26.7%	34.5%	38.8%	54.8%	31.5%	13.6%
III - Arousa	33.5%	48.9%	17.5%	56.3%	38.6%	5.1%
IV - Muros	49.8%	44.7%	5.5%	76.8%	21.6%	1.6%
V - Fisterra	21.5%	50.4%	28.2%	51.9%	33.4%	14.7%
VI - Costa da Morte	23.4%	66.1%	10.5%	52.8%	42.0%	5.2%
VII - Coruña-Ferrol	21.4%	39.2%	39.5%	52.5%	29.4%	18.1%
VIII - Cedeira	15.5%	59.8%	24.6%	44.5%	41.9%	13.7%
IX - A Mariña	2.9%	21.1%	75.9%	12.2%	23.1%	64.8%

* Culture Farms, Artisanal fishing and both Shellfishery segments are aggregated in the Artisanal and traditional activities; Rafts and Coastal Fishing are aggregated in the Intermediate activities; and finally, Farms and Hatcheries, Distant-water fishing and Long-distance water fishing are aggregated in the Highly Industrialized activities.

Source: Compiled by the authors.

Figures

Figure 1. Galicia's Maritime Zones.

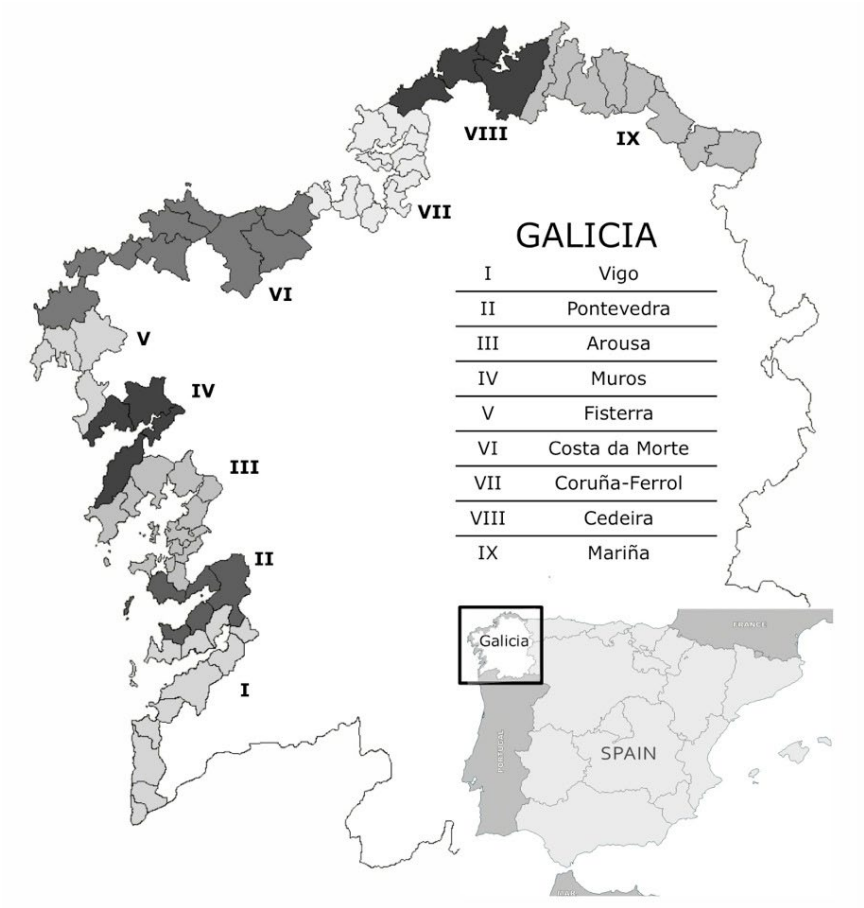

Figure 2. Galicia’s Maritime Zones fishing-dependent.