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THE ARTISANAL FISHING FLEET IN ASTURIAS: CHARACTERIZATION AND QUANTITATIVE ANALYSIS OF ITS ECONOMIC AND SOCIAL IMPORTANCE

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The artisanal fishing fleet in Asturias: characterization and quantitative analysis of its economic and social importance

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RESUMEN DEL CONTENIDO DE TESIS DOCTORAL

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RESUMEN (en español)

La pesca artesanal es aún una importante fuente de alimento, empleo y renta en Europa, así como un activo cultural y de identidad. Sin embargo, la información disponible sobre las flotas artesanales es escasa, lo que dificulta el diseño y evaluación de medidas de gestión y ordenación sostenibles. El Principado de Asturias, donde al menos el 75% de la flota se considera artesanal, constituye un caso paradigmático. El objetivo de esta tesis es mejorar el conocimiento de las características socioeconómicas de flota artesanal asturiana y del papel que juega en la economía regional, tanto en términos absolutos como comparados respecto a las flotas industriales y la pesca marítima de recreo. Esta disertación también explora cómo modelos económicos habitualmente usados para orientar las políticas pesqueras deberían considerar ciertas características de estas flotas.

La flota artesanal asturiana se caracteriza por barcos de pequeño tamaño, que operan como multi-arte en aguas cercanas a la costa persiguiendo gran variedad de especies de alto valor comercial. Estos barcos alternan anualmente distintos oficios, siendo frecuente un bajo nivel de capitalización, lazos familiares entre los tripulantes y un importante papel del conocimiento tradicional. Se identificaron 21 oficios y se han descrito los patrones espacio-temporales del esfuerzo pesquero, y las diferencias de output e inputs de cada oficio. Esta investigación describe las estrategias a corto plazo de los pescadores artesanales (alternancia) y a largo plazo (procesos de abandono-concentración). La rentabilidad es significativamente diferente según tipos de artes, pese a que su estructura de costes está muy ajustada y siguen un sistema de retribución variable y muy adaptativa.

Medir su contribución al empleo y a la generación de valor añadido en la economía regional ha sido el segundo objetivo de investigación. Para ello se aplicó un análisis input-output (IO), previa desagregación de la rama pesquera del marco IO de Asturias 2010 en dos nuevas ramas (Flota artesanal y Resto de pesca y acuicultura). Los resultados indican que la actividad de la flota artesanal ejerce efectos multiplicadores sobre el empleo y la renta regional superiores a los del promedio de la economía y el resto del sector pesquero (básicamente, la flota industrial). El potencial de la flota artesanal para generar valor añadido bruto es particularmente importante.

Se ha abordado también el reto de ampliar dicha comparación a la pesca marítima recreativa, que compite por una parte de los recursos y el espacio usado por la flota artesanal y no es una industria formal, sino una actividad de ocio (básicamente, consumo privado). Para ello se aplicó el mismo modelo IO, utilizando criterios de tratamiento del gasto recreativo que permiten integrarlo en un marco IO y garantizar su comparabilidad respecto a la pesca comercial. Aunque en 2010 el valor del consumo final de productos del mar de los hogares satisfecho por la pesca comercial fue similar al consumo final de los pescadores recreativos residentes, la pesca comercial generó más valor añadido bruto y empleos en Asturias. El efecto multiplicador sobre el empleo es mayor en el sector profesional, especialmente en las flotas artesanales.

Finalmente se exploraron las implicaciones de ciertos rasgos de las flotas artesanales en la modelización económica de la eficiencia técnica productiva, clave para orientar la política pesquera. Las decisiones de pesca en estos barcos multi-arte se basan en aspectos diferentes a la pesca industrial, y las flotas observadas pueden adolecer de sesgo de selección muestral. Por ello se propuso un método para comprobar y corregir fronteras estocásticas (SF) con sesgo tomando la pesquería artesanal de pulpo en Asturias en 2008-2009 como caso de estudio, que confirmó que los pesqueros habían pasado un proceso de autoselección. A diferencia del modelo SF clásico, la frontera corregida condujo a diferencias notables en la productividad estimada de los inputs y en la eficiencia de la pesquería, permitiendo identificar la mejora de las condiciones a bordo y el eco-etiquetado de las capturas como las medidas de gestión preferibles, e identificar a las flotas locales más eficientes para recibir la eco-certificación.

Los resultados se discuten a la luz de la situación de otras regiones, la política pesquera común en Europa y las medidas de ordenación futura de la pesca artesanal. Se destaca la necesidad de contemplar su heterogeneidad productiva y adoptar criterios socioeconómicos para su segmentación, así como nuevos incentivos que reconoczcan su contribución a la economía local, su patrimonio sociocultural y su mayor sostenibilidad ambiental.

RESUMEN (en Inglés)

Artisanal fisheries are still an important source of food, employment and income in Europe, as well as a cultural and identity asset. However, little information use to be available about artisanal fleets, which hampers the development of sustainable management measures The Principality of Asturias represents a paradigmatic case, as at least 75% of the fleet is considered to be artisanal. Hence, the objective of this thesis is to improve the current knowledge on the socioeconomic characteristics of the Asturian artisanal fishing fleet and the role it plays in the regional economy, both in absolute and comparative terms with respect to industrial fleets and marine recreational fishing. The dissertation also explores how some economic models commonly used to guide fishing policies should consider certain characteristics of artisanal fleets.

The Asturian artisanal fleet comprises small sized boats which operate as multi-gear close to the coastline targeting a great variety of high-valued species. They change frequently the fishing gears over the year; they use to have low levels of capitalization, family ties between the crewmembers and high level of traditional know-how. 21 artisanal fishing métiers have been identified, as well as the spatio-temporal patterns of fishing effort and the differences in output and inputs demands at métier level. Short-term (métier rotation) and long-term (abandonment-concentration of métiers) fishing strategies were also described. Significant differences in profitability levels were found for the main gear types, despite costs structure is very tight in this fleet, which follows a variable and highly adaptive salary system.

A second aim was to quantify the contribution of this fleet to regional income and employment. An input-output (IO) analysis was applied after having carried out a disaggregation procedure to split the fishing industry of the Asturian IO framework 2010 into two new subsectors (Artisanal fleet and Rest of fishing and aquaculture). Results showed that artisanal fleet´s activity had higher multiplier effects on regional employment and income than the average economy and the rest of the fisheries sector (mostly, non-artisanal fleets). The potential of the artisanal fleet to create gross value added seems to be particularly important.

The third part of the thesis addressed the challenge of extending the comparison to marine recreational fishing, which competes with artisanal fleets for part of the resources and space (although it is not an industry of the formal economy, but a leisure activity that translates into final private consumption). To apply again the same IO model, a specific valuation procedure was proposed for the treatment of recreational expenditures and the direct comparability between both marine activities within an IO framework. Although final consumption by households of fish and sea products from commercial fishing was similar to the final consumption of resident recreational fishermen in 2010, the former supported more gross value added and jobs than recreational fishing. The multiplier effect on employment is greater in the professional sector, especially in the artisanal fleets.

The implications of some artisanal fleets´characteristics for the economic modelling of technical efficiency (TE) were analysed, due to its relevance to guide fishing policies. Multi-gear artisanal vessels (compared to the industrial ones) do not always participate in certain fisheries and different issues influence their fishing decisions, so samples may be affected by selection bias. A method to test and correct stochastic frontiers (SF) affected by sample selection bias was proposed and applied to the octopus artisanal fishery in Asturias for the season 2008-2009, confirming that vessels in the sample had undergone a self-selection process. Unlike the classic model, the SF adjusted for sample selection bias produced significant differences in the estimates of vessel length and effort productivities, together with smaller TE scores. It allowed to select the improvement of on-board conditions and eco-labelling as the best management measures, as well as to identify the most efficient local fleets to obtain an eco-label.

Finally, results are discussed considering the situation in other regions, the common fisheries policy in Europe and future management measures for artisanal fisheries. The need to consider their productive heterogeneity and set socio-economic criteria for their segmentation is highlighted, as well as new incentives that recognise their contribution to the local economies, socio-cultural heritage and higher environmental sustainability.

SR. PRESIDENTE DE LA COMISIÓN ACADÉMICA DEL PROGRAMA DE DOCTORADO EN _________________

RESUMEN EN ESPAÑOL

La pesca artesanal y de pequeña escala constituye todavía hoy una importante fuente de alimentos, empleo y renta para muchas comunidades costeras de Europa meridional, así como un factor cultural y de identidad fundamental en regiones de todo el mundo. Sin embargo, y a pesar de su importancia, suele haber poca información disponible sobre las flotas artesanales y, en general, se ha prestado poca atención a sus características socioeconómicas y culturales, lo que dificulta la posibilidad de elaborar medidas de gestión y ordenación sostenibles e integradoras que tengan en cuenta las complejas interacciones entre las dimensiones social, económica y ambiental de esas pesquerías. El Principado de Asturias constituye un caso paradigmático de estudio sobre este tipo de pesca, dado que al menos el 75% de la flota regional se considera artesanal, aunque tradicionalmente se ha desconocido su importancia económica y social. Por ello, el objetivo de esta tesis es mejorar el conocimiento actual sobre la flota pesquera artesanal asturiana centrándose en sus características socioeconómicas, y tratando de determinar el papel que desempeña en la economía regional, tanto en términos absolutos como comparados respecto a las flotas industriales y a la pesca marítima de recreo. Esta disertación también explora cómo ciertas características de las flotas artesanales deberían ser consideras en algunos modelos económicos comúnmente utilizados para orientar las políticas pesqueras, como los de eficiencia técnica. Todas las conclusiones y resultados se discuten a la luz de la situación de otras regiones, de la política pesquera y del protocolo de recopilación de datos pesqueros en toda Europa. Se espera que los resultados sirvan de base para futuras investigaciones relacionadas con la aplicación de medidas de ordenación específicas para mejorar la sostenibilidad de la pesca artesanal en nuestro ámbito.

La primera parte de la tesis tiene como objetivo caracterizar la flota artesanal asturiana desde el punto de vista económico, social y operativo, a fin de comparar esas características con las de otras pesquerías artesanales del sur de Europa y generar datos socioeconómicos básicos y novedosos a utilizar en análisis posteriores. La flota artesanal asturiana presenta muchas similitudes con otras flotas europeas: está compuesta por barcos de pequeño tamaño, muy heterogéneos en cuanto a artes de pesca (distintos tipos de redes, palangres, trampas, etc.) que operan como multiarte en aguas poco profundas cercanas a la costa. Esta flota persigue una gran variedad de especies de alto valor comercial y cambia frecuentemente de artes y técnicas de pesca a lo largo del año (alta alternancia o rotación). Las embarcaciones artesanales presentan un bajo equipamiento tecnológico a bordo, bajos niveles de capitalización del negocio pesquero, lazos familiares entre los miembros de la tripulación y un alto nivel de conocimientos transmitidos de

padres a hijos durante generaciones. También se identificaron los oficios (métiers) que utiliza actualmente la flota pesquera artesanal, gracias a un análisis integrado de datos administrativos sobre licencias de pesca, estadísticas de ventas diarias e información obtenida con encuestas: como resultado, se han identificado 21 oficios artesanales, lo que refleja el alto grado de conocimientos tradicionales/locales, con especial relevancia del trasmallo (dirigido a *Lophius spp.*), el palangrillo y la beta para la pesca de merluza del Cantábrico. También se han descrito los patrones espacio-temporales del esfuerzo pesquero y se han confirmado y cuantificado las diferencias existentes en el output y los inputs necesarios para desarrollar cada oficio. El alto grado de alternancia entre los diferentes oficios durante la temporada de pesca muestra las estrategias a corto y largo plazo de los pescadores artesanales (elección de oficios). La información económica obtenida a partir de una encuesta económica realizada a dos tercios de la flota artesanal asturiana ha permitido por primera vez evaluar los indicadores de rentabilidad real teniendo en cuenta tanto las ventas declaradas como las no declaradas. Los resultados confirman que los niveles actuales de rentabilidad son inferiores a los de otras actividades económicas alternativas, lo que actúa como una barrera de entrada para nuevos barcos artesanales; básicamente, esto es consecuencia de los bajos precios en primera venta en los mercados locales, ya que los análisis de costes revelaron que su estructura de gastos está ya muy ajustada en esta flota, cuya tripulación sigue mayoritariamente un sistema de retribución salarial variable y muy adaptativo.

La segunda parte de la tesis aborda el problema de cuantificar la importancia de las flotas artesanales para la economía regional. Las flotas artesanales representan uno de los segmentos de pesca más sostenibles y, según la actual Política Pesquera Común (PPC), una cuestión clave es cuantificar su contribución al empleo y a la generación de valor añadido en las economías locales; sin embargo no se han desarrollado herramientas metodológicas para analizar específicamente esta cuestión y se han llevado a cabo pocos ejercicios empíricos debido a la falta de información (producción total, consumos intermedios, etc.) que suele caracterizar a estas flotas. En la segunda parte de esta tesis se presenta una metodología para medir la importancia de las flotas artesanales en una economía, a partir del análisis input-output (IO) y aplicando un procedimiento de desagregación que permite distinguir su actividad cuando esta información se agrega en uno de los sectores observables en una tabla IO. Para el caso de la flota pesquera artesanal de Asturias se ha realizado un ejercicio empírico mediante la integración de diversas fuentes de datos sobre su actividad y la desagregación de toda la rama "Pesca y acuicultura" en la tabla IO simétrica. La tabla IO de Asturias 2010 ha permitido estimar el impacto de la actividad de la flota pesquera artesanal, mostrando que ésta ha ejercido en 2010 unos efectos multiplicadores sobre el empleo y la renta regional superiores a los del conjunto de la economía y el resto del sector pesquero (básicamente, la flota industrial). Las conclusiones también revelaron que el potencial de la flota artesanal para generar valor añadido bruto es particularmente importante. Estos resultados también sugieren que la desagregación sectorial de las tablas IO es una metodología muy versátil, útil y reproducible para estudios similares sobre la pesca artesanal.

Una vez conocida la importancia de la pesca artesanal para la economía regional, así como su capacidad de crear renta y empleo en comparación con la pesca industrial, la tercera parte de esta tesis aborda el reto de ampliar dicha comparación a otra actividad que compite por una parte de los recursos pesqueros y el espacio costero de la flota artesanal: la pesca marina recreativa. Para ello se aplicó un modelo IO que permite cuantificar y comparar, por primera vez en Europa, la contribución económica de la pesca marítima recreativa (MRF) y de la pesca comercial (MCF) a una economía regional (la de Asturias). El enfoque considera por separado la pesca artesanal comercial (MCAF) e intenta superar problemas clásicos en otros estudios previos asociados al tratamiento del gasto recreativo y a la comparabilidad directa entre ambas actividades marinas. Aunque en 2010 el valor del consumo final de pescado y productos del mar procedentes de la pesca comercial fue similar al del consumo final de los pescadores recreativos residentes, la pesca comercial generó más valor añadido bruto (VAB) y puestos de trabajo que la pesca deportiva. Los multiplicadores (del efecto directo e indirecto) del consumo final muestran que la pesca marítima recreativa (MRF) tuvo un potencial ligeramente superior al de la pesca profesional para inducir la producción final de la economía regional, si bien ambas ejercen un efecto similar sobre el VAB; sin embargo, el efecto multiplicador directo e indirecto sobre el empleo es mayor en el sector profesional, especialmente en las flotas artesanales. El consumo privado asociado a la pesca recreativa y a los productos de la pesca profesional generó, en conjunto, el 0,25% del VAB regional y el 0,40% del empleo en 2010; sin embargo, el efecto económico del gasto pesquero recreativo sigue estando fuertemente vinculado al comercio minorista, ciertas manufacturas y hostelería/restauración, mientras que el consumo final asociado a la pesca comercial (incluida la artesanal) se vincula a la propia actividad pesquera y, en mucha menor medida, a las manufacturas.

En la cuarta y última parte de la tesis se discuten las implicaciones que ciertos rasgos distintivos de las flotas artesanales pueden tener en la modelización económica de aspectos tan interesantes como la eficiencia técnica productiva. La eficiencia (ET) ha sido un tema central en los estudios de economía pesquera debido a su relevancia para orientar regulaciones y medidas de política pesquera. En comparación con la pesca industrial, las embarcaciones artesanales multi-arte no siempre participan en determinadas pesquerías, ya que aspectos como la meteorología, la abundacia de recursos o la posibilidad de alternancia/rotación entre varias pesquerías influyen a la hora de decidir su participación, que persigue maximizar la rentabilidad y las posibilidades de pesca. En consecuencia, las muestras de embarcaciones artesanales multi-arte en una pesquería pueden no ser totalmente aleatorias y contener un sesgo de selección muestral que dé lugar a estimaciones sesgadas y conclusiones erróneas a efectos de gestión. A diferencia de otros campos del análisis económico y social, esta cuestión no se ha tenido en cuenta en general en los estudios de ET y productividad de la pesca artesanal y de pequeña escala. Así pues, en el cuarto capítulo de la tesis se aborda el sesgo de selección muestral, sus fuentes y consecuencias en estudios de ET pesquera que utilizan fronteras estocásticas (SF), con el fin de mejorar la modelización de la eficiencia de pesquerías y proponer una corrección. Como han hecho antes otros estudios ajenos a la pesca, se propone un método para comprobar y, en su caso, corregir la función de SF afectada por sesgo de selección teniendo en cuenta las estimaciones resultantes de un modelo de probabilidad de participación conectado con ella. Para ello se llevó a cabo un ejercicio empírico de estimación de ET basado en la pesquería artesanal de pulpo en Asturias en la temporada 2008-2009. Los resultados mostraron que los buques participantes habían pasado por un proceso de autoselección y que el modelo de SF ajustado para evitar la selección muestral arrojaba diferencias notables en la productividad estimada de la eslora y del esfuerzo pesquero de los buques, así como menores niveles de eficiencia técnica para la pesquería. Se analizó después la trascendencia de estas estimaciones a la hora de identificar nuevas medidas de gestión para esta flota: los resultados corregidos por sesgo permitieron identificar la mejora de las condiciones a bordo para los tripulantes y el apoyo al proceso de eco-etiquetado de las capturas como las dos medidas preferibles entre otras posibles, así como identificar correctamente a las flotas locales más eficientes candidatas a poner en marcha la certificación ambiental. Las conclusiones también sugieren el interés de ampliar este enfoque a otros estudios sobre ET que impliquen a pesquerías en las que intervienen embarcaciones artesanales multi-arte.

RESUMEN EN INGLÉS

Artisanal and small-scale fisheries constitute an important source of food, employment and income for many South European coastal communities, as well as a fundamental cultural and traditional identity factor at a regional level worldwide. However, and despite its importance, there use to be little information available about artisanal fleets and, generally, low attention has been given to their social, economic and cultural characteristics, which hampers the chance of developing sustainable and integrated management measures that take into account the complex interactions and linkages between the socioeconomic and the environmental dimensions of these fisheries. The Principality of Asturias represents a paradigmatic case study on this type of fishing, given that at least 75% of the regional fleet is considered artisanal and there has traditionally been a lack of knowledge regarding its economic and social importance. Hence, the objective of this thesis is to improve the current knowledge about the Asturian artisanal fishing fleet focusing on its socioeconomic characteristics, trying to better understand the role that it plays in the regional economy, both in absolute and comparative terms with respecto to industrial fleets and marine recreational fishing. This dissertation also explores how certain characteristics of artisanal fleets should be considered in some economic models commonly used to advice fishing policies, as technical efficiency models, and it discusses all the findings within the framework of the regions, policies and data collection framework for fisheries in Europe. Results are hoped to be a baseline for further research linked to the implementation of specific management measures to improve artisanal fisheries sustainability in this area.

The first part of the thesis is aimed to characterise the Asturian artisanal fleet from the economic, social ons operational points of view, in order to compare such characteristics with those of other artisanal fisheries in South Europe and to generate basic and novel socioeconomic data to be used in further analyses. The Asturian artisanal fleet shows many similarities with other European fleets: it comprises small sized boats, highly heterogeneous in terms of fishing gears (such as gillnets, trammel nets, longlines, traps, etc) which operate as multi-gear in shallow waters close to the coastline. This fleet targets a great variety of high-valued species and change frequently the fishing gears and techniques over the year (high alternation/rotation). Artisanal vessels present low technological equipment on-board, low levels of fishing business capitalization, family ties between the crewmembers and high level of know-how transmitted from fathers to sons for generations. The métiers currently used by the artisanal fishing fleet were also identified and characterised by integrating the analysis of administrative data on fishing licenses, daily sales statistics and information from surveys: as result, 21 artisanal fishing métiers have been identified,

reflecting the high degree of traditional/local knowledge, with special relevance of the trammel net (targeting *Lophius spp.)*, the *Merluccius* longline and the *Merluccius* gillnet métiers. Spatio-temporal patterns of fishing effort have been also described, and differences in outputs and inputs at métier level were confirmed and quantified. The high degree of alternation between different métiers during the fishing season shows fishermen´s short and long-term fishing strategies (métier choice). The collection of economic information from a wide economic survey carried out to the two-thirds of the Asturian artisanal fleet has allowed for the first time the assessment of real profitability indicators taking into consideration both declared and undeclared incomes. Results confirm that current levels of profitability are clearly lower than those from other alternative economic activities, fact that acts as an entry barrier for new artisanal vessels: basically, this is a consequence of the low first-sale prices at local markets, as costs analyses revealed that their cost structure is already very tight for this fleet, which mostly follows a variable and highly adaptive salary system.

The second part of the thesis addresses the problem of quantifying the importance of artisanal fleets in a regional economy. Artisanal fleets represent one of the most sustainable fishing segments, and according to the current Common Fisheries Policy (CFP), a key issue consists of quantifying their contribution to employment and value added generation in local economies, but methodological tools have not been specifically developed to analyse this question and few empirical quantifications have been carried out due to lack of information (output, intermediate consumptions, etc.). The second part of this dissertation presents a methodology to measure the importance of artisanal fleets in an economy, on the basis of input-output (IO) analysis and by applying a disaggregation procedure that allows for distinguishing their activity when this information is aggregated into one of the sectors observable on an IO table. An empirical exercise has been conducted for the case of the artisanal fishing fleet of Asturias by drawing together many different sources of data concerning its activity and by splitting the whole “Fisheries and aquaculture” sector in the symmetric IO table. The IO table of Asturias 2010 has allowed to estimate the impact of the artisanal fishing fleet´s activity, showing that it exerted in 2010 higher multiplier effects on regional employment and income than the whole economy and the rest of the fisheries sector (basically, the industrial fleet). Findings also revealed that the potential of the artisanal fleet to generate gross value added is particularly important. These results also suggest that sectoral disaggregation of IO tables is a highly versatile, useful and replicable methodology for socioeconomic studies of artisanal fisheries.

Once the importance of artisanal fishing for the regional economy was known, as well as its capacity to create income and employment in comparison with industrial fishing is known, the third part of this thesis addresses the challenge of extending the comparison to another activity that competes for the same fishing resources and coastal spaces as the artisanal fleet: the recreational marine fishing. To achieve that, an IO model was appplied to quantify and compare, for the first time in Europe, the economic contribution of marine recreational (MRF) and commercial fishing (MCF) to a regional economy (Asturias). The approach considers separately the commercial artisanal fishing (MCAF) and attemps to overcome traditional problems concerning the treatment of recreational expenditure and the direct comparability between these marine activities. Although final consumption by households of fish and sea products from MCF was similar to the final consumption of resident recreational fishermen (MRF) in 2010, commercial fishing supported more gross value added (GVA) and jobs than recreational fishing. Multipliers of final consumption show that MRF had slightly higher potential than MCF to induce the final output of the regional economy, and both of them show a similar effect on GVA; nevertheless, the multiplier effect on employment is greater in the professional sector, especially in the artisanal fleets. MRF and MCF private consumption jointly supported 0.25% of the regional GVA and 0.40% of the employment in 2010; however, the economic effect of MRF expenditure remains strongly linked to retail, manufacturing and hotels/restaurants, while final consumption associated with MCF and MCAF supports the fishing industry itself and, to a much lesser extent, manufacturing.

The fourth and last part of the thesis discusses the implications that certain distinctive features of artisanal fleets can have on the economic modelling of highly interesting aspects as technical productive efficiency. Technical efficiency (TE) has been a key topic in fisheries economics due to its relevance to guide fishing regulations and policy measures. A distinguishing feature of small-scale and artisanal fleets when compared to industrial fishing is that the first ones do not always participate in certain fisheries: weather conditions, resource abundance or alternation/rotation possibilities among different métiers influence the decision to take part on a fishery, trying to maximize profitability and fishing possibilities. As a consequence, data coming from samples of multi-gear artisanal vessels may not be purely random (sample selection), leading to biased estimations and erroneous conclusions for management purposes. Contrary to other fields of economic and social analysis, this issue has not been generally considered when studying TE and productivity in artisanal and small-scale fisheries (SSF). Thus, Chapter IV of this dissertation tackles sample selection bias, its sources and consequences in fishing TE studies that use stochastic frontiers (SF), with the objective of improving TE modelling in fisheries and proposing a correction. To achieve this, as has been applied in other non-fisheries studies, an alternative method is proposed to test and, if applicable, correct an SF function affected by selectivity bias by taking into account the estimates resulting from a connected participation probability model. An empirical exercise has been conducted to estimate TE for an octopus artisanal fishery in Asturias for the season 2008-2009. Results showed that participant vessels had undergone a self-selection process and that the SF adjusted for sample-selection produced noticeable differences in the estimates of the contributions to productivity of vessel length and fishing effort, together with smaller technical efficiency scores. In terms of policy implications, these results led to identify the improvement of on-board conditions of crewmembers and a market-based policy of eco-labelling as preferable among other possible measures, and allowed the most efficient local fleets to be correctly identified to apply for an eco-label. The method is an alternative when non-technical determinants (fishermen´s attributes) are not subject to analysis, and it can be extended to other TE studies dealing with fisheries that involve multi-gear artisanal and small-scale vessels.

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INTRODUCTION

1. SOME REFLECTIONS ON THE MOTIVATION OF THIS RESEARCH

Although the concept of artisanal fisheries depends on the geographical context and there is not a universally accepted definition, terms as "*artisanal*", "*small-scale*" or "*traditional*" use to be indistinctly applied to differentiate them from the industrial and semi-industrial fisheries and to refer to coastal/inshore traditional extensive fishing. In Europe, the existing differences in management and regulatory frameworks as well as the high heterogeneity of these activities across countries and regions, have prevented so far a common definition of artisanal fisheries (EU Parliament, 2012; García-Flórez et al., 2014), and small-scale coastal fishing (SSCF or SSF) is the most usual term[1] to define the *"(…) fishing carried on by fishing vessels of an overall length of less than 12 meters and not using towed gear*[2] *(…)*" (Commission of the European Communities, 2004).

The EU small-scale fleet consists of around 50,000 vessels, which have accounted for the 74-75% of the European active fleet during the last decade (STECF, 2019, 2014). They constitute an important source of development for most of coastline communities in coastal regions: in 2017 this fleet employed almost 77,000 fishermen (51% of the total in the EU) and it accumulated 56% of the total days-at-sea. The ratio between Gross Value Added (GVA) and revenues for the EU small-scale fleet (67%) has been in 2017 the highest of all the European fleets (STECF, 2019). Apart from direct employment, many upstream and downstream fisheries-related activities are connected to this fishing segment that, in parallel, provides a valuable cultural heritage to many coastal areas. All this makes the artisanal fleets a central piece for coastal economies and for the maintenance of the territorial and social cohesion, especially in rural and peripheral areas (Macfadyen et al., 2011).

But despite this dimension and their recognized contribution to human food security worlwide (Chuenpagdee et al., 2006), historically low attention has been given to their social, economic and cultural relevance, which hampers the application of fitted, sustainable and integrated management measures for these fisheries and fleets. As Varela Lafuente et al. (1989) outlined, in past decades research on fisheries economics has been mainly dominated by a neoclassic approach focused on

[1] Derived from European legal framework, as the *Proposal for a Council Regulation European Fisheries Fund (COM (2004) 497 final)* (Commission of the European Communities, 2004).
[2] As defined in the Table 2, Annex I of the Commission Regulation (EC) No 26/2004 of 30th of December 2003.

the specification and estimation of theoretical models on fishing effort, efficiency and fisheries´ net social value and addressing, among other, topics such as the optimum catch rates, fishing stocks, property models or management measures (Gordon, 1954; Hardin, 1968; Schaefer, 1954). In more recent times, fishing literature has shown an increasing interest for studies with a structural approach, focused on improving the available data on fisheries, making for the first time a clear differentiation between large (industrial) and small-scale fisheries (non-industrial, artisanal), and paying attention on their socioeconomic dimension in order to improve fishing management models under sustainable, adaptive social-ecological schemes (Allen and Garmestani, 2015) and ecosystem approaches (García et al., 2003; Santos-Martín et al., 2015).

However, a number of reasons explain why artisanal fisheries have continued to be scarcely considered by researchers and decision makers in recent decades (Battaglia et al., 2010; Guyader et al., 2013; Tzanatos et al., 2005). Traditionally, their contribution to national and regional GDP and to economic growth has been considered low (Guyader et al., 2007; Zeller et al., 2006) and there is little empirical quantification of the economic impact of their activity, due to the lack of detailed information on their output, intermediate consumptions or primary inputs used. Secondly, their wide spatial distribution, poor entrepreneurial character of productive units and internal heterogeneity (diverse fishing techniques and gears, targeted species, seasons) have greatly limited their monitoring, data collection and availability of reliable information (Chuenpagdee, 2011; Tzanatos et al., 2006a, 2005), even in the European area. Finally, artisanal fishermen usually are poorly organized (Bown et al., 2013) and therefore weakly represented in local, regional, national and EU organisms (Guyader et al., 2013), which has excluded them for a long time in decision-making processes on management measures and fisheries regulations (Lleonart and Maynou, 2003; Tzanatos et al., 2005).

In the last decade, the situation of territories such as the Principality of Asturias (hereinafter, Asturias) was well suited to this reality. Asturias is an Atlantic coastal region belonging to the EU Southern Western Waters fishing area; as in many other South-European regions, the artisanal segment represents around 75-80% of the total fishing fleet (EU Parliament, 2012; Forcada et al., 2010; Guyader et al., 2013; Stergiou et al., 2006). At the end of the last decade, in Asturias there were a series of non-integrated administrative databases containing disperse economic and operational data concerning fisheries (first-sales at fishing guilds, fishing licenses in coastal waters, crewmembers data), which had never been analysed in an integrated way to study in detail artisanal vessels´ activity or fishing effort. There were also no information on cost structure, social and labour characteristics of these fishermen, spatial-temporal patterns of the activity or perceptions of the sector itself about their main problems and challenges. National statistics did not provide this type of information either (MARM, 2011a), and regional statistics were limited to a few general indicators concerning landings (weight and value), fleet´s evolution and main technical characteristics, by national categories and ports (SADEI, 2012a).

Aware of the significant knowledge gaps that existed, the Asturian government (General Directorate on Maritime) decided to participate with other South European Atlantic regions in the project *PRESPO: Sustainable Development of Atlantic Arc Artisanal Fisheries* between 2009 and 2011[3]. The studies carried out and data obtained in that project, in which researchers such as the author of this dissertation also participated, represented a milestone for the knowledge of artisanal marine fisheries in Asturias. Chapter I of this document was a direct output of that project, and it also provided the basis for further research, as shown in Chapters II-IV of this dissertation.

2. ASTURIAS: A GOOD LAB TO STUDY SMALL-SCALE FISHERIES AND ARTISANAL FLEETS

The Principality of Asturias, a region of Spain located in the north of the Iberian peninsula (Figure 1), has a total surface of 10,608 km^2 and around 335 km of shoreline along the Cantabrian Sea. Regional fishing grounds, recently redefined and mapped (Consejería de Medio Rural y Pesca, 2011), take up 984,938 hectares. Different sedimentary environments are common to be found throughout the coastline: small but numerous beaches nested between the steep cliffs, a few dune systems associated to the widest beaches and, finally, estuaries formed by the advancing sea waters on the river valleys. The Cantabrian Sea bathing the Asturian coast has its own characteristics that differentiate it from the Atlantic waters of Galicia and Brittany. Its higher temperature is partly due to a system of currents in which, during summer, alternates a branch of the Gulf Stream with the surface water currents ocean caused by the northeast wind. Regarding the coast morphology, the so-called *Cabo Peñas* (northernmost regional cape) acts as a frontier cutting the regional coast in two main areas: west and east. Towards the west temperature and salinity decrease and the flora and fauna are quite similar to that of the south coast of England or

[3] Within the Atlantic Area Transnational Cooperation Programme 2007-2013 and co-funded by the European Regional Development Fund (ERDF).

the French Brittany. The eastern region presents southern characteristics similar to those of south Portugal or the Moroccan Atlantic coast.

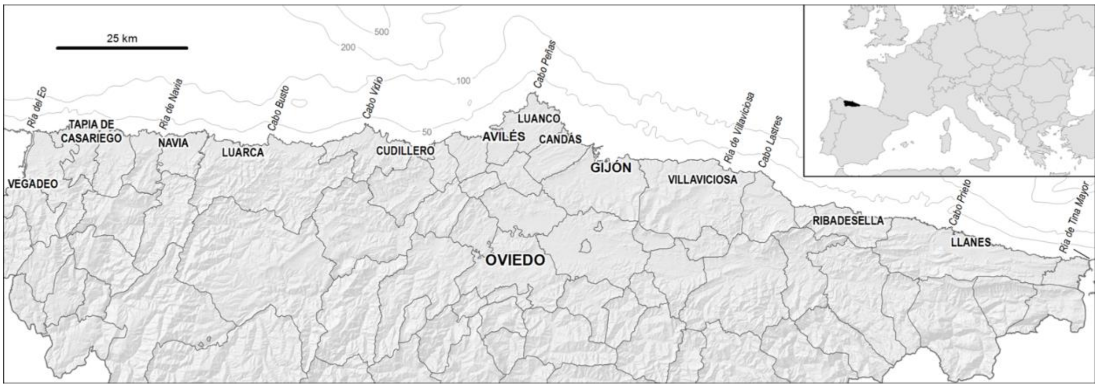

Figure 1. Area of study.

The diversity and richness of the Cantabrian fishing grounds have favored the historical settlement of a great number of coastal communities strongly attached to the marine environment and the fishing resources. This has encouraged the development of an important fishing fleet based along 19 fishing harbors, where 18 fishermen guilds (named *Cofradías*) are located. These harbors present differences in terms of total landings, species commercialized and number of vessels, and only 17 of them register sales for, at least, six months per year.

The "Updated Spanish Strategic Plan for the European Fisheries Fund 2007-2013" (MARM, 2011b) declared 18 from the 21 Asturian coastal municipalities as fishing-dependent areas. According to the 2010 Regional Accounts (SADEI, 2012b), the "Fisheries and aquaculture" sector generated in Asturias 1,684 direct jobs, an output of € 74.3 million and a GVA of € 44.9 million at basic prices, which only represents the 0.2% of the regional GDP. Nevertheless, fishing activities are highly concentrated on coastal villages and municipalities, where direct, indirect and induced impacts on income and employment are expected to be significant.

In the context of many South-European Atlantic areas there is a broad consensus in considering artisanal fleet at least those vessels classified by the national census as multi-gear vessels using mainly polyvalent passive/static gears (García-Flórez et al., 2014). In Spain, the National Census of Operating Fishing Fleet (CFO) is the national database of fishing vessels based in our country yearly updated by the Ministry with powers on fishing affairs; it includes the category named "multi-gear vessels in the Cantabrian and Northwest fishing ground" (original name *Artes menores en Cantábrico y Noroeste*), which mainly corresponds to the "only passive gears" European census category, and embraces small-scale multi-gear vessels operating with a wide range of traditional gears over the year, mainly passive gears (longlines, hooks, trammel nets, gillnets, pots, etc.). In Asturias (Table 1), this fleet comprised 233 vessels in 2010 (71% of the total regional fleet) with an average length of 8.8 m, an average capacity of 4.6 GT, an average engine power of 51.8 kW. According to the Spanish Marine Social Institute (ISM), the fleet named *Artes menores* accounted in 2010 for the 40% of the Asturian fishermen boarding in vessels (477 crewmembers) and registered an average of 2.1 crewmembers per boat.

Table 1. Asturian fleet characteristics by Census category. 2010*

Categories in the National Census (*original name in brackets*)		No Vessels	Average length (m)	Gross tonnage (GT)		Engine power (Kw)		Average age
				Total	Mean	Total	Mean	
Bottom trawlers	*(Arrastre de fondo en Cantábrico NW)*	11	28.1	2,400	218.2	4,120	375	10
Passive gears in international waters.	*(Artes fijas en zonas CIEM VB, VI, VII y VIII abde)*	8	30.1	2,101	262.6	3,824	478	11
Purse seiners	*(Cerco en Cantábrico NW)*	8	21	539	67.5	2,088	261	14
Longliners in international waters	*(Palangre de fondo menores 100 TRB en VIII abde.)*	10	24.3	1,430	143.1	3,454	345	14
Set gillnetters	*(Rasco en Cantábrico NW)*	6	14.1	107	17.9	777	130	15
Set gillnetters	*(Volanta en Cantábrico NW)*	11	16.3	462	42.0	1,811	165	16
Only passive gears – Multi-gears	*(Artes menores en Cantábrico y NW)*	233	8.8	1,060	4.6	11,854	51	19
Bottom longliners	*(Palangre de fondo en Cantábrico NW)*	40	12.1	523	13.1	3,337	83	15
TOTAL		**327**	**11.5**	**8,624**	**26.4**	**31,265**	**95.6**	***17***

* Date of reference: June 2010

In terms of fishing strategies, most of this this regional artisanal fleet is multi-gear (Table 2), changing between different fishing gears along the year and exploiting areas that can be reached in a few hours from the fishing harbors. Although landings from the artisanal fleet (in kilograms) only represented the 11% of the total regional catches in 2009 (1,719,950.69 kg), they summed up the 29% of the total economic value generated from landings, due to the higher first-sale price of these captures (high-value sea products) compared to those from other fleet segments (average of 4.25 €/kg *versus* 1.68 €/kg). The regional artisanal fleet targets many species, including high-value species (as shellfish, glass eel, goose barnacle, etc.; landings are characterised by their quality, freshness and, in aggregate and comparative terms with respect to the catches of other fleets, better first-sale price. This fact partially compensates for the lower weight of landings and lower fishing power.

Landings in 2010 were distributed over 100 species, although the main 7 species (Figure 2) accounted for 66% of the total weight fished: mackerel (*Scomber scumbrus*), hake (*Merluccius merluccius*), conger (*Conger conger*), octopus (*Octopus vulgaris*), sea bass (*Dicentrarchus labrax*), ray (*Raja spp.*) and red mullet (*Mullus surmuletus*).

Table 2. Main gears used by the Asturian artisanal fleet categorized according to the gear types established by the European Data Collection Framework (European Commission, 2010).

Gear classes	Gear type	Main target species	
		Common name	**Scientific name**
Hooks and lines	Set longlines (LLS)	Hake Sea bass Conger	*Merluccius Merluccius* *Dicentrarchus labrax* *Conger conger*
	Hand and Pole lines (LHP) / (LHM)	Hake European Squid	*Merluccius Merluccius* *Loligo vulgaris*
	Trolling lines (LTL)	Mackerel Tuna	*Scomber scumbrus* *Thunnus alalunga*
Nets	Trammel net (GTR)	Red Mullet Various fishes	*Mullus surmuletus* -
	Set gillnet (GNS)	Hake Red Mullet	*Merluccius Merluccius* *Mullus surmuletus*
Traps	Pots and Traps (FPO)	Octopus Spider crab	*Octopus vulgaris* *Maja squinado*
Other gear	Other gear	Glass eel fishing	*Anguilla anguilla*

Both the Asturian artisanal fleet and its crewmembers on-board reduced considerably during 2003-2009 (by 19% and 27% respectively), marking a worrying trend that compromise the sustainability of artisanal fisheries in Asturias. In spite of this, the reduction of vessels was less unfavourable than in other fishing fleets in Asturias (40%), and that of employment has been similar. Moreover, power and tonnage remained almost constant in those years thanks to modernisation and on-board safety improvements.

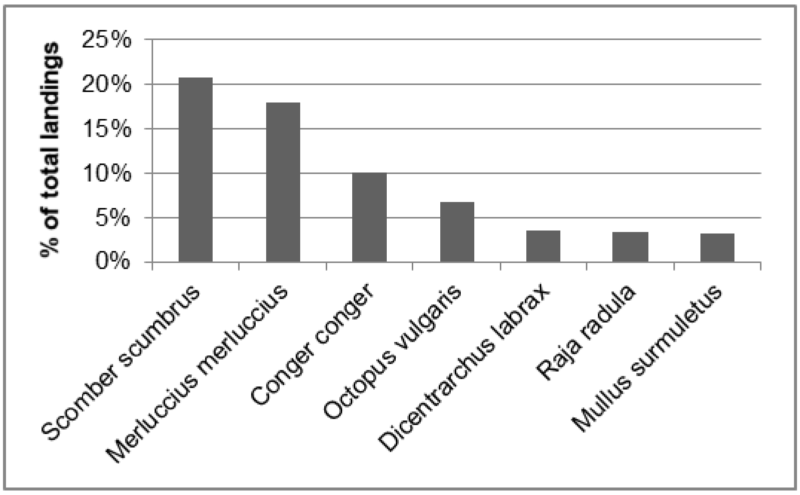

Figure 2. Relative weight of the seven main species landed by the Asturian artisanal fleet in 2010.

The landed weight and income obtained in Asturian fish markets (first-sales) increased in 2008-2009 with respect to their levels since 2005, although the weight increased more (48.5%) than the commercial value (5.2%). In fact, the average price of catches (euros/kg) fell by 34% over that period; considering the low capacity of the artisanal fleet to influence market prices, it implies that these vessels increased their fishing effort to compensate for the loss of income resulting from the decrease in average prices and the increase in production costs.

According to Regulation (CE) 1224/2009 (European Council, 2009), vessels under 12 and 10 metres of total length[4] are no subject to comply with Vessel Monitoring Systems (VMS) and logbooks fill-in requirements respectively, which derived in a historical lack of accurate, reliable and quantitative information on spatial and temporal fishing patterns for most of the Asturian artisanal vessels. In addition to this, the large size of this fleet, its heterogeneity and variability of fishing techniques hindered the implementation of standardize data collection routines so far. This situation has traditionally complicated a sustainable management of these boats, as basic and detailed data on their activity were not available. Usually in this poor-data context, first-sales notes became the only systematic source of information, although it allowed analysing neither spatial issues nor duration of fishing operations (so fishing effort and its location remained unknown for these fleets). On the other hand, other alternative data collection processes to gather socioeconomic information from specific surveys on vessels less than 12 metres had never been explored before 2009 in the region and needed the voluntary collaboration of fishermen. Finally, other administrative databases on operational issues generated by the regional fishing authority had significant integration problems with other fisheries data sources and had never been used for getting a highly-disaggregated and detailed knowledge on the métiers[5] developed by the Asturian artisanal fleet.

Before 2009, some research projects as IBERMIX (Castro et al., 2007) or TECTAC (Marchal, 2006) tried to addressed the problem of identifying artisanal métiers in the South-European area, but the aforementioned limitations on fishing data concerning vessels under 12 metres excluded most of Asturian artisanal boats from these relevant analyses. Although a precedent study carried out by Punzón and Gancedo (2000) provided a basic description of the artisanal fisheries in this area, it was focused on fishing gears, catches and seasonality using information dated in 1996.

Other issues surrounding artisanal fisheries in the region have also not been addressed before. Despite artisanal fleet´s dimension in Asturias, its specific contribution to regional income

[4] As example, in this case study, 212 of the total 233 artisanal vessels belonging to the *Artes menores* National Census category were under 12 metres of total length (91%), and 157 were under 10 metres (67%). Similar situations can be found in other South-European regions with large artisanal fishing fleets, as it has been recently outlined in García-Flórez et al. (2014).

[5] A métier has been defined by the EU Decision 2008/949/CE (European Commission, 2008) as "*a group of fishing operations targeting a similar (assemblage of) species, using similar gear, during the same period of the year and/or the same area and which are characterised by a similar exploitation pattern".* Therefore, the concept of métier is closely linked to the fishing activities, patterns, traditions and gears employed by artisanal fishermen: each métier gathers a group of fishing operations defined by the combination of fishing gear, target species, area and season (Russo et al., 2011; Tzanatos et al., 2006b), making up homogeneous units that summarize in a single variable the main characteristics of a large number of fishing trips (Ulrich and Andersen, 2004).

and employment were unknown, which can be a weakness in the framework of a Common Fisheries Policy (EU Parliament and Council, 2013) interested in the so-called *regional reliance on fishing activities,* opening the possibility that Member States use environmental, social and economic criteria (including the contribution to the local economy) to allocate fishing opportunities (i.e. allocation of fishing quotas among artisanal and industrial fleets within Member States and regions).

In parallel, professional fishing faces an increasing competition for marine space and resource with other uses and activities, such as recreational fishing and off-shore energy. Although the latter is not yet established in Asturias, there are important forecasts for future growth at European level (Ramírez et al., 2020). However, special attention should be paid to recreational fishing, given that Asturias is the Spanish region with the highest marine recreational fishing participation rate (7% of the total population) (Gordoa et al., 2019). During this last decade Asturias registered about 75,000 marine recreational licences (boat fishing, spearfishing and angling from the shore) and it represents a highly popular form of outdoor recreation that targets a vast array of species, which are also mostly fished by the regional artisanal fleet (as well as other species). Given these scenarios, it seems interesting to compare the contribution of each activity to the regional economy, the way in which each one generates employment and value added, and the potential effects of decisions on them, in order to guide an integrated coastal management, marine spatial planning and the allocation of resources/space or fishing rights between (artisanal) fishing and other competing activities.

3. OBJECTIVES OF THIS DISSERTATION

The objective of this dissertation is to improve the current knowledge about the Asturian artisanal fishing fleet focusing on its socioeconomic characteristics, trying to better understand its multiple dimensions (technical, economic and social) and the role that it plays in the regional economy. This is considered to be a baseline for further research linked to the implementation of specific management measures to improve artisanal fisheries sustainability.

This research aims at answering four specific questions, which represent the particular objectives of this thesis; findings and answers for each one of them have allowed to address, sequentially, the following ones.

What are the main economic and social characteristics of artisanal fisheries in Asturias?. Knowledge´s improvement about artisanal fisheries is a key issue to progress in the design and implementation of specific sustainable policies for this part of the fleet (from the socioeconomic and environmental points of view). For this purpose, specific research is needed, particularly in regions as Asturias, and new methods of data gathering and analysis must be implemented. Taking this into account, the first particular objective of this thesis has been to know the economic and social characteristics of the Asturian artisanal fisheries, with special attention to a number of key issues as the level of employment, crew´s social and professional profile, profitability, property and organizational system, output prices and markets, costs structure, gears and fishing practices used (métiers) and fishing effort. This first objective is addressed in Chapter I.

How important artisanal fisheries are for the creation of income and employment at a regional level?. Socioeconomic characterisation provides new knowledge and data allowing to carry out an analysis of economic impacts derived from artisanal fleets´s activity. Their wide spatial distribution along the regional coastline contributes to employment and income creation: in macroeconomic terms, in Asturias the whole fishing and aquaculture sector provided less than 0.4% of the regional GDP in 2010 and concentrates 0.43% of the employment, although it is unknown the specific contribution of the artisanal sector. Such percentage does not look very high on regional terms, but it is highly concentrated on coastal villages and municipalities, where direct, indirect and induced impacts may be quite significant. Thus, the second particular objective of this thesis will be to quantify the economic contribution of artisanal fisheries to the regional economy of Asturias in terms of income and employment, comparing it with the effect of the rest of fishing and aquaculture industry. This second objective is addressed in Chapter II.

How important is this contribution to the regional economy compared to that provided by other concurrent activities?. In comparative terms, it is not only relevant to know the economic dimension of the artisanal fleet with respect to the industrial one, but also its relevance with respect to the main use with which it shares some of the fishing resources and coastal space: recreational marine fishing. In many regions of Europe, and especially in Asturias, the decline of artisanal fleets coexists with a very relevant and expanding recreational sector; however, these are non-market leisure activities, which are not defined as a formal sector of the economy and basically represent final consumption. These different realities in the economic nature of both activities have made comparative analyses difficult in economic research. Thus, the third objective of this thesis has been to compare the contribution of recreational and commercial fisheries, particularly artisanal fisheries, to the final output, gross value added and employment of a European regional economy as Asturias. This third objective is addressed in Chapter III.

How certain characteristics of artisanal fleets may be considered in economic models commonly used in fisheries analysis?. Much of the analysis and modelling studies in fisheries economics are applied to guide management decisions and policies formulation; however, the poor-data context of many artisanal fisheries has traditionally made it difficult, or in case of being carried out, some of the economic-operational particularities of small-scale fleets have often been overlooked. Their adaptability, ability to alternate between different métiers and flexible cost structure determine the way in which these fleets make their fishing decisions, and this may condition the specification of economic models. Thus, the fourth objective of the thesis was to analyse the potential incidence of sample selection bias on fisheries technical efficiency models that considered artisanal fleets, and to explore how this may affect the design of sustainable management measures. This fourth objective is addressed in Chapter IV.

This dissertation concludes with a final Chapter that provides a summary of the main results emerging from the Asturian case and elevates the regional evidence to a reflection in terms of policy implications on a European and national scale.

CHAPTER I. CHARACTERISING THE ASTURIAN ARTISANAL FLEET

I.1 INTRODUCTION AND LITERATURE REVIEW

Artisanal or small-scale fisheries are often defined as small capital exploitations, usually owned by the fishermen, that develop their activity in the coastal zone (basically on the continental shelf) exploiting areas within a few hours from the ports where the vessels are based (Colloca et al., 2004). Their fishing patterns are characterised by the use of diverse fishing gears targeting a great variety of species (Battaglia et al., 2010; Farrugio et al., 1993; Guyader et al., 2007), as well as by frequent changes in gears and techniques used trying to maximize profitability (Forcada et al., 2010). Regardless of the existence of these common characteristics, artisanal fisheries are highly heterogeneous in terms of their activities and fishing strategies, showing great variations from one area to another depending on the environmental and socio-economic conditions where the activity takes place (Farrugio et al., 1993; Stergiou et al., 2006). In terms of its socioeconomic relevance, artisanal fishing activities provide food and income to millions of people worldwide. FAO (Béné et al., 2005) estimated that approximately 35 million of fishermen around the world (90% of the total) can be considered as artisanal fishermen, while over a 100 million people are employed within artisanal fisheries' dependent sectors.

Despite the difficulty of finding a common definition at European level (Commission of the European Communities, 2001; Tzanatos et al., 2005), artisanal or small-scale vessels represent around 75% of the boats making up the European fishing fleet (Forcada et al., 2010; Paulrud et al., 2015; STECF, 2019; Stergiou et al., 2006). This fleet not only has economic relevance (income creation, direct and indirect employment, induced effects in other economic sectors), but it also plays a very significant role for human and territorial development (cultural and social dimensions) at a local-regional scale. However, in spite of it, the European artisanal fishing sector had been poorly investigated until recent years, especially South European artisanal fisheries, where the lack of information is particularly marked. The lack of a common definition of artisanal fisheries and the large heterogeneity of their activities, gears and exploited stocks have also traditionally hindered the collection of standardized data (Battaglia et al., 2010; García-Rodríguez et al., 2006; Tzanatos et al., 2005).

In the context of multi-gear small-scale fleets, the concept of métier has been traditionally used to describe and characterise fisheries as it is able to capture the major part of their heterogeneity (Biseau, 1998; Laurec et al., 1991; Mesnil and Shepherd, 1990). The métier-based approach is very useful for understanding the real spatio-temporal patterns of fishing effort allocation (Forcada et al., 2010; Tzanatos et al., 2006b). This understanding constitutes a key issue to implement a sustainable and ecosystem-oriented fisheries management, as it helps to select well-fitted management strategies (Cabrera and Defeo, 2001; Oliveira et al., 2014), and provides basic information to address marine spatial planning concerning artisanal fleets (Pascual et al., 2013). As acknowledged by Forcada et al. (2010), identification of métiers has been widely based on the analysis of large historical datasets on species composition or catches data (Castro et al., 2011, 2010; Holley and Marchal, 2004; Jiménez et al., 2004; Murawski et al., 1983; Silva et al., 2002; Ulrich et al., 2001). Unfortunately such kind of information is not available for all artisanal fisheries, so the identification and characterisation of métiers have been carried out in the literature by using alternative approaches such as on-board samples or surveying methods (i.e. Forcada et al., 2010; Guillou et al., 2002; Jabeur, 2001; Tzanatos et al., 2006b, 2005); nevertheless, researchers have also pointed out reliability problems that may arise when data elicited from resource users are employed (O'Donnell et al., 2012). These poor-data contexts show the interest of exploring new sources of information, as for example administrative registers; particularly in Asturias, artisanal vessels are required to communicate to the fishing Administration each daily change in the fishing gears they used (equivalent to different artisanal fishing licences), so that it supplies an interesting data source to be explored for a detailed (level métier) socioeconomic characterisation.

Finally, and sharing common problems that also affect other fisheries (Stead, 2005), low attention has been generally given to social, economic and cultural considerations concerning artisanal fisheries in comparison to other aspects such us the technical characteristics of the fleets or the biological dynamics of the target species (Guyader et al., 2013, 2007). This lack of information has reduced the chance of developing effective and integrated management measures aimed at enhancing the sustainability of artisanal fisheries in the long term, taking into account the complex interactions and linkages between the human (socioeconomic, technical, cultural issues) and the natural dimension within these fisheries (Bowen and Riley, 2003).

In recent years there has been an increasing interest of researchers and fishing managers to improve the available data on European small-scale fisheries (Battaglia et al., 2010), with a clear focus on the socio-economic aspects of the artisanal fishing sector (Tzanatos et al., 2006a). As a result, a number of studies concerning several aspects of artisanal or small-scale fisheries have been carried out based on a selection of European case studies (Guyader et al., 2013) or specifically in Greece (Merino et al., 2007; Stergiou et al., 2006; Tzanatos et al., 2006a, 2005), Italy (Battaglia et al., 2010; Colloca et al., 2004; Himes, 2003; Whitmarsh et al., 2003), France (Guillou et al., 2002) and Mediterranean and SW Spanish waters (Forcada et al., 2010; García-Rodríguez et al., 2006; Merino et al., 2008; Piniella et al., 2007). However, the vast majority of the aforementioned studies are focused on the Mediterranean Sea, while studies on other areas, as northern Spanish and the Cantabrian Sea, are scarce (Freire and García-Allut, 2000; García del Hoyo and Santiago Pereira, 2007; Puente and Astorkiza, 2002). In addition to this, the existence of undeclared sales in the fishing sector, including artisanal fisheries (Freire and García-Allut, 2000), represents a well-known problem for economic analyses, and previous studies (Agnew et al., 2009; MRAG, 2005; Pitcher et al., 2002) have outlined the need of using different statistical and evidence-based techniques to estimate illegal, unreported and unregulated catches (IUU) with different levels of reliability (Agnew et al., 2009). Some authors (Otero et al., 2005; Villasante et al., 2010) have used direct interviews to artisanal fishermen to assess more reliable figures concerning IUU and total catches for important artisanal fisheries in northern Spain (as *Octopus vulgaris)*, emphasizing the utility of this kind of information to fill data gaps not covered by other sources.

This Chapter is aimed at analysing and describing the socioeconomic characteristics of the artisanal fleet of Asturias (northern Spain), with special attention on the fishing effort, its geographical distribution and the main socioeconomic aspects concerning the regional artisanal fisheries (social profile, costs and revenues, fishermen perceptions), and deepening, where possible, the knowledge of some of these aspects at the métier level. It is hoped that results achieved represent a baseline to allow further socioeconomic studies that may guide to the implementation of new regional management measures.

I.2 METHODOLOGY AND DATA SOURCES

I.2.1 Global approach

Two sources of data have been used to gather socioeconomic information on the artisanal regional fleet: a survey specifically designed for the purposes of this study, and administrative data from official statistics. Both of them were combined in order to complete respective information gaps. Studies elsewhere using interview data show that this approach can produce highly valuable information for fisheries assessment (Forcada et al., 2010; Neis et al., 1999).

In Asturias, vessels registered in the National Census of the Operating Fishing Fleet (CFO) in the category *Artes menores* (only passive gears – multigears) comprised 233 boats in 2010[6], distributed along 19 ports from where they exploit areas that can be reached in a few hours (see Table 1 in page 7). Furthermore, some vessels from other census categories, mainly bottom longliners (*Palangre de fondo en Cantábrico NW*) may also be allowed with a temporary license to operate with métiers included in the *Artes menores* category upon previous request to the regional fishing administration.

Table 3. Sample design

FISHING PORT	**Sample objective**	**Vessels surveyed, according to CFO categories**					
		Only passive gears or multi-gear (*Artes menores*)	**Longliners**	**Gillnetters (*Rasco*)**	**Bottom trawlers**	**Others[(a)]**	**Total**
Avilés	6	2	1	0	1	0	**4**
Bañugues	4	0	0	0	0	0	**0**
Bustio	3	2	0	1	0	0	**3**
Candás	5	4	0	0	0	0	**4**
Cudillero	26	21	9	0	0	0	**30**
Figueras	3	3	0	0	0	0	**3**
Gijón	10	10	1	0	0	0	**11**
Lastres	7	6	0	0	0	0	**6**
Llanes	5	7	0	0	0	0	**7**
Luanco	13	13	1	0	0	0	**14**
Luarca	22	21	1	0	0	0	**22**
Ortiguera	1	1	0	0	0	1	**2**
Oviñana	6	3	0	1	0	0	**4**
Puerto de Vega	10	10	1	0	0	0	**11**
Ribadesella	5	5	0	0	0	0	**5**
S. J. de la Arena	11	5	0	0	0	0	**5**
T. de Casariego	5	5	0	0	0	0	**5**
Tazones	7	8	0	0	0	0	**8**
Viavélez	5	4	0	0	0	1	**5**
TOTAL	**154**	**130**	**14**	**2**	**1**	**2**	**149**

[(a)] Surveys carried out to presidents of fishermen organizations who did not have any active fishing boat at the time of the survey.

[6] Data referred to June 2010.

In the context of the European project PRESPO[7], a specific sampling was designed and carried out in order to characterise the Asturian artisanal fleet from the socioeconomic point of view. The objective population was the whole artisanal fleet based in Asturias, considering as artisanal both the boats listed under *Artes menores* in the CFO and those listed in other census but fishing with license for *Artes menores*. The main objective was to collect economic, social and operative information from a representative sample of the regional artisanal fleet. It was the first time a systematic process of socioeconomic data collection was made gathering data directly from fishermen in this region. The target was to cover 60-65% of artisanal vessels in the survey (about 154 boats, as shown in Table 3), surveyed directly through face-to-face interviews to ship owners and some ship masters of local fishing guilds (the type of crewmembers who are supposed to better know the economic questions addressed in the survey[8]). The interviews were carried out between May 2009 and March 2010 following a stratified random sampling based on the number of boats per fishing port in order to avoid overestimating the importance of highly located métiers (Silva et al., 2002).

As result, a total of 146 vessels from 18 Asturian fishing ports were interviewed, which implied a coverage of 71.2% of the artisanal vessels with landings in 2009. This sample was also considered to be representative by port: in 13 fishing ports, a sample covering between 40-64% of the local artisanal vessels was surveyed, while in other 2 fishing ports this coverage raised up to 73% and 88% respectively. Finally, only in 3 cases the sample was under the 30% of vessels based in the local fishing port. The questionnaire (see Appendices A and B) was structured in three parts: i) Fishing effort (information regarding days at sea, fishing grounds and gears/métiers carried out (specifying the month/s of the year, main target species, frequency of hauls, and distance from the coast to the fishing areas), ii) Socioeconomic profile (data on incomes -including non-declare revenues and direct sales out of the fishing guilds´ control- and costs' structure of artisanal vessels, as well as social aspects of crewmembers), and iii) Difficulties and potentials (fishermen´s perceptions regarding the main difficulties or constraints faced by the artisanal sector in Asturias and which would be the best management responses to such issues).

On the other hand, official data concerning vessel characteristics (length, tonnage and engine power), type of fishing license, number of days for which each fishing license was granted and annual landings per vessel were provided by the regional fishing administration.

[7] *PRESPO: Sustainable Development of Atlantic Arc Artisanal Fisheries* (2009- 2011). Interreg Atlantic Area Transnational Cooperation Programme 2007-2013, co-funded by the European Regional Development Fund (ERDF).
[8] When necessary, some interviewees were visited more than once to complete information and give them time enough to compile their accountant data.

The data gathered from the surveys were stored in a database, from which a descriptive statistical analysis of each of the sections was made. The assessment of significant mean differences was carried out through t-test for both independent and paired samples, while the identification of significant particularities was based on the analysis of variance (ANOVA) when the requisites of the variables were met. When these requisites were no met (in case of annual incomes and costs data), the log-transformation $x' = log(x + 1)$ was applied. In addition to this, spatial information was integrated into a Geographic Information System (GIS) to get the spatial distribution of some fishing pressure indicators along the Asturian coastline.

I.2.2 Métiers approach

Administrative data on artisanal fishing modalities (licenses) used per day and vessel and daily sales notes[9] of the artisanal fleet during 2009 were exploited together[10]. The regional ministry with competences in marine fishing affairs establishes a series of fishing modalities (licenses), considering as different modalities those similar gears with minor technical differences (i.e. mesh size) and targeting different species. This represent a highly disaggregated regional classification based on local knowledge. Although Asturian artisanal vessels are allowed to alternate between different fishing modalities, they are requested to use just one fishing modality per fishing day and to communicate to the fishing administration any change of modality.

The analysis of both information sources resulted in an integrated database for 205[11] vessels. A matrix was built from this database, whose rows represented daily sales bills per vessel (a total of 14,254 fishing operations or cases), while columns contained information about the vessel, fishing modality, landings weight (per species) and income obtained. It was assumed that daily sales notes correspond to the landings and retained captures for commercial purposes of a single fishing day for the analysed vessels. In addition to this, the survey revealed that some vessels used some of the existing fishing modalities to develop different fishing operations in terms of seasonality and objective species, so further métiers could be identified[12]. This information was confirmed by the analysis of daily sales data.

[9] Commercial information per vessel concerning daily sales at local first-sale fish markets.
[10] Detailed information about total catch, including discards and unsold catches, was not available for this study.
[11] Some of the vessels belonging to the *Artes menores* census category in 2009-2010 (233 boats) were not active and did not register sales in 2009.
[12] Although they were allowed to fish using the same administrative license.

On the other hand, some limitations arose when trying to classify artisanal métiers according to a system as the one included in Decision 2008/949/EC[13] (European Commission, 2008), as its maximum level of disaggregation (six levels) did not allow reflecting all the rich and vast array (amount and variety) of regional artisanal métiers. Thus, this research adopted an alternative framework with higher resolution and level of disaggregation, in correspondence with European DCF.

To assess significant differences, average landed weight and value per daily first-sales among the identified métiers were tested by one-way analysis of variance (ANOVA). However, none of the analyses met the requisite of variance homogeneity (Levene's test for equality of variances) needed to address the ANOVA. Alternatively, a non-parametric Kruskal-Wallis test was applied. To test significant differences in the average technical characteristics demanded per métier ANOVA techniques were carried out; when requisites on normality and homogeneity of variance were not met, log-transformation $x' = log(x + 1)$ was applied (variables as gross tonnage and crewmembers).

I.3 RESULTS

I.3.1 Fishing days and métiers

The comparison between survey responses about annual days at sea (fishing activity) per fishing vessel and the number of days for which each vessel was in possession of a fishing license showed that the annual number of fishing days (days at sea), with an average of 166, is significantly lower ($t = -21.194$, $df = 145$, $P<0.01$) than the number of days for which vessels had a fishing license, with an average of 285 days (Figure 3). Therefore, time possessing an artisanal fishing license is not a good indicator of real fishing effort.

[13] See Appendix IV, North Atlantic Region: ICES areas V-XIV and NAFO areas.

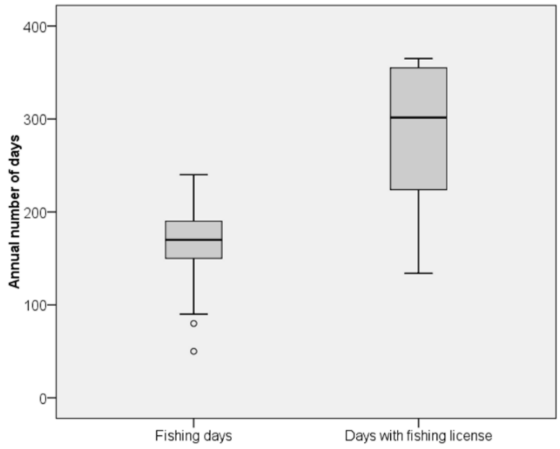

Figure 3. Comparison of fishing days (survey results) and annual days with a fishing license (n = 143 vessels).

Length class (m)	No	Average fishing days	s.d.
<10 meters	83	159	36
≥10 <12 meters	40	171	26
≥12	23	178	27

Table 4. Average fishing days by vessel's length class (n = 146 vessels).

Another interesting relation was confirmed between annual fishing days and vessel's length class (<10m; ≥10m<12m and ≥12m). The three length classes present in the sample show significant differences in their annual number of fishing days (ANOVA, $F = 5.220$, $df = 145$, $P<0.01$). The smallest vessels depend much more on climatic and sea conditions, making more difficult the achievement of a stable income flow and, thus, generating problems of long-term economic sustainability and workforce stability (Table 4).

A total of 21 artisanal fishing métiers were identified[14], using 8 types of fishing gears according to the aforementioned DCF (Table 5). Of these métiers, 18 correspond directly to fishing modalities as established by the regional fishing administration, while 3 new métiers were identified (*Conger* longline, *Nephrops* trammel net and *Homarus* pot). Although these métiers are practiced under some of the existing fishing licenses, they target different species and present slight technical variations, which justifies considering them as a distinct métier.

Table 5. Métiers identified in the Asturian artisanal fleet, according to gear type categories established by the European DCF

Gear type (DCF)	Identified métiers		Target species	No of fishing days in 2009
	Métiers	Local name		
Set longlines (LLS)	*Merluccius* longline	Palangrillo	*Merluccius merluccius*	2,672
	Conger longline[a]	Palangrillo de congrio[a]	*Conger conger*	562
	Dicentrarchus longline	Palangrillo de lubina	*Dicentrarchus labrax*	847
Hand and Pole lines (LHP) / (LHM)	Rod-hook[b]	Pincho-caña[b]	*Merluccius merluccius*	0
	Squid jig-hook	Potera	*Loligo vulgaris*	731
	Rod-hook	Anzuelo para caballa	*Scomber scombrus*	278

[14] Another three métiers linked to bait capture have been identified. However, these métiers have not been included in the analysis as they do not have any commercial interest.

Gear type (DCF)	Identified métiers		Target species	No of fishing days in 2009
	Métiers	**Local name**		
Trammel net (GTR)	*Mullus* trammel net	Trasmallo	*Mullus surmuletus*	902
	Nephrops trammel net[a]	Trasmallo de cigala[a]	*Nephrops norvegicus*	5
	Lophius trammel net	Miño	*Lophius spp.*	3,012
Set gillnet (GNS)	*Mullus* gillnet	Beta salmonetera	*Mullus surmuletus*	629
	Merluccius gillnet	Beta	*Merluccius merluccius*	1,658
	Maja gillnet[b]	Volanta marisquera[b]	*Maja squinado*	0
Driftnet (GND)	Driftnet[b]	Abareque[b]	*Sardina pilchardus*	0
Purse seine (PS)	Purse seine[b]	Cerco de chicharro[b]	*Trachurus trachurus*	0
Pots and traps (FPO)	*Octopus* pot	Nasa pulpo	*Octopus vulgaris*	880
	Maja pot	Nasa marisco	*Maja squinado*	1,203
	Homarus pot[a]	Nasa bugre[a]	*Homarus gammarus*	163
	Anguilla pot	Nasa butrón	*Anguilla anguilla*	3
Miscellaneous	Glass eel	Cedazo	*Anguilla anguilla*	689
	Seaweed	Algas	*Gelidium spp*	0
	Mirror	Espejo	*Maja squinado*	19
TOTAL	***21 métiers identified. 16 métiers currently active***		***11 target species linked to the active métiers***	***14,254 fishing days***

a. Métiers identified through the survey. [b] Artisanal métiers allowed by existing fishing modalities but that were not practiced by the artisanal fleet in 2009. [c] Unlike the Rod-hook métier targeting *Merluccius merluccius,* in the Rod-hook métier targeting *Scomber scombrus* artificial bait us used. [d] *Merluccius merluccius; Conger conger; Dicentrarchus labrax; Loligo vulgaris; Scomber scombrus; Mullus surmuletus; Nephrops norvegicus; Lophius spp.; Octopus vulgaris; Anguilla Anguilla; Gelidium spp.*

The main métiers performed by the Asturian artisanal fleet were *Lophius spp.* trammel net[15] (31% of the fishing days), *Merluccius* longline (19%) and *Merluccius* gillnet (12%). Other important métier were *Octopus* pot, *Maja* pot and *Mullus* trammel net. On the other hand, at least four[16] of the potential métiers were not carried out by the artisanal fleet during 2009 (Rod-hook, *Maja* gillnet, Driftnet, Purse seine), while some others were only used by few vessels (Mirror, *Nephrops* trammel net and *Anguilla* pot). In terms of gear types, longlines were the most used gears (29% of fishing operations), followed by trammel nets (27%) and gillnets and traps (both with 16% of fishing operations).

Fishermen's answers provided by the survey revealed that artisanal fishing patterns have changed significantly over the last years, and it is expected that their evolution will continue through the coming years.

[15] Although trammel net is considered a multi-species métier, *Lophius spp.* represents one of the main groups of target species according to the artisanal fishermen interviewed. Additionally, 2009 registered a high amount of *Lophius spp.* sales, with an important relative weight within the species composition of this métier. For these reasons , a specific reference to *Lophius spp.* trammel net is made.

[16] It is impossible to assess the number of sale notes considered as fishing days for the seaweed recollection métier as these sales are not considered as a fishing resource and, consequently, are no registered on the sales database. However, it is known that just one artisanal vessel operated with such fishing modality in 2009.

Figure 4. Artisanal métiers practiced in the Asturian coastline: Glass eel (top left), Mirror (bottom left), Rod-hook targeting *Merluccius merluccius* (top right) and *Octopus* traps (bottom right)

Certain métiers such as Rod-hook, Seaweed recollection or Purse-seine are practiced only by vessels not belonging to the *Artes menores* census category (that request to operate with artisanal gears temporarily), while other métiers are disappearing in Asturias. As result, only 76% of the identified métiers can be considered active nowadays. Moreover, a trend of progressive reduction in the diversity of métiers practiced by this fleet in the last years has been confirmed: due to changes in fishing strategies and variations in fishermen`s rational behavior to maximize activity´s profitability, in recent times net métiers (as for example *Lophius* trammel net, *Mullus* trammel net and *Merluccius* gillnet) are getting higher presence and replacing other traditional ones.

Finally, in addition to the identified métiers, the goose barnacle (*Pollicipes pollicipes*) recollection is recognized as an important complementary fishing activity for artisanal fishermen in the central and west coast of Asturias, especially from October to April, when other fishing possibilities are scarce. Even though this activity cannot be considered as a métier (it requires other kind of personal fishing license), a large number of crewmembers alternate goose barnacle recollection with other fishing métiers considered compatible[17]. As a consequence, the vessel

[17] Those daily set and hauled, and always practiced in different days as goose barnacle recollection.

remains inactive for certain periods of time when all the crewmembers are dedicated to the recollection activity and the obtained incomes are distributed among the crew[18].

I.3.2 Spatio-temporal activity and métiers alternation

Data about spatial distribution of the fishing activity allowed the estimation of the range of operations (distance from the coast) of the artisanal vessels according to the different gear classes used by this fleet and the classification based on the European Data Collection Framework (European Commission, 2010). Operations using hooks and lines mostly range between 3 and 12 miles of distance from the coastline (Figure 5), although this distance increases beyond the 12 miles for particular objective species (i.e. tuna fishing during summer). On the other hand, fishing activities with nets, traps and other gears (i.e. glass eel fishing) are carried out mostly within the first 3 miles from the coast.

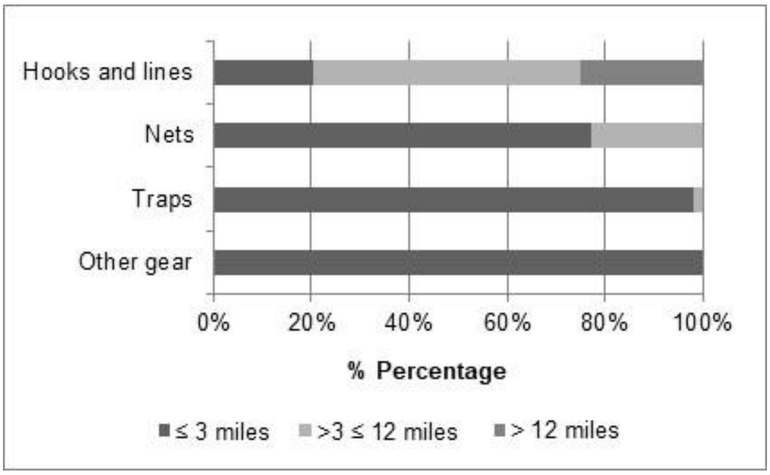

Figure 5. Range of operations of the artisanal fleet by gear class. Frequency of responses (in percentage, n = 145 vessels).

The integration of this spatial information into a Geographic Information System (GIS) has allowed a preliminary assessment of the fishing pressure exerted by the artisanal fleet along the limit of three miles from the coastline, where most of vessels operate (Figure 6). Data confirms that artisanal vessels tend to develop their activity close to the home fishing harbor. As a consequence of a higher density of fishing harbors, fishing grounds in the west coast of Asturias (between Gijón and Viavélez) support the highest fishing pressure in terms of number of active vessels and accumulated engine power (kW) and gross tonnage (GT).

[18] Nevertheless, crewmembers keep the same retribution pattern and benefits share that when they fish using the vessel.

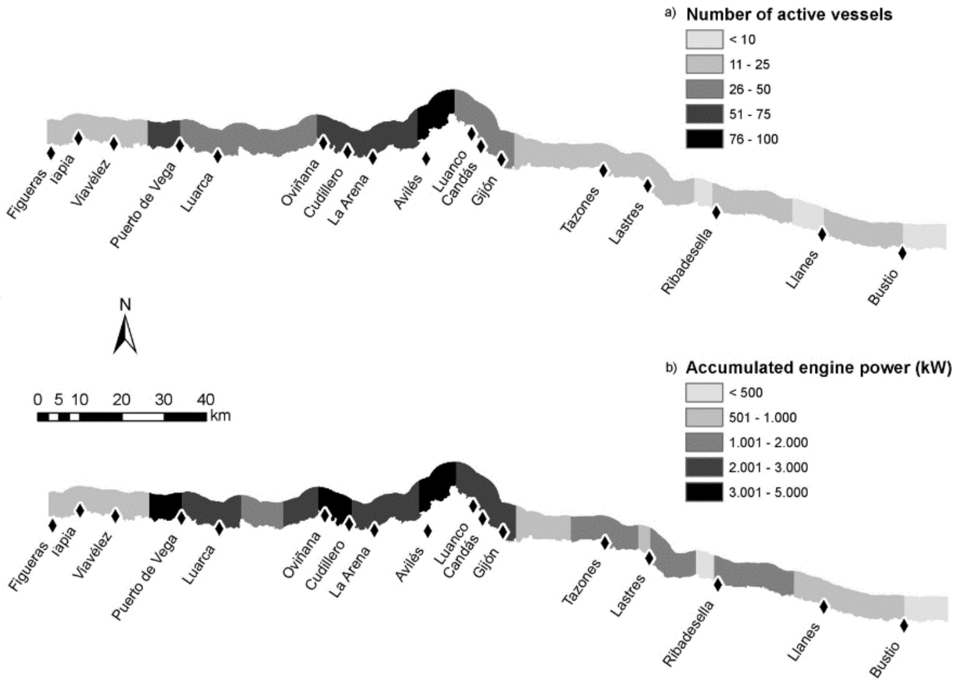

Figure 6. *a)* Number of active artisanal vessels. *b)* accumulated engine power by fishing area (n = 145 vessels).

Artisanal vessels have shown a high degree of alternation between different métiers along the year. Results in Figure 7 confirm the multi-specific and multi-gear character of the Asturian artisanal fleet, as in 2009 the 55% of artisanal vessels practiced 3 or more different métiers. This high flexibility is also observed in terms of fishing gears alternation, with 18.4% of boats using métiers corresponding to 3 or more different gear types. The annual mean number of métiers practiced was 2.89 (with a standard deviation of ± 1.23).These findings reflect that annual fishing effort is distributed among an optimal combination of métiers for each vessel, and a certain degree of substitution effect among métiers exists.

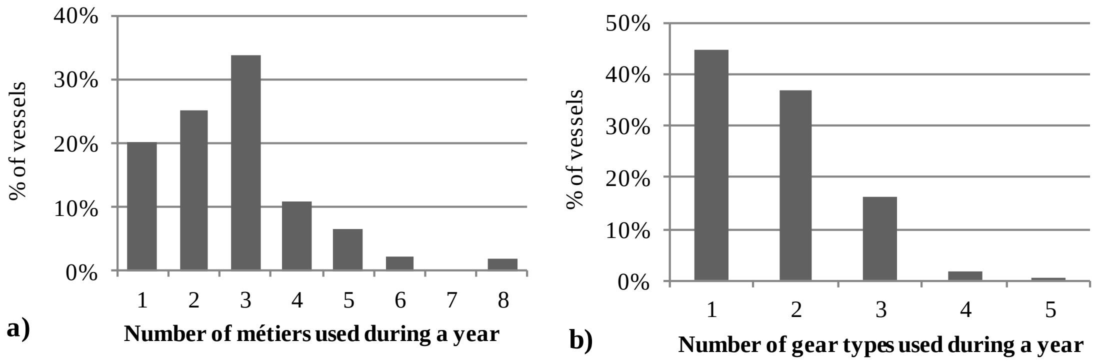

Figure 7. Alternation of gear types and artisanal métiers

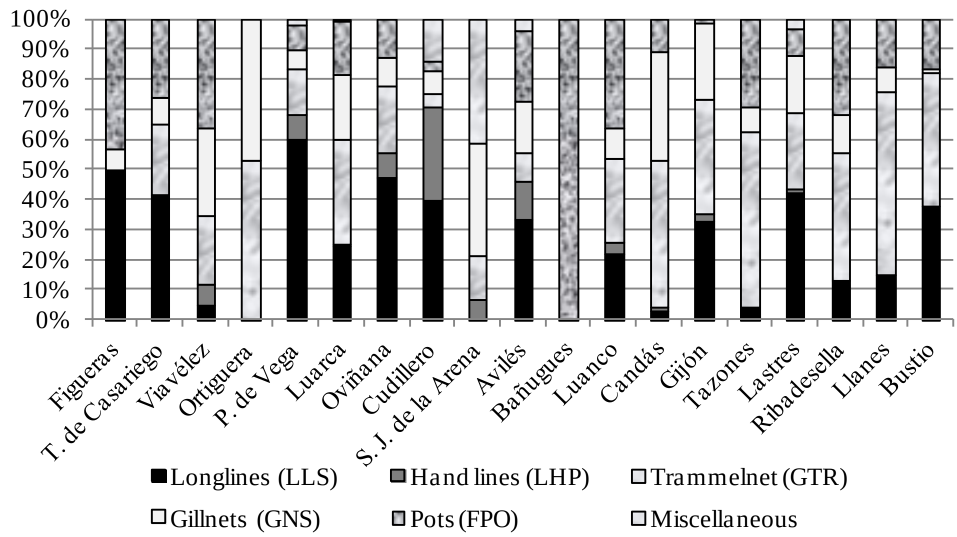

Figure 8. Degree of utilization of different gear types by fishing port (in percentage)

The main métiers in terms of annual number of fishing days (*Lophius spp.* trammel net and *Merluccius* longline) are present along most of the Asturian fishing ports. Most of the ports have local fleets highly diversified (develop a vast array of métiers), although a few of them seem to be specialized (Figure 8) in certain types of fishing gears (i.e. in Bañugues only pot gears are used, while 60% of the fishing operations in Puerto de Vega are carried out using longlines). On the other hand, métiers carried out in shallow waters close to the shore and in estuaries targeting crustaceans (pots and mirror), cephalopods (*Octopus* pot) or anguilliformes (*Anguilla* pot and Glass eel fishing) show a highly seasonal pattern, being generally located in a few ports with a long tradition in the utilization of these type of métiers (Table 6).

These latter métiers (and the mentioned goose barnacle recollection) are a clear expression of the traditional local knowledge on fishing gears performed by the regional fleet, and they also play a fundamental role as a complementary fishing activity during certain periods of the year when, for these vessels and crewmembers, it is not possible to carry out other métiers. This is especially important between January and March, when longlines use to be inactive as the adverse weather conditions do not allow the gear to be operated efficiently.

Table 6. Main characteristics of the artisanal métiers active in Asturias in 2009

Métier	Type of bottom[a]	Average catch (kg) per sale note	Average income (€) per sale note	% of fishing days	No of fishing vessels using it	No of fishing ports	Seasonality											
							J	F	M	A	M	J	J	A	S	O	N	D
Merluccius longline	R, M	70.08	433.97	18.75%	66	16												
Conger longline	R	126.26	304.29	3.94%	33	11												
Dicentrarchus longline	R	75.15	359.26	5.94%	20	8												
Squid jig-hook	R, S	34.23	300.14	5.13%	36	8												
Scomber rod-hook	A	1,468.23	885.69	1.95%	13	7												
Mullus trammel net	R, RT	67.25	240.50	6.33%	22	9												
Nephrops trammel net	M	55.70	387.94	0.04%	2	1												
Lophius trammel net	S, M	72.28	422.93	21.13%	61	16												
Mullus gillnet	S	41.61	240.50	4.41%	16	8												
Merluccius gillnet	S, M	116.24	425.35	11.63%	40	14												
Octopus pot	A	56.42	275.34	6.17%	38	7												
Maja pot	R	31.56	295.65	8.44%	32	16												
Homarus pot	R, RT	29.80	428.19	1.14%	28	12												
Anguilla pot[b]	-	54.66	458.66	0.02%	1	1												
Glass eel[b]	-	4.75	323.85	4.83%	40	5												
Mirror	R	8.64	185.63	0.13%	1	1												

a. Type of bottom (R, rocky bottoms; S, sandy bottoms; M, muddy bottoms; RT, mixture of rocky and sandy bottoms; A, All types of bottoms); Seasonality (no shading, no use or residual use; light grey shading, moderate use; dark grey shading, intensive use). b. Fished on estuaries

I.3.3 Social profile

The mean artisanal fisherman age is 45 years (standard deviation = 8.2 years). The fishermen age distribution compared to that of the working population of Asturias is presented in Figure 9. The artisanal fishing sector presents a higher proportion of older population than the rest of the economic sectors of Asturias (χ^2 = 11.085, df = 4, P<0.05), with most of the interviewees in age ranges over 45 years (55%).

The educational level also differs from that of the working Asturian population (χ^2 = 23.410, df = 3, P<0.01). Results (Figure 10) show that 84.3% of interviewees have at best finished the primary school, while just 15.1% have attained secondary education or vocational training degrees. On the other hand, 62.3% of the Asturian population has accomplished an educational level over primary education.

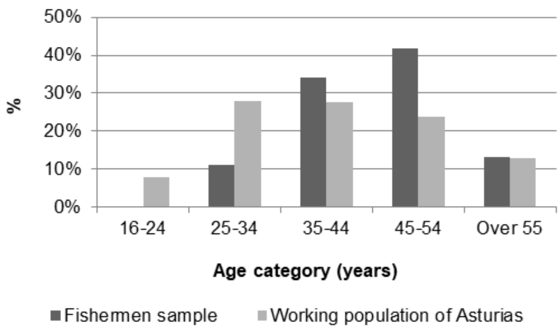

Figure 9. Percentage of the Asturian artisanal fishermen and of the working Asturian population by age category (n = 146 vessels).

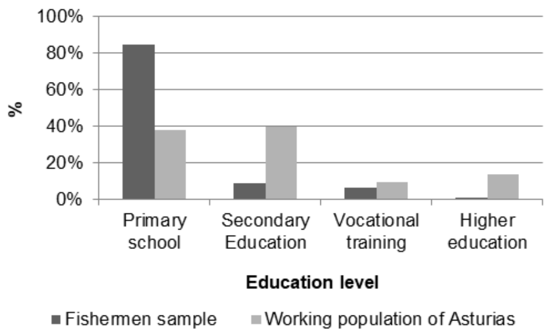

Figure 10. Percentage of the Asturian artisanal fishermen and of the Asturian population by level of education (n = 146 vessels).

In terms of the structure and social organization of the artisanal vessels (Table 7), stands out the fact that 95.5% of the ship-owners work on-board as one more crewmember. As a result, artisanal ship-owners actively participate, and have a deep understanding, of all aspects of fishing related activities: fishing strategies and techniques, management, commercialization, etc. Actually, the vast majority of the ship-owners have direct responsibilities over the management of the financial accounts. Artisanal vessels use to be family owned (40% of the interviewed vessels presented family relationships among its crewmembers), where there is not a clear hierarchy among crewmembers and the retribution system follows an ancient scheme by shares of the net profits[19] (traditionally known as *a la parte*).

Table 7. Social and organizational profile of the Asturian artisanal fleet (n = 146 vessels).

Socioeconomic characteristics	**Affirmative (%)**	**Negative (%)**
Ship-owner works aboard	95.2%	4.8%
Ship-owner manages accounts	92.5%	7.5%
Profit-sharing retribution	100%	0%
Alternative economic activities	0.7%	99.3%
Level of association	100%	0%
Family ties	39.7%	60.3%
Crew from coastal communities	94.5%	5.5%
Generational replacement	17.1%	82.9%

Asturian artisanal fishermen are highly dependent on fishing activities: most of ship-owners (99.3%) stated that the fishing activity constituted their only source of income[20]. This result is in line with a general low level of diversification activities for the artisanal fisheries in several countries of the South-European Atlantic Area (Chapela et al., 2009).

Although a hundred percent of the vessels are associated to their respective fishermen guilds, interviewees declared the inexistence of common trade or sales agreements given the heterogeneity of interests of the associated members. Additionally, most of the crewmembers come from coastal communities close to the fishing port where vessels operate (94.5%); in fact, just 6 of the interviewed vessels had foreign crew on-board, adding up 7 foreign crewmembers in total, which confirms the existence of strong linkages between the artisanal fleet and the regional coastal communities.

Finally, generational replacement perspectives for the artisanal vessels are quite low: just 17% of the interviewed ship-owners stated to have perspectives of passing on the business to younger members of the family. This result has to be analysed in conjunction with the data about the ageing process of the artisanal fishermen and bearing in mind that the artisanal fishing knowledge has been traditionally transmitted from one generation to another. Generational replacement perspectives present significant differences depending on the vessels' length ($t = 4.202$, $df = 50$, $P<0.01$): the longer the vessel, the higher the probability of having a younger family member to take on the activity in the future. This might be due to the fact that longer vessels are

[19] The retribution of the workers takes the form of a proportional share in function of the job position held and the incomes obtained from the catch sales (Guyader et al., 2007; Piniella et al., 2007).

[20] Seasonally, some artisanal fishermen carry out other marine capture activities without using their vessels (as shellfish harvesting), but they cannot be considered as a complementary or alternative source of income because crewmembers of each vessel share these earnings in the same way that the rest of on-board fishing incomes.

less dependent on climatic conditions, and, as a consequence, they are able to generate more stable income flows, resulting more attractive to younger generations. No significant differences have been found in the generational replacement perspectives among the different fishing ports or areas (East and West of Asturias).

I.3.4 Output: landed weight and value per métier

Only eleven species were identified as target for the regional active métiers (Table 5). Although most of them were fishes, several crustaceans (*Maja squinado, Homarus gammarus, Necora puber, etc.*) and cephalopods (*Octopus vulgaris, Loligo vulgaris*) were also recorded. The species with the highest market value was *Anguilla Anguilla* (glass eel), followed by several crustaceans (*Scyllarus arctus, Palinurus elephas* and *Palaemon serratus*); nonetheless, landings of such species are relatively low in terms of weight, although crustaceans total landings are likely higher than official sales registered because an important percentage is commercialized through direct sold (not in fish markets). Thus, other species with lower market prices contributed in a higher proportion to the total income of the artisanal fleet (*Merluccius merluccius, Scomber scombrus, Mullus surmuletus*).

Average weight per sale note was 99.19 kg (s.d. ± 382.78) in 2009, while the average value landed per fishing day was € 396.65 (with a standard deviation of € 454.82). The analysed métiers significantly differed in the average values of both parameters (catches Kruskal-Wallis, χ^2 = 4,246.78, df = 15, P<0.001; incomes Kruskal-Wallis, χ^2 = 862.69, df = 15, P<0.001). *P*-values obtained in the Kruskal-Wallis test (under 0.05) confirmed that significant differences did exist between the analysed métiers in terms of landed weight and value.

The rod-hook targeting *Scomber scombrus* is the métier that generates the highest weight landed and value per fishing day, significantly greater than the rest of métiers (Table 6). Notwithstanding, its use is reduced to a few months (or even a few weeks) between February and May, depending on the migratory patterns of the objective species (*Scomber scombrus)* and, mainly, the existence of Total Allowable Catch (TAC) established at a EU level. On the other hand, the versatility (possibility of been carried out at least 7 months per year), high-catch and income profile of the *Lophius* trammel net and the *Merluccius* longline métiers explain their high degree of utilization by the Asturian artisanal vessels. The significant commercial value (first sale prices) of *Lophius spp.* and *M. merluccius* (about 6 €/kg both species) assures a relatively good income to vessels operating with *Lophius* trammel net and *Merluccius* longline (an average landed value of € 422.93 and € 433.97 respectively per fishing day). Other métiers used through most of the year are the *Conger* and *Dicentrarchus* longline and the *Merluccius* gillnet, that also show relatively high average incomes per fishing day, ranging from € 300 to € 425 (about 2.4 and 3.6 €/kg respectively).

I.3.5 Incomes, costs structure, profitability and other economic indicators

Incomes, costs and profitability were analysed for the three main gear classes (hooks and lines, nets and traps); as economic data from surveys were referred to vessels´s annual activity as a whole, costs and profits could not be determined at métier level. Thus, these analyses were based on a sub-sample of 71 vessels (34 netters, 21 using hooks and lines, and 16 operating mainly with traps) that used just one gear class during all (or almost all) the fishing season.

In order to consider undeclared sales in the artisanal sector, two approaches were applied when estimating fishing incomes: *apparent* incomes based on the official (reported) data about fishing sales provided by the regional administration, and *real* incomes that consider data regarding undeclared sales from the survey, as fishermen were invited to reveal those earnings obtained from unrecorded catches and sales. The reliability of this second type of information for the Asturian artisanal fleet was double-checked: firstly, fishermen´ responses on undeclared sales with a low degree of reliability were excluded from the analyses, and secondly individual responses were specifically checked, showing a high level of coherence and coincidence in terms of percentages of undeclared sales by gear class among those fishermen that agreed to answer.

Apparent incomes significantly differ ($F = 9.340$, $df = 70$, $P<0.01$) depending on the gear type (Figure 11) and range from € 24,189 to € 53,144: average incomes from recorded first-sales at fishing guilds are clearly higher for vessels operating with nets than for vessels operating mainly with hooks and lines or traps. Net gears have as objective species a diversified basket of highly priced fishes (*Mullus surmuletus, Conger conger, Lophius spp., Psetta maxima*, etc.) that allows the maintenance of a constant income flow through the whole fishing season. Opposed to this, traps represent a more selective gear type aimed at particular species during specific fishing periods and, thus, output is more exposed to changes in the exploited biomass.

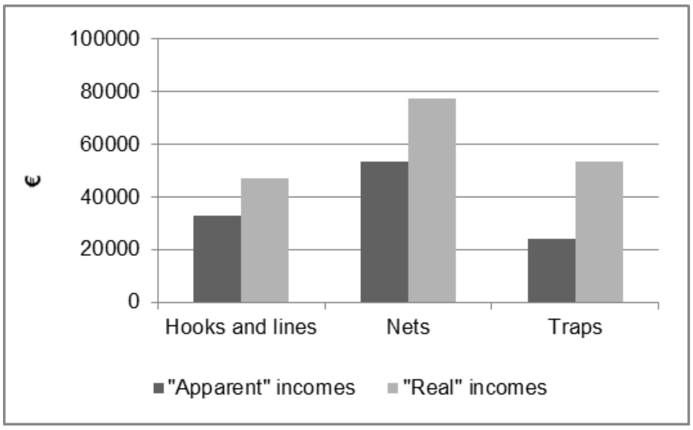

Figure 11. Annual average income assessment by gear class (n = 71 vessels).

Differences by gear type remained statistically significant (F = 6.497, df = 23, P<0.01) for real incomes (including undeclared sales), and earnings range from € 46,757 to € 77,180, being now almost equivalent for hooks/lines and traps. Vessels operating mainly with traps reported the highest level of undeclared sales (Figure 11).

The costs' structure of the artisanal fleet by gear class has been estimated from the economic information provided by ship-owners. Moreover, as it has been stated previously, artisanal fishermen salaries depend on the vessel's incomes, so salaries' costs vary depending whether or not undeclared incomes are considered. The average annual costs of the artisanal fleet and the costs structure in terms of percentage of each item of over total costs are presented in Table 8.

Table 8. Asturian artisanal fleets' costs. Figures without parenthesis represent results from apparent incomes, while results based on estimated real incomes are shown in parenthesis (annual values in euros, n = 71 vessels).

Type of expenses	Hooks and lines		Nets		Traps	
	Average	% of total expenses	Average	% of total expenses	Average	% of total expenses
Variable expenses	**29,801 (36,304)**	**91% (93%)**	**38,066 (55,473)**	**93% (95%)**	**21,034 (38,665)**	**89% (94%)**
Salaries	13,254 (19,757)	41% (50%)	18,162 (35,569)	44% (61%)	9,573 (27,204)	40% (66%)
Social security	3,986	12% (10%)	6,201	15% (11%)	4,152	18% (10%)
Fuel	5,349	16% (14%)	5,458	13% (9%)	3,547	15% (9%)
Bait	4,594	14% (12%)	n/a	n/a	1,362	6% (3%)
Gears' maintenance	1,282	4% (3%)	6,679	16% (11%)	1,313	6% (3%)
Other expenses	1,336	4% (3%)	1,566	4% (3%)	1,087	5% (3%)
Fixed expenses	**2,826**	**9% (7%)**	**2,925**	**7% (5%)**	**2,650**	**11% (6%)**
Insurance	1,423	4% (4%)	1,355	3% (2%)	1,562	7% (4%)
Licenses	775	2% (2%)	726	2% (1%)	483	2% (1%)
Financial consultant	628	2% (2%)	844	2% (1%)	605	3% (1%)
Total operating costs	**32,627 (39,130)**	**100%**	**40,991 (58,398)**	**100%**	**23,684 (41,315)**	**100%**

Total salaries' costs (adding up salaries and social security) constitutes the bigger item of the total costs, ranging between 50% and 75% of the total costs depending on the gear class and whether real incomes are taken into account. Fuel costs are the second item in terms of relative weight, around 10%-15% of the total costs. In terms of costs' typology, results show that variable costs or expenses represent over 90% of the total costs of the artisanal fleet. In general terms, results show that the Asturian artisanal fleet has a highly adjusted cost structure, where the main expense is the remuneration of the crew. Moreover, given the multi-gear character and flexibility of the fleet, current cost's structure can be considered as greatly adaptive, and vessels may vary their fishing strategies in the short-term in order to minimize costs and maximize benefits.

The average annual costs present significant differences ($F = 7.548$, $df = 70$, $P<0.01$) depending on the gear class when only apparent incomes are considered. Netters are the vessels with higher annual costs, followed by boats using mainly hooks and lines and, finally, boats operating with traps. These results are a direct consequence of the income differences, given that salaries (the item with a higher relative weight) depend directly on the earnings. Nonetheless, when real incomes were estimated, annual costs of traps' vessels increased considerably up to a more realistic figure: from € 23,684 to € 41,315. In terms of costs' structure, it was observed that fuel expenses had a higher relative weight for hooks and lines' vessels (14%-16% of the total costs) because of their larger operational distance. Likewise, bait represents a high cost only for vessels operating with hooks and lines, being quite low when operating mainly with traps and inexistent for netters.

Estimates of fishermen´s annual gross salaries resulted from dividing the total salaries' costs by the number of crewmembers. Despite vessels within the hooks/lines class do not present the highest apparent income (Table 9), their income *per* fisherman is higher than in the case of netters as result of having smaller average crew (1.8 vs. 2.8 crewmembers of the netters). On the other hand, the annual gross income per fisherman working on vessels using traps seemed to be the lowest (€ 5,065 per year), although estimated real incomes implied a high reduction in retribution gaps and the annual gross salaries per fisherman raised to € 13,000.

Table 9. Average gross salaries in euros (standard deviation in parenthesis) per fisherman (n = 71 vessels).

Main gear class	Based on estimated apparent incomes	Based on estimated real incomes
Hooks and lines	7,323 (3,342)	12,584 (5,896)
Nets	7,207 (4,015)	13,524 (6,874)
Traps	5,065 (2,896)	13,602 (6,121)

Finally, a number of economic indicators were also estimated: (i) profitability, based on the EBITDA[21], (ii) income return rate[22] and (iii) workforce productivity[23]. If only declared incomes are considered, the apparent profitability (operating surplus) of vessels using hooks/lines and traps would be nearly zero (Table 10), which was considerably lower than the € 12,153 reported by netters and did not seem realistic. However, when stated undeclared incomes were taking into account (estimated real profitability), netters become the most profitable vessels (€ 18,782), but profits provided by traps boost to € 14,635. This figure doubles the operating surplus obtained by hooks and lines' gears, which is clearly lower as a consequence of higher fuel and bait expenses. Workforce productivity could be considered as high for all typologies, ranging from € 13,000 if the indicator was based on apparent incomes to € 28,000 if undeclared incomes were taken into account.

Table 10. Profitability, return rate and workforce productivity of the Asturian artisanal fleet (n = 71 vessels).

Economic indicators	**Hooks and lines**		**Nets**		**Traps**	
	Apparent incomes	**Real incomes**	**Apparent incomes**	**Real incomes**	**Apparent incomes**	**Real incomes**
EBITDA (in €)	67	7,627	12,153	18,782	505	14,635
Incomes return rate	0.00	0.16	0.23	0.24	0.02	0.27
Workforce productivity (in €)	18,063	25,833	18,779	27,272	12,798	28,280

Ship-owners have stated that despite that high yield and income traditionally generated by longlines, bait costs have increased greatly over the last years, pushing down the final profitability of such métiers. As a consequence, many vessels have recently invested in trammel net gears (*Lophius* trammel net) as they present relatively lower exploitation costs.

On average, ship-owners of artisanal vessels have estimated the present value of their business assets (boats, gear, navigation instruments, value of the fishing licence, etc.) at around 115,000, approximately half the asset value estimated by ship owners of bottom longliners and gillnetters .

[21] EBITDA – Earnings Before Interest, Taxes, Depreciation and Amortization
[22]The ratio *EBITDA / Total incomes* expresses the rate of return per income.
[23] Measured in terms of *Total incomes / Crewmembers*.

I.3.6 Inputs: technical and workforce demands per métier

In order to better understand artisanal activity and exploitation patterns, technical and workforce demands per métiers were studied. Both technical and workforce (number of crewmembers) characteristics significantly differed depending on the métiers (Table 11). Rod-hook targeting *Scomber scombrus* presented the higher demands of technical inputs (Figure 12) in terms of vessels total length (12.32 m), engine power (98.9 kW) and gross tonnage (11.55 GT); this is a direct consequence of exploitation patterns, which implies longer distance travels and large captures per fishing day (an average of 1,468.23 kg, Table 6).

Table 11. Summary of the one-way ANOVA for technical characteristics among the artisanal métiers identified[a]

Vessel characteristics	Transformation		Sum of squares	d.f.	Mean squares	F
Length (m)	-	Between groups	15,645.24	15	1,043.02	315.37*
		Within groups	47,089.49	14,238	3.31	
		Total	62,734.73	14,253		
Engine power (kW)	-	Between groups	1,796,675.25	15	119,778.35	105.91*
		Within groups	16,102,276.83	14,238	1,130.94	
		Total	17,898,952.08	14,253		
Tonnage (GT)	ln(x + 1)	Between groups	56,611.49	15	3,774.10	152.42*
		Within groups	352,543.27	14,238	24.76	
		Total	409,154.76	14,253		
Crewmembers	ln(x + 1)	Between groups	2,520.76	15	168.05	230.58*
		Within groups	10,022.15	13,751	0.73	
		Total	12,542.91	13,766		

a. n = 14,254 (13,766 for crew members' analysis); d.f., degrees of freedom; F, F-Ratio, P, level of significance (*p<0.001). A dash (-) indicates no transformation.

Vessels targeting mainly crustaceans and glass eel presented the opposite typology: small vessels with low gross tonnage, engine power and crewmembers that develop their activity in shallow waters close to their respective fishing ports. Such small vessels may find difficulties to assure a stable income level throughout the year, as they focused on highly seasonal métiers and vessels´ characteristics may limit the capacity of performing other métiers for which different technical characteristics are required. In general terms, it can be observed that vessels using trolling lines show the highest technical parameters, followed by vessels using trammel net métiers, gillnets, longlines and, finally, pots and other gears.

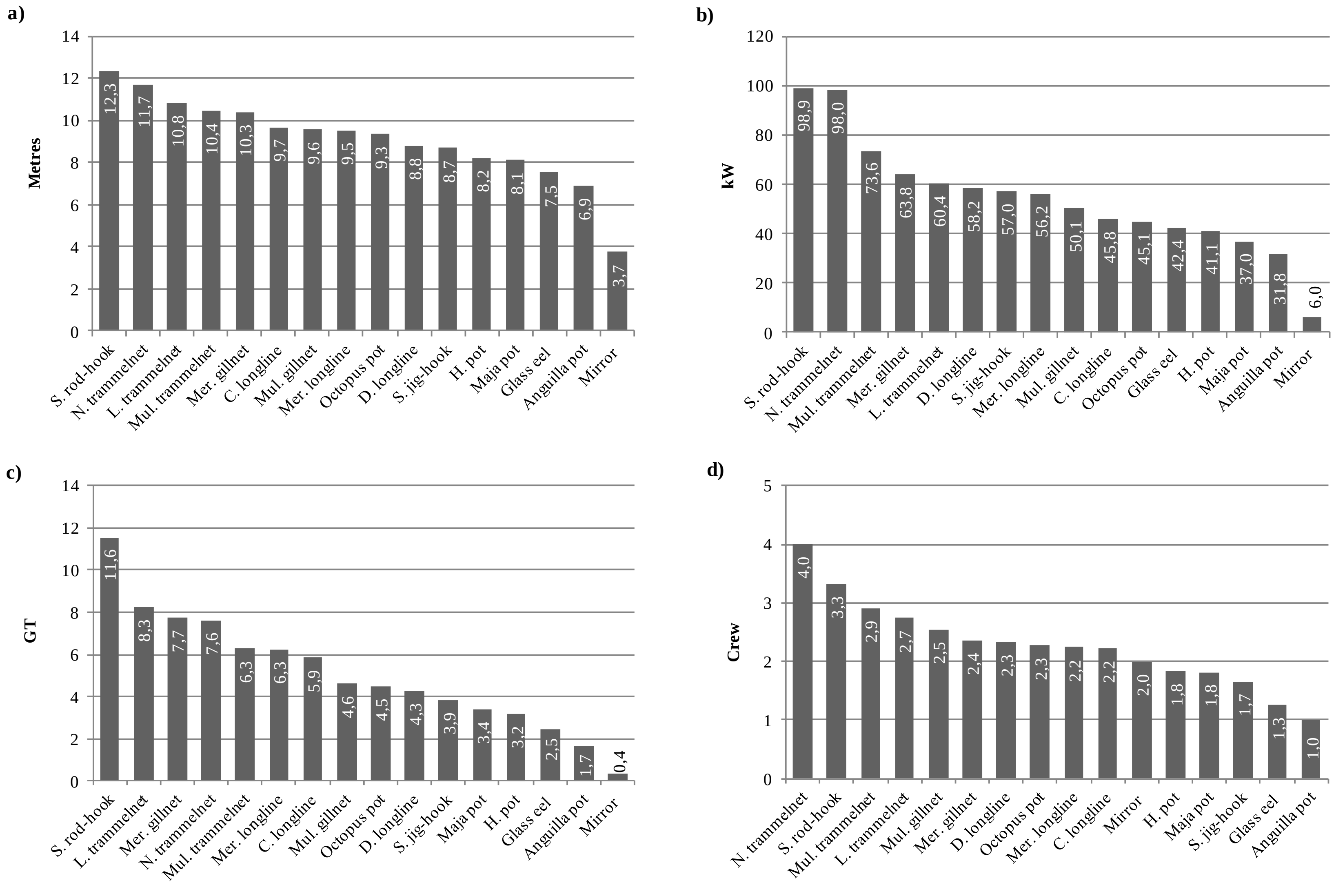

Figure 12. Average input demands of artisanal vessels per métier: (a) total length, (b) engine power, (c) tonnage and (d) crewmembers.

I.3.7 Fishermen´s perceptions

As it has been previously underlined in other studies (Freire and García-Allut, 2000; Hall and Close, 2007), Asturian artisanal fishermen did not find themselves identified with many of the existing fishing policies since, in general, they considered that their needs, views, characteristics and traditional knowledge were not properly reflected by the legislation and coastal management measures. According to survey responses, Asturian fishermen believed that the low level of first-sale prices was the main problem faced by the artisanal fleet (as stated by 77% of the interviewees), jeopardizing the economic viability of the activity (Figure 13). They also highlighted the lack of generational replacement perspectives as one of the main problems to achieve the desired long-term sustainability (19% of the responses). According to the sector’s opinion, this problem was aggravated by excessive training requirements and administrative constraints to recruit new and young fishermen. Other problems stressed by the artisanal fishermen were the excessive control over the artisanal fleet compared to industrial fisheries and the overexploitation of marine resources.

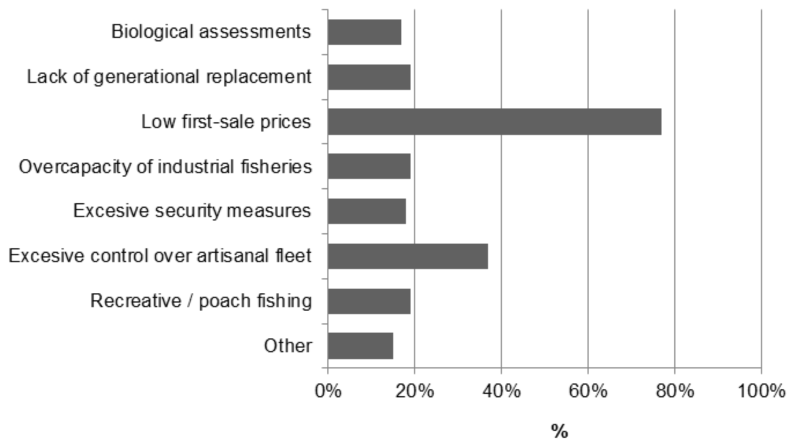

Figure 13. Main problems affecting the artisanal fleet identified by the own sector. Frequency of responses (in percentage, n = 146 vessels).

In terms of the solutions suggested (Figure 14), over 50% of fishermen´s responses highlighted the need of adopting measures aimed at increasing first sale prices and promoting economic diversification. Although the own sector put in place some measures aimed to respond to these demands, the surveying process revealed that the fishing sector lacked the knowledge, know-how and necessary resources to develop such initiatives by their own means. Artisanal fishermen also asked for an increasing biological knowledge of exploited species, taking into account local and traditional knowledge, and the implementation of co-management strategies.

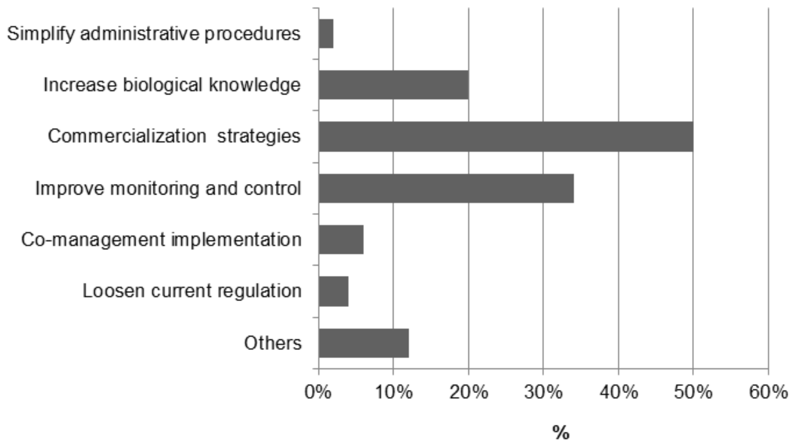

Figure 14. Main management measures suggested by the artisanal fishing sector in order to improve the sustainability of the activity. Frequency of responses (in percentage, n = 146 vessels).

I.4 DISCUSSION

Findings on the annual days of activity (166 days on average) of the artisanal vessels are in line (163 days) with results in other case studies from some South Europe artisanal fisheries (Portugal, France and Greece) shown in Guyader et al. (2013), having confirmed that licensed periods can not be used as a good proxy of the real fishing effort in Asturias. The large number of métiers identified in this study (21 métiers, 16 of which were active) is a consequence of the coastal, close-to-port character of the Asturian artisanal fisheries, as the use of fixed fishing gears in coastal areas, where seasonal environmental variability and spatial heterogeneity are high, promotes the diversification of fishing tactics (Forcada et al., 2010; Tzanatos et al., 2006b). Distances from the coast where the regional artisanal fleet operates have resulted slightly smaller than those of other Spanish artisanal fisheries (Piniella et al., 2007).

The relation between vessels' length and days of activity confirms, as expected, that smaller fishing boats depend more and are more exposed to external meteorological conditions. As previous studies have underlined (Guyader et al., 2013, 2007), probably days at sea are also limited by the time spent by artisanal fishermen developing on their own other related activities (sales, gear maintenance, etc.). Regional results also show significant differences in the technical characteristics of vessels depending on the performed métiers. Although other South-European regional studies have found out that métiers are independent from vessel size (Tzanatos et al., 2005), most of the literature highlighted existing relationships between vessels' size, other technical characteristics and the type of métiers used by small-scale boats (Forcada et al., 2010; Guyader et al., 2013; Le Pape and Vigneau, 2001; Tzanatos et al., 2006b).

As in another artisanal and small-scale fisheries in South Europe (Battaglia et al., 2010; Colloca et al., 2004; Forcada et al., 2010; Freire and García-Allut, 2000; Jabeur, 2000; Tzanatos et al., 2006b, 2005), the high level of annual rotation of fishing métiers in the Asturian vessels confirm that polyvalence is one on the most important features of these fleets, representing the fishermen´s ability to adapt, up to some extent, to dynamic environmental conditions and to different presence of resources in order to ensure stability in landings and sustain returns throughout the whole year. On one hand, it implies that certain substitution degree does exist among some métiers, so that in those cases, a percentage of negative effects from changes in fish stocks, limitations of captures or increases in costs can be softened by changing to another fishing métier. On the other hand, developing métiers with low possibilities of substitution introduces rigidity in fishing strategies and reduces adaptation possibilities for the fleet, which should be considered by managers when, for example, designing subsidies. As it was found, the smaller vessels have constraints to redistribute their fishing effort, especially in those periods of worst weather conditions: in this contexts, some of the artisanal métiers identified (i.e. the glass eel fishing and the goose barnacle (*Pollicipes pollicipes*) recollection), play a fundamental role as alternative fishing activities during certain periods when it is difficult and unprofitable to carry out another métiers (i.e. first months of the year when longlines use to be inactive because of bad weather conditions). In terms of sustainable management of artisanal fisheries, this kind of métiers should be prioritized by sectoral support measures, as they have strong socioeconomic effects at a local scale, play an important subsidiary role in such periods (when other métiers cannot be practiced) and contribute, as a result, to the stability of artisanal fishermen revenues along the year.

The high alternation between different métiers and gear types along one fishing season shows that Asturian artisanal vessels decide on the métiers` choice in two time scales: daily or weekly (short-term) and annually (long-term), when they have to make investments in fishing gears. As it has been underlined by (Tzanatos et al., 2006b), in the short-term the choice of fishing tactics or métiers depends on multitude of factors: recent yield and income, market demand and price, seasonal availability of fishing grounds, tradition, skippers' experience, rumors about other fishermen yields, etc., so changes in the biological or economic conditions results in a rapid redistribution of the fishing effort of artisanal fisheries (Holland and Sutinen, 1999). Fishing long-term decisions (fishing strategies) are affected by different considerations: fishing patterns within the Asturian artisanal fleet are changing significantly in the last years, and some of the identified métiers are nowadays in disuse or barely employed. Although the final choice of available gears may be limited by the lack of experience in some of them (Salas et al., 2004) ship-owners mainly face a cost-benefit assessment regarding what would be the best investment in fishing gears. According to the interviewing process, the Asturian artisanal fleet is tending to concentrate their activity on net gears, which in turn provide the highest net profit rates according to this research (surpassing artisanal métiers based on hooks and lines and traps).

As most of artisanal fisheries across Europe (Forcada et al., 2010; Freire and García-Allut, 2000; Guyader et al., 2013; Merino et al., 2007; Piniella et al., 2007; Puente and Astorkiza, 2002), the social characterisation has remarked that Asturian artisanal vessels are defined as small capital investment units made up of few fishermen with a weak hierarchical organization, where the owner works on-board and it is common the existence of family relations between the crewmembers, most of them natives from nearby coastal communities. Fishermen´s ageing and their low level of education are also frequent (Battaglia et al., 2010; Guyader et al., 2013; Puente and Astorkiza, 2002; Tzanatos et al., 2006a). As it has been remarked by the amazing low level of alternative economic activities that Asturian artisanal fishermen have admitted to carry out, this social profile severely difficults the development and implementation of diversification activities that would contribute to reduce fishing effort, ensuring a sufficient income flow to artisanal fishermen. Actually, the own fishermen highlighted the difficulties faced when they have tried to implement new commercialization and diversification strategies. Although this fact contrasts with findings from other South European artisanal fisheries (Battaglia et al., 2010; Bowen and Riley, 2003; Forcada et al., 2010), where it is usual that artisanal fishermen develop alternative economic activities in order to complement the incomes generated through the fishing activity, other recent studies (Chapela et al., 2009; Guyader et al., 2007) have outlined that socioeconomic diversification of artisanal fisheries in the European Atlantic Area is relatively recent, hampered by the uncertainty arising form an ambiguous regulatory framework.

Estimates of real incomes or Asturian artisanal fleet (including undeclared sales) ranged from € 46,757 to € 77,180 per boat and year, results that are in line with the gross revenues per boat found by Guyader et al. (2013, 2007) in artisanal fisheries of Portugal, France and Greece (average around € 57,509). On this basis, annual costs of vessels increase considerably up to a realistic figure (from € 23,684 to € 41,315). In terms of costs’ structure, fuel expenses have a higher relative weight for hooks and lines’ vessels (14%-16% of the total costs) as a consequence of their larger operational distance, while bait represents a high cost only for those vessels operating with hooks and lines (quite low when operating mainly with traps and inexistent for netters). These findings are similar to those presented by Puente and Astorkiza (Puente and Astorkiza, 2002) regarding the costs' structure by vessels typology (longliners, netters and traps) of the Basque artisanal fleet. In addition to this, annual gross salary per artisanal fisherman in Asturias (about € 13,000) are similar to those reported by other South European studies (Battaglia et al., 2010; Puente and Astorkiza, 2002; Tzanatos et al., 2006a).

Workforce productivity levels for the Asturian artisanal fleet, taking into account real incomes, ranged between € 25,833 and € 28,280 depending on the gear type, resulting a bit lower than productivity of labour estimated by Guyader et al., (2013, 2007) (€ 34,000 on average), although these studies also addressed bivalves fisheries carried out by dredges, which are characterised by higher first-sale prices than most of species usually caught by the Asturian fleet. In any case, estimated real profitability is barely able to allow the economic viability of this activity, especially taking into account that the net operating result still has to pay off the depreciation and amortization of capital investments; this may represent an entry barrier for new artisanal vessels (Colloca et al., 2004), explaining the observed reduction of the artisanal fleet.

Finally, a deeper understanding of local and traditional knowledge confirms the interest of promoting an active participation of the artisanal fishing sector in the decision-making process (co-management) to engage the own sector as co-responsible for the conservation and sustainability of the exploited fishing resources (Rivera et al., 2014). Regional artisanal fishermen are aware of the main problems and constraints affecting the artisanal sector and demand an active participation in the potential management measures that may be put in place to overcome such difficulties. Moreover, local knowledge provided by artisanal fishermen may be able to broaden and complement existing scientific knowledge (Consejería de Medio Rural y Pesca, 2011; Freire and García-Allut, 2000; Hall and Close, 2007; Neis et al., 1999) and, therefore, it could play an important role in artisanal fisheries' management.

I.5 CONCLUSIONS

The aim of this Chapter has been to improve the knowledge and available information about the Asturian artisanal fleet (northern Spain), focusing on its social characteristics, economic performance and different aspects of its fishing activity. New and detailed socioeconomic data on artisanal vessels have been collected and analysed, mainly based on an exhaustive interviewing process to a wide sample of regional artisanal fishermen and the joint exploitation of different data sources generated by the regional fishing authorities. This research has involved over 230 vessels (205 vessels with sales in 2009) that represented around 70% of the whole Asturian fleet in 2010.

The small-scale fishing fleet belonging to the Spanish census category *Artes menores* is the most representative of what can be considered artisanal fishing in Asturias. However, artisanal métiers can be carried out by vessels from other census categories (mainly bottom longliners). While the average number of days with small-scale fishing licences was 252 in 2009, the average number of actual fishing days was 164, and the relationship between length and fishing days was found to be significant: the longer the vessel, the greater the opportunity to go fishing. Vessels using nets, traps, squid jig-hook and glass eel gears usually fish less than 3 miles from the coast, while the ones using hooks have a much greater range of operations (dependent on the mobility or location of the target species). The fishing grounds of the central-western coast of Asturias (between Gijón and Viavélez) within 3 miles are those that receive the greatest influence from fishing ports. Especially, the coast between Cabo Peñas and Cabo Vidío is the one with the highest artisanal fishing pressure (number of fishing boats and accumulated power and tonnage).

The high richness and variety of artisanal fishing activities carried out by Asturian vessels has also been noted, confirming the multi-art and multi-species character of most of them. This fleet retains a unique human capital and traditional knowledge based on experience and generational learning. In correspondence with categories of licenses established by the EU and the regional administration, 21 artisanal métiers were identified, some of which are already in a stage of abandonment. Findings reflect that annual fishing effort is distributed among an optimal combination of métiers for each vessel, according to boats characteristics, expected annual profitability and fishing possibilities in the area, given the existing regulatory framework, so there is some margin of flexibility to adapt fishing decisions to changes in fish stocks, limitations of catches or increases in costs. Nevertheless, artisanal fishing patterns within Asturian fleet have changed significantly in the last years, and some of the identified métiers are nowadays in disuse or barely employed: as nets register lower exploitation costs than hooks, lines and traps, many vessels have recently invested in trammel net gears (*Lophius* trammel net). Goose barnacle recollection represents another important métier: although it is not operated from vessels, it is a complementary fishery for many small-scale fishermen in the centre and west of Asturias during the winter months when fishing opportunities with other gears are reduced.

Nets the most widely used gears, followed by hooks/lines, traps/pots and other gears. Analyses have shown that the higher degree of use of net gears is due to their higher current profitability compared to the other gears (pots/traps and ultimately hooks). The analysis of rotation between métiers has confirmed that one third of the vessels use to alternate with 3 métiers during the year. Results by vessel typology have confirmed the existence of significant differences in terms of inputs needed for production depending on the performed métiers. Additionally, although the average landed weight was 99.19 kg and the average landed value was € 396.65 per sale note in 2009, there are significant differences between artisanal métiers.

This research has also gathered novel information on undeclared incomes that has allowed for the first time a realistic estimation of both apparent and real revenues and profits. Findings on apparent incomes have showed the existence of significant differences between different vessels typologies. However, when estimated real incomes are taken into consideration these differences among the main gear types are mitigated. On the other hand, costs' analysis has stressed out that most of the artisanal vessels' expenses are devoted to remunerate the crew. The rest of the operating expenses are reduced and do not have a significant weight on the overall operating costs. The factor that limits profitability in the fleet is income (low prices at first sale), which acts as an entry barrier to the incorporation or renewal of the vessels. However, it has been confirmed that there is a significant difference between the apparent profitability (calculated on the basis of turnover from first sale at auctions), and the real profitability (which includes a percentage of undeclared income estimated on the basis of the replies provided by the sector itself).

From a social-labour point of view, artisanal vessels in Asturias work as micro-companies with an average crew of 2 people, where in 95% of cases the owner is part of this crew, developing the role of worker, manager and marketer. Moreover, in almost 40% of small-scale fishing vessels there are still family ties among the crewmembers, and 95% of the crew come from the coastal areas near the base port, maintaining a strong link between the artisanal activity and the coastal communities. Other particularities are reflected in the ownership and remuneration system: most of the artisanal multi-gear vessels belong to self-employed workers (75%) or small businesses registered as a joint ownership (22%); in 100% of the cases, moreover, the remuneration system is the so-called *a la parte* (equal remuneration for all crewmembers that varies each month according to sales, once the vessel's fixed costs have been deducted). Probably the most relevant social problem is the lack of generational replacement, a consequence not only of the low expected profitability, but also of the hard working conditions, the low dignity of the sector and the increase in recent times of employment opportunities in sectors such as construction and tourism.

CHAPTER II. ANALYSING THE IMPACT OF THE ARTISANAL FLEET ON THE REGIONAL ECONOMY

II.1 INTRODUCTION AND LITERATURE REVIEW

Artisanal fisheries constitute an important source of employment, income and food to millions of people from coastal communities worldwide, as well as a fundamental cultural and traditional identity factor at a regional level (Béné et al., 2005). Most of artisanal fisheries present a number of important strengths and potentials: high level of environmental sustainability (Santos-Martín et al., 2015), relative high labour demands, good fitting into the principles of development, maritime and environmental European policies, specialization on high-valued sea products with recognized quality, and flexible and adaptive production patterns (multi-gear polyvalent vessels) that provide non-seasonal income and employment for many coastal communities. As result of being an activity with key social and economic linkages with coastal communities of European maritime regions as Asturias, they are expected to play a key role in the *blue growth* of these regional economies in the future. Although fishing sector usually has a low weight in terms of total contribution to aggregate GDP and Gross Value Added generation, its impact is highly concentrated in certain coastal areas. Additionally, artisanal fisheries are a fundamental cultural and traditional identity factor for coastal communities (Johnson et al., 2018). As the European Commission recognizes (DG MARE, 2013), EU policies support[24] and the assessment of their effectiveness needs a deep understanding of the context that surrounds local decisions about fisheries, so socio-economic indicators must be used to assess the performance and impacts of sectoral policies.

As it was concluded in Chapter I concerning the Asturian case, artisanal fleets have distinctive features with regard to industrial fishing and the rest of the harvesting sector; this requires implementing specific planning and management measures[25] (Freire and García-Allut, 2000), designed on the basis of a proper knowledge of their situation, their contribution to the generation of income and employment in coastal regions, and the role played in the integrated development of coastal areas taking into account the complex interactions between the human and the natural dimension within these fisheries (Bowen and Riley, 2003). Nevertheless, European artisanal fisheries represent an area of marine and fishery science that has been largely ignored. In spite of their dimension, detailed and high-quality information about artisanal fleets is limited and,

[24] Mainly the Common Fisheries Policy (CFP), but also the cross-sectoral Integrated Maritime Policy (IMP), environmental and regional policies.
[25] Concerning issues as subsidies, supports to investments and training, definition of spatial fishing rights, criteria for allocation of fishing capabilities, promotion of diversification activities, etc.

generally, little attention has been paid to their social, economic and cultural characteristics and relevance. This issue has traditionally hampered the application of fitted, based-on-knowledge sustainable and integrated management measures to these fleets, reducing the chance of developing effective and integrated management measures to enhance their situation. Unfortunately, there is also little empirical quantification of the socioeconomic impacts of artisanal fleet's activity in Europe and their entire contribution to coastal regions and communities' growth and development.

Due to this lack of information, in Europe many previous characterisation studies have been focused on outlining the differences between artisanal and non-artisanal fishing fleets (Colloca et al., 2004; Fundación CETMAR, 2008; Puente and Astorkiza, 2002; Tzanatos et al., 2006a). Other studies have focused on profitability analysis of the harvesting sector (STECF, 2014) or have been mainly focused on employment (Arthur et al., 2011; Natale et al., 2013; Salz et al., 2006). The aforementioned studies conclude that this activity represents a relevant percentage of the total contribution of the fishing and aquaculture sector to the generation of employment and income, and this impact is expected to be higher at a local scale because the activity is concentrated on certain coastal areas highly dependent on it.

Input-Output (IO) modelling can be considered as a useful framework in policy analysis to identify strategic sectors and quantify their whole contribution to the economy [see Miller and Blair (2009) for an exhaustive recent description of IO methodology]. There is recent literature on marine and fisheries economics that uses IO analysis to describe and quantify the importance of fishing and aquaculture industries and how much employment and value added depend on them (Goulding et al., 2001), or to evaluate the economic importance of fishing industries in a national economy, as in Kwak et al. (2005) for Korea and Morrissey and O'Donoghue (2013) for the case of Ireland.

For the specific case of Spain, some previous studies applied an IO-based methodology focusing on the region of Galicia (Northwest Spain), which is one of the most fishing-dependent regions in Europe. Fernández Macho et al. (2006) constructed Social Accounting Matrices (SAM) to quantify the importance of the fishing sector within the regional economy in 1999.[26] Surís-Regueiro et al. (2014) based on the IO table of Galicia in 2005 to quantify the importance and socio-economic impacts of fisheries and aquaculture activities, although the results of this study circumscribe to the urban area of the Ría de Vigo (the most populated city in Galicia). More recently

[26] See Pyatt and Round (1985) for an extensive description of the methodology for constructing and analysing Social Accounting Matrices.

these authors (Garza-Gil et al., 2017) used the IO table of Galicia 2011 to quantify the contribution of marine commercial fishing and aquaculture to the regional economy. Older studies in the same area (García Negro, 2003) used the IO 1999 framework in Galicia to analyse the whole value chain of the fishing sector (harvesting and processing).

Although applying this methodology is feasible when the analysed sectors are clearly delimitated in the sectoral division of IO tables (as, for example, the whole fishing industry), its application for the particular case of artisanal fisheries is not straightforward, since this activity is not specifically distinguished from the vast array of marine industries in national or regional accounts. In the present research this application has been possible thanks to several results from Chapter I: the economic and operational data from the regional survey and the analysis of fishing métiers have now allowed to segment the artisanal fleet, to estimate some needed magnitudes such as exports, and to correct disparities that arise when official values of fishing production are compared on the supply and demand side, as explained throughout the following Sections.

This Chapter is aimed at applying a methodology to isolate the importance of artisanal fisheries sector in an economy. The method is based on IO analysis and applies a disaggregation procedure that allows for distinguishing the activity of artisanal fleets when this information has been previously aggregated into one of the sectors observable on an IO table. The application of this methodology is illustrated by using the case of Asturias. The Chapter is structured as follows: Section II.2 two depicts the characteristics of the methodology to be applied. Section II.3 describes the data used for the empirical exercise, as well as the process to link and integrate them according to the analytic requirements of IO table structure. Section II.4 shows the results, quantifying the impact of the artisanal fleet´s activity on the regional economy in terms of estimates of multipliers for output, value added and employment. Section II.5 contains a discussion about the relevance of this study and the methodological approach for the future of artisanal fishing fleets under the new CFP, emphasizing the advantages and challenges of the method proposed. Finally, Section II.6 provides the concluding remarks.

II.2 METHODOLOGY

II.2.1 The basic IO model

The main objective of an IO model, as originally developed by Leontief (1936), is to study the interdependence among the different sectors in any economy. This tool holds upon a very simple, yet essential notion, according to which the output is obtained through the consumption of inputs which can be, in their turn, the output of other industries. Assume that the economy can be categorized into n sectors. If the total output (production) of sector i is denoted by x_i, z_{ij} represents sales by sector i to sector j and y_i the total final demand for i, then it can be written $x_i = \sum_{j=1}^{n} z_{ij} + y_i$.

The basic IO model assumes that the output produced in one industry j (x_j) and the intermediate inputs (z_{ij}) from industry i that this industry j needs to produce its output are related linearly. These proportional relationships are reflected in the technical coefficients $a_{ij} = z_{ij}/x_j$. In an economy with n sectors, the vector containing the outputs used as intermediate inputs is defined by the product $\mathbf{Ax}$, where $\mathbf{x}$ is the $(n \times 1)$ vector of output by industry and $\mathbf{A}$ is the $(n \times n)$ matrix with technical coefficients. This yields $\mathbf{x} = \mathbf{Ax} + \mathbf{y}$, in which $\mathbf{y}$ is the vector with the final demands by industry. By reordering terms, the so-called open Leontief model is derived:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \mathbf{Ly} \tag{1}$$

Equation (1) presents the matrix $(\mathbf{I} - \mathbf{A})^{-1} = \mathbf{L}$ that contains the output multipliers. Its typical element l_{ij} accounts for the additional output in sector i produced as a consequence of a unit change in the final demand for industry j. A multiplier quantifies the potential of a sector to pull other through its demand for intermediate goods and stimulating, in turn, the activity of such sector. In this sense if a small sector acquires a relatively large amount of intermediate goods, could present a high multiplier.

Even when output multipliers are interesting to quantify the impact in the production generated by changes in the final demand of the different industries, multipliers concerning other economic indicators are of interest as well. Employment multipliers can be derived following the same IO modelling simply by defining a coefficient of labour required by unit of output as

$c_j = n_j / x_j$, where n_j represents the units of labour in industry j. Equation (1) can be extended to account for such multipliers as:

$$\mathbf{n} = \hat{\mathbf{c}}\mathbf{x} = \hat{\mathbf{c}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \mathbf{M}\mathbf{y} \tag{2}$$

where $\hat{\mathbf{c}}$ is a diagonal matrix with elements c_j on the main diagonal and zeros elsewhere. By summing over the elements in columns of $\mathbf{M}$ it is possible to quantify the change experienced in employment as a consequence of changes in the final demand (employment multipliers).

Finally, Gross Value Added (GVA) multipliers were estimated following a very similar procedure to equation (2). In this case, the value added multipliers are calculated by summing over columns in matrix $\boldsymbol{G} = \hat{\mathbf{v}}(\mathbf{I} - \mathbf{A})^{-1}$ in the following expression:

$$\mathbf{g} = \hat{\mathbf{v}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \mathbf{G}\mathbf{y} \tag{3}$$

where $\hat{\mathbf{v}}$ is a diagonal matrix with elements $v_j = g_j / x_j$ on the main diagonal and zeros elsewhere and g_j represents the GVA in industry j.

II.2.2 A model for sectoral disaggregation

Wolsky (1984) developed a simple in essence procedure to construct a more disaggregated IO model from an available "*(…) but too highly aggregated model*" and additional information about the sectors previously merged. As Lenzen (2011) has recently shown in the context of environmental analysis, dealing with disaggregated IO models is preferable to work with more aggregated databases. Although later authors have developed different extensions of this method (Gillen and Guccione, 1990; Lindner et al., 2012), Wolsky´s formulation remains as a reference when exact disaggregation is aimed and rich information on the disaggregated sectors is available.

The following description is focused on the so-called augmenting and distinguishing stages of Wolky´s procedure. As the author explicitly acknowledges, Wolsky´s model pays attention to the particular but most frequent problem of disaggregating one sector into two. The aggregated model is represented by a technical coefficient IO matrix ($\mathbf{a}$) with dimension ($n \times n$) that describes a certain economy with n sectors. Taking this as a basis, let ($\mathbf{A}$) be the ($n + 1 \times n + 1$) technical coefficient matrix that describes the same economy but embodies $n + 1$ sectors, as result of the disaggregation of the last sector of $\mathbf{a}$ into two different sub-sectors (*disaggregated* model). Thus, the first $n-1$ sectors are identical in both matrices (*common* sectors), being the last n and $n+1$ sectors in $\mathbf{A}$ the new (disaggregated) ones.

Total output of a sector i is denoted by x_i^a for the aggregated model and by x_i^A for the disaggregated one, so $x_i^a = x_i^A$ for the $n-1$ common sectors. Wolsky (1984) and more recently other authors (Barrera-Lozano et al., 2015) that have followed his work assume that total outputs of the disaggregated sectors are usually known or can be inferred from statistical agencies or sector associations. Thus, it is possible to define the scalars w_1 and w_2 as the ratios of the output of the new disaggregated sectors in matrix $\mathbf{A}$, respectively, over the total output of the original (to be disaggregated) sector in matrix $\mathbf{a}$. More specifically:

$$w_1 = \frac{x_n^A}{x_n^a} \text{ and } w_2 = \frac{x_{n+1}^A}{x_n^a} \tag{4}$$

where $w_1 + w_2 = 1$. Following Wolsky's procedure, the following set of equations shows the relationships between these ratios and the matrices $\mathbf{a}$ and $\mathbf{A}$:

$$\mathbf{a_{ij}} = \mathbf{A_{ij}} \qquad i,j = 1,\dots,n-1 \tag{5}$$

$$\mathbf{a_{nj}} = \mathbf{A_{nj}} + \mathbf{A_{n+1,j}} \tag{6}$$

$$\mathbf{a_{in}} = w_1\mathbf{A_{i,n}} + w_2\mathbf{A_{i,n+1}} \tag{7}$$

$$\mathbf{a_{nn}} = w_1\left(\mathbf{A_{n,n}} + \mathbf{A_{n+1,n}}\right) + w_2\left(\mathbf{A_{n,n+1}} + \mathbf{A_{n+1,n+1}}\right) \tag{8}$$

Given that matrix $\mathbf{A}$ includes a higher level of information than matrix $\mathbf{a}$, there are many possibilities of defining $\mathbf{A}$ from $\mathbf{a}$. In order to solve this problem, Wolsky defines the augmented matrix ($\mathbf{A}^*$) as a tool to achieve the disaggregated model embodied in $\mathbf{A}$ by using the aggregated model described by $\mathbf{a}$ as:

$$\mathbf{A}^*_{\mathbf{ij}} \equiv \mathbf{a}_{\mathbf{ij}} \quad i,j = 1,\dots,n-1 \tag{9}$$

$$\mathbf{A}^*_{\mathbf{nj}} \equiv w_1\mathbf{a}_{\mathbf{nj}} \text{ and } \mathbf{A}^*_{\mathbf{n+1,j}} \equiv w_2\mathbf{a}_{\mathbf{nj}} \tag{10}$$

$$\mathbf{A}^*_{\mathbf{in}} = \mathbf{A}^*_{\mathbf{i,n+1}} \equiv \mathbf{a}_{\mathbf{in}} \tag{11}$$

$$\begin{pmatrix} \mathbf{A}^*_{\mathbf{nn}} & \mathbf{A}^*_{\mathbf{n,n+1}} \\ \mathbf{A}^*_{\mathbf{n+1,n}} & \mathbf{A}^*_{\mathbf{n+1,n+1}} \end{pmatrix} \equiv \mathbf{a}_{\mathbf{nn}} \begin{pmatrix} w_1 & w_1 \\ w_2 & w_2 \end{pmatrix} \tag{12}$$

Matrix $\mathbf{A}^*$ is characterised by containing the first *n-1* sectors that are common to $\mathbf{A}$ and $\mathbf{a}$. Additionally, the new sectors are assumed to have identical technologies to the original aggregated sector in matrix $\mathbf{a}$ and to supply output to the rest of sectors in fixed proportions. Nevertheless, although the augmented matrix ($\mathbf{A}^*$) has the same size as the target matrix, it just basically contains two new disaggregated sectors that are a direct reflection of the aggregated one. As a consequence, additional information must be put into the model to distinguish between the new disaggregated sectors. According to Wolsky (1984), this role is played by the distinguishing matrix ($\mathbf{\Delta}$):

$$\mathbf{\Delta} = \mathbf{A} - \mathbf{A}^* \tag{13}$$

The result of adding matrices $\mathbf{A}^*$ and $\mathbf{\Delta}$ is the target disaggregated matrix $\mathbf{A}$. Elements of matrix $\mathbf{\Delta}$ represent the deviations between the disaggregated and the augmented matrices, and they can be parameterized by a number of independent variables denoted as $\boldsymbol{\delta}_{\mathbf{i}}$, $\boldsymbol{\delta}_{\mathbf{n}}$, $\boldsymbol{\sigma}_{\mathbf{j}}$, $\boldsymbol{\sigma}_{\mathbf{n}}$ and $\boldsymbol{\xi}$ as it is shown below:

$$\mathbf{\Delta}_{\mathbf{i,n}} = w_2\boldsymbol{\delta}_{\mathbf{i}} \qquad \text{and} \qquad \mathbf{\Delta}_{\mathbf{i,n+1}} = -w_1\boldsymbol{\delta}_{\mathbf{i}} \tag{14}$$

$$\mathbf{\Delta}_{\mathbf{n,j}} = \boldsymbol{\sigma}_{\mathbf{j}} = -\mathbf{\Delta}_{\mathbf{n+1,j}} \tag{15}$$

$$\begin{pmatrix} \mathbf{\Delta}_{\mathbf{n,n}} & \mathbf{\Delta}_{\mathbf{n,n+1}} \\ \mathbf{\Delta}_{\mathbf{n+1,n}} & \mathbf{\Delta}_{\mathbf{n+1,n+1}} \end{pmatrix} \equiv \frac{1}{2}\boldsymbol{\delta}_{\mathbf{n}} \begin{pmatrix} w_2 & -w_1 \\ -w_2 & w_1 \end{pmatrix} + \boldsymbol{\sigma}_{\mathbf{n}} \begin{pmatrix} 1 & 1 \\ -1 & -1 \end{pmatrix} + \boldsymbol{\xi} \begin{pmatrix} w_2 & -w_1 \\ -w_2 & w_1 \end{pmatrix} \tag{16}$$

$\boldsymbol{\delta}_{\mathbf{i}}$ and $\boldsymbol{\sigma}_{\mathbf{j}}$ are vectors that contain, respectively, the differences between the new disaggregated sectors in terms of input demands from the i sector and supply to the j sector respectively. Vectors $\boldsymbol{\delta}_{\mathbf{n}}$, $\boldsymbol{\sigma}_{\mathbf{n}}$ and $\boldsymbol{\xi}$ represent demand-supply relations between the new sectors themselves. Quantifying these parameters requires having a good knowledge about the economic features of the disaggregated sectors (cost structure and input requirements, output destination, etc.) and the way in which they relate to each other. Being aware of this fact, Wolsky (1984) proposed a procedure to bound the aforementioned parameters in case of incomplete or unreliable information about the elements of the distinguishing matrix ($\boldsymbol{\Delta}$).

II.3 DATA SOURCES

II.3.1 Total output assessment

According to Chapter I, vessels based in Asturias in 2010 and registered as "multi-gear in the Cantabrian and Northwest fishing ground" (*Artes menores*) in the National Census (CFO) were considered artisanal (233 boats), as well as "bottom longliners in the Cantabrian and Northwest fishing ground" (*Palangre de fondo en CNW*), as most of them were allowed to temporary operate with the same fishing gears as multi-gear vessels[27] (40 boats). This segmentation was highly coincidental with the definition established by García-Flórez et al. (2014). As result, the artisanal fishing fleet came to 273 vessels in 2010 (Table 1), which accounts for 83.5% of the regional fishing fleet, distributed along 19 ports from where they supply local markets directly and exploiting areas that can be reached in a few hours from the respective fishing ports. The rest of Asturian fishing vessels (54 boats) were considered non-artisanal fleet.

Total fisheries output assessment implies quantifying the value of the domestic fisheries production at basic prices (supplied to domestic intermediate and final consumption) and exports[28]. Different available information has been used to achieve this goal depending on the subsector and activities described in Figure 15 (page 55).

The regional IO framework is calculated every 5 years, being the IO Tables of Asturias 2010 (SADEI, 2012b) the most recent ones at the time of this research and coincident with the time of

[27] Data on fishing licenses given by the fishing regional authorities during 2010 were checked. Results confirmed that almost all the vessels (95%) registered as "longliners in the Cantabrian and Northwest fishing ground" census category (small-scale longliners) also operated with artisanal gears included in the multi-gear typology.

[28] According to regional accounts (SADEI, 2012b), *Fisheries and aquaculture* industry does not supply any output for investment (gross fix capital formation).

analysis. The "Fisheries and aquaculture" industry includes four activities that can be grouped in two main subsectors: *artisanal fishing fleet* (fisheries production from the artisanal regional fleet, *sector 1* in Figure 15) and *rest of fishing and aquaculture* (*sector 2* in Figure 15). The latter covers the production of fisheries from the non-artisanal regional fleet (*2a*), the sea products gathered in shellfishing and other fishing modalities which do not need vessel support[29] (*2b*), and the yield from marine and continental aquaculture (*2c*).

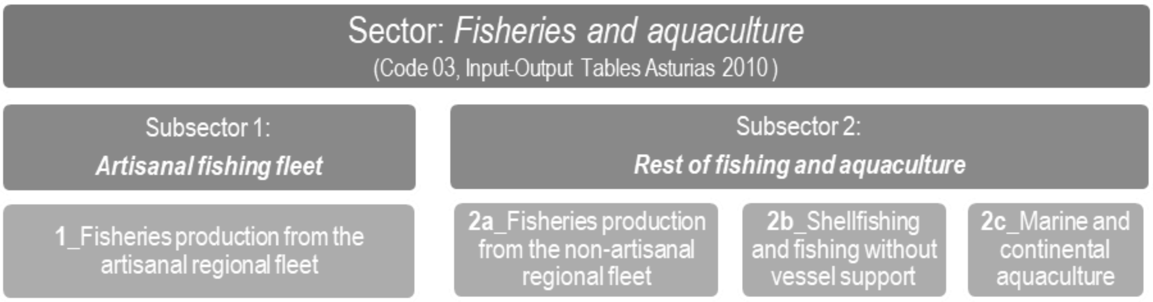

Figure 15. Disaggregation of the Fisheries and Aquaculture sector in Asturias into subsectors and activities

On the one hand, marine domestic fisheries production from the whole regional fleet (activities *1* and *2a*) and shellfishing (activity *2b*) is recorded throughout data on first-sales of sea products in Asturias: landings auctioned in the 18 quayside local fish markets of Asturias are annually communicated to the fisheries regional authority in order to compile a general database on fresh fish and shellfish first sales. This register contains data on each transaction, specifying if the seller is a boat or a self-employed shell fisherman, as well as additional information on species, local port/market where first-sale is registered, value and weight auctioned. As daily micro-data are not public due to privacy protection reasons, a specific query was submitted to fishing authorities to use this kind of information in this research. Given that the value attained by these fisheries production represents payments directly received by fishermen before applying indirect taxation (as VAT) and any other trade margins, it is equivalent to the domestic fisheries production at basic prices (Surís-Regueiro et al., 2014). For this research, data concerning first-sales during 2010 were analysed.

On the other hand, landings auctioned by the regional fleet and shellfishermen in ports located out of Asturias represent exports (information on total output is necessary). Regarding activity *2a*, detailed accounting data for a sample of non-artisanal Asturian vessels owned by fishing companies is available in SABI (Bureau Van Dijk, 2014), a comprehensive financial database with

[29] Shellfishing and fishing from the sea constitute a miscellaneous group of harvesting activities focused on different highly-valued shellfish and fish species.

information on 2.5 million of Spanish and Portuguese companies. Regarding activities *1* and *2b*, socioeconomic information on artisanal vessels interviewed during the regional survey[30] described in Chapter I was used; given that accounting and financial information about artisanal fishing is usually unknown, it represented the only source of accurate and updated information on total incomes and costs for artisanal vessels in Asturias. All these things considered, the difference between the total income from fishing (from SABI and the regional survey databases) and the first-sale incomes (from regional fish auction markets) results in an exports estimation for a sample of artisanal and non-artisanal vessels. Findings in Chapter I also revealed the close linkages between many artisanal vessels and shellfish harvesters, so data from the regional survey carried out to the Asturian artisanal fleet also allowed to deduce exports from activity *2b.*

Finally, aquaculture domestic production and exports at basic prices in 2010 from marine (*oysters*) and continental (*trouts*) businesses are published in the *National Survey on Aquaculture Businesses* (Ministerio de Agricultura, 2014).

II.3.2 Employment

Information on fishing fleet employment in 2010[31] has been supplied by the Marine Social Institute (ISM), which is the public agency belonging to the Ministry of Employment and Social Security that manages the special social security scheme for sea workers in Spain. Employment data represent registered workers in the aforementioned ISM scheme on-board fishing vessels. This group is made up of fishermen self-employed and employed by ship-owners, developing full-time jobs. Additionally, as on-board jobs are linked to a number of fishing jobs on land, data on net menders, staff of fishermen guilds and fishing guards has been provided by the fishing regional authority.

Shellfishing and fishing without vessel jobs are largely developed by self-employed men and women involved on temporary and part-time activities as goose barnacle shellfishing (*Pollicipes pollicipes*), glass eel fishing *by foot* (*Anguilla anguilla*) and seaweeds harvesting (genus

[30] As mentioned in Section I.2.1 Global approach, this regional survey was carried out in the context of the European project PRESPO.
[31] Administrative data on Asturian fishing vessels´ crew members in 2010 provided under request by the Ministry of Employment and Social Security.

Gelidium)[32]. Data on first-sales in local markets during 2010 has been used to know the number of people active in these activities.

Finally, information on people employed in aquaculture businesses in 2010 in Asturias was included in the "Updated Fisheries Strategic National Plan 2007-2013" (MARM, 2011b) in terms of annual equivalent jobs, given that there is a number of part-time jobs within this activity.

II.3.3 Intermediate demands and value added

The annual "Economic Survey on Marine Fishing" published by the Spanish Ministry with powers on fishing affairs (MARM, 2011c) contains economic results about this activity in 2010 according to a European classification of fishing segments and grounds. This survey provides data on economic structure referred to the North-Atlantic waters that can be applied to assess the intermediate demands and value added of activities *1*, *2a* and *2b*. Nevertheless, correspondences must be set up between the survey classification (characterised by fishing gears and vessels total length) and the type of vessels based in Asturias according to the National Census of Operating Fishing Fleet (CFO).

In the same way, the annual "Economic Survey on Aquaculture" published by the aforementioned Ministry (MARM, 2011a) contains economic results about marine and inland waters aquaculture in Spain in 2010, according to the species farmed and the type of businesses (location and farming type). Results regarding economic structure of horizontal marine farming of oyster (*Crassostrea gigas*) and inland aquaculture of trout (*Oncorhynchus mykiss*) were used to assess the intermediate demands and value added of the so-called activity *2c* of this research.

Finally, in order to link the input categories defined in the cited national surveys (9 for marine fishing and 7 for aquaculture) with the IO framework, information on the current national classification of economic activities (CNAE-2009) provided by the Spanish Statistical Institute (Instituto Nacional de Estadística, 2013) and the Asturian 2010 IO structure (66 sectors) (SADEI, 2012b) was used.

[32] Glass eel fishing and *Gelidium* gathering represent fisheries developed both from vessels and directly from the coast (beaches, estuarine riversides, etc.).

II.3.4 Distribution of sales

The fishing fleet based in Asturias does not encompass large-scale freezers or manufacturing vessels, so all fisheries domestic production is fresh or refrigerated. Although there are no detailed data on the destination of first-sales carried out in the Asturian markets, it is known that only the non-artisanal fishing fleet (seiners, trawlers, etc.) allocates some percentage of its pelagic catches (sardine, anchovy, etc.) to fish manufacturing industries, as it happens with other Cantabrian fleets (Fernández Macho et al., 2006; García-Allut, 2003). Taking these facts into account, a four-step analysis has been carried out to assess the split of activities *1* and *2a* domestic productions (Figure 16) between intermediate and household final consumption according to the structure of the IO table. In other words, this analysis allows for assessing to what extent the output (valued at basic prices) of each type of fleet is allocated to other sectors that use fish as an input (intermediate consumption of fish processing industries, restaurants, hotels, etc.) or to households.

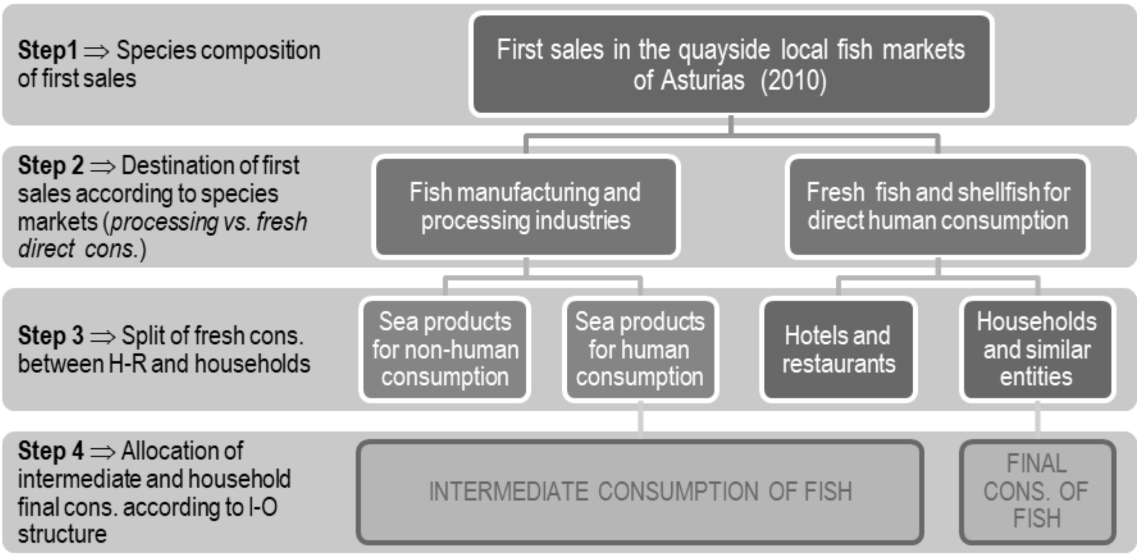

Figure 16. Four-step process to assess the destination of domestic productions from activities 1 and 2a.

The analysis of first-sales registered in the fish local markets of Asturias in 2010 per vessel is informative about the mix of species that characterises their output. Additionally, recent reports carried out by the Spanish Ministry with powers on fishing provide a general overview on markets and commercial issues for the most important species for the Spanish fishing sector.[33] This information has been mainly used to assess the percentages in which species are generally

[33] In particular, reports and analyses consulted concerning species as anchovy, hake, tuna, mackerel, sardine, blue whiting and horse mackerel are available at http://www.magrama.gob.es/es/pesca/temas/mercados-economia-pesquera/ESPECIES.aspx#para0

allocated to fish processing/manufacturing industries or to direct human consumption for fresh, and thus, to get the proportion in which the main domestic production of the analysed fishing fleets is allocated to both destinations in Asturias (*step 2*).

Then, the domestic output allocated to direct human consumption for fresh must be distributed among the main groups of consumers: hotels/restaurants (H-R) and households or similar entities (social food services). This task (*step 3*) has been carried out by applying the percentages in which total fish consumption is consumed by the cited groups in Spain according to an annual average for 2010 from data on the quarterly "Report on food consumption" (Ministerio de Agricultura, 2011). Finally, the estimated output allocated to fish manufacturing and processing industries and to hotels/restaurants were considered to assess the domestic output of the fleets supplied for intermediate consumption (input for other industries and services) according to the IO Table structure (*step 4)*. It should be noted that there is no information on the destination of the main part of the shellfishing and aquaculture regional output (activities *2b* and *2c*), although the species farmed and gathered are supplied to fresh/refrigerated markets for human consumption (H-R and households). Due to this, the general structure of intermediate and final consumption of fish products in the IO Tables of Asturias 2010 (SADEI, 2012b) was assumed for these activities.

II.4 RESULTS

II.4.1 The activity of the artisanal fishing fleet dissaggregated in the IO table for Asturias (2010)

Taking as point of departure the structure of the domestic use matrices at basic prices in the IO table of Asturias in 2010, the application of Wolsky´s disaggregation method requires quantifying some economic aggregates for the disaggregated sectors. To do so, this research opted for taking as relevant information the percent distribution of the variables of interest between artisanal and non-artisanal fisheries, instead of relying on the point estimates that could have been derived from the data sources. This decision is motivated by the potential gap between the estimates achieved in this research and those corresponding to the aggregated sector in the Regional Accounts, due to the existence of unreported catches and landings in the sector (so-called IUU in fisheries literature), as shown in Chapter I (I.3.5 Incomes, costs structure, profitability and other economic indicators). The unreported part of fishing activity may be captured when total consumption statistics are employed, but it cannot be measured when supply and production official data are analysed. As a solution, the proportions between the estimates of this research for both subsectors were transferred to the regional IO figures for the "Fisheries and Aquaculture" sector.

Table 12. Summary of figures estimated for the disaggregated subsectors and the total "Fisheries and aquaculture" sector, according to the IO table for Asturias 2010 (domestic IO table at basic prices)

	Total intermediate consumption*	Final cons. expenditure by households*	Gross fix capital formation*	Total exports*	Final uses*	TOTAL uses*	GVA at basic prices*	Jobs**	Landings***
Artisanal fishing fleet	4,527	16,823	0	3,888	19,296	**24,447**	16,680	642	3,822
Rest of fishing and aquaculture	18,910	18,196	0	11,988	31,599	**49,885**	28,306	1,042	11,032
TOTAL Fisheries and aquaculture	**23,437**	**35,019**	**0**	**15,876**	**50,895**	**74,332**	**44,986**	**1,684**	**14,854**

* In thousands of €. ** In number. *** In tonnes

By applying these proportions (Table 12), artisanal fishing fleet´s activity supplied in 2010 is estimated in one third of the total fisheries regional output at basic prices (€ 24.5 million) and represented 38% of fisheries employment in that year (642 direct employments). Concerning value added, the volume generated by the artisanal fleet was 37% of total GVA from fisheries in Asturias in 2010 (€ 16.7 million). As expected, these estimates reflect two important economic features: comparing to other fishing activities, the Asturian artisanal fleet gets on average higher first-sale prices for their output due to the high-valued species composition of their landings and the better quality in their products (size, freshness, etc.). When the ratio total output/employment is analysed, results reflect an average labour productivity of € 38,079 per job for the artisanal fleet´s activity against a ratio of € 47,874 per job for the rest of the fishing sector in 2010. Nevertheless, this gap is strongly reduced when the ratio GVA/direct employment is analysed: € 25,981 per job in the artisanal fishing fleet versus € 27,165 per job in the rest of fishing and aquaculture subsector.

Table 13. Output value in 2010 (€/kg)*.

Sector: Fisheries and aquaculture			
Subsector 1: Artisanal fishing fleet	**Subsector 2: Rest of fishing and aquaculture**		
3.7 €/kg	2.1 €/kg		
	Non-artisanal regional fleet	Shellfishing and fishing without vessel	Marine and continental aquaculture
	1.9 €/kg	6 €/kg	2.6 €/kg

* Values for artisanal, non-artisanal fleets and shellfishing represent first-sale prices at local fish auctions in Asturias. The value for aquaculture represents total output value.

Other estimates (Table 13) remark that artisanal fleet´s activity in 2010 represented just 19% of intermediate consumption (€ 4.5 million) and 24% of exports (€ 3.9 million) of the whole “Fisheries and aquaculture” sector in Asturias, although 48% of “Fisheries and aquaculture” domestic output with destination to final consumption of households came from the regional artisanal fishing fleet (€ 16.8 million). The IO table to be disaggregated on this basis is the domestic industry-by-industry matrix of Asturias 2010 (SADEI, 2012b), originally classified into 66 sectors, being one of them “Fisheries and Aquaculture”. As shown in Figure 17, the disaggregation process consisted of 6 steps, where the estimation of the distinguishing matrix is the most important one. As result of the disaggregation process, a new 67-sectors IO table has been generated.

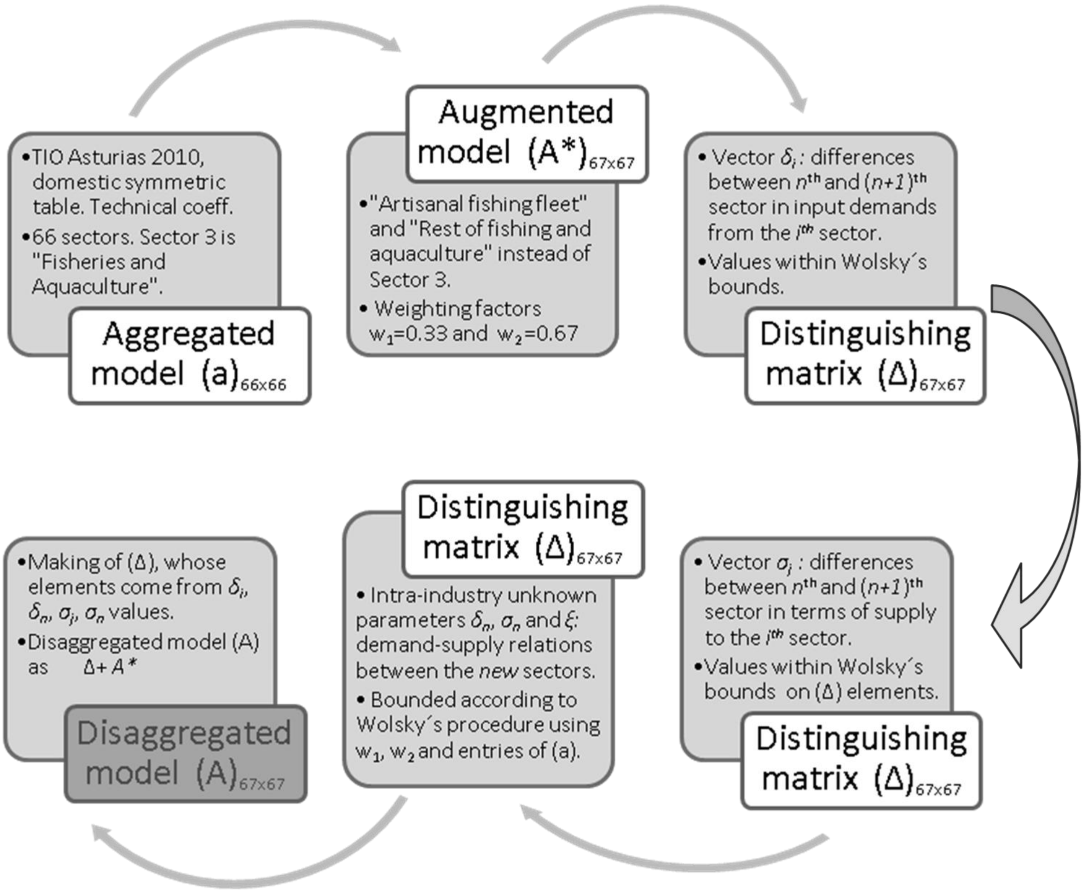

Figure 17. Diagram of the process to disaggregate the “Fisheries and aquaculture” sector into twos subsectors in the IO table for Asturias 2010

II.4.2 Analysis of multipliers

Once the “Fisheries and Aquaculture” sector has been disaggregated, the importance of artisanal fisheries subsector will be analysed by determining the multipliers of output, employment and value added. Starting from the inverse Leontief matrix $\mathbf{L} = [\mathbf{I} - \mathbf{A}]^{-1}$, equation (1) was applied to estimate the output multipliers. Under this formulation, $\mathbf{\Delta x}$ represents the changes in output due to exogenous variations in the final demand ($\mathbf{\Delta y}$) and the output multipliers are found by summing over the elements in columns of $\mathbf{L}$.[34]

Table 14. Output multipliers (in € for each additional € spent in final demand)

Sector	Output multiplier
Artisanal fishing fleet	1.2670
Rest of fishing and aquaculture	1.2938
Average Economy	1.3681
Fisheries (Whole)	1.2850

The values obtained for the *artisanal fishing fleet* and the *rest of fishing and aquaculture* are shown in Table 14. According to them, an increase by one monetary unit in the final demand of the artisanal fishing fleet generates a growth in the total output of the regional economy of 1.267 units. If that increase takes effect on the final demand of the rest of fishing and aquaculture industries, the output of the economy is expected to grow by 1.294. It can be seen that the multiplier effect on the economy of the rest of fisheries subsector is slightly higher than the artisanal fishing fleet multiplier effect, although both remain below the average of the regional economy (1.368).

Another interesting aspect to consider is the change experienced in employment due to variations in the final demand, which is quantified by the employment multipliers and by applying the expression (2) to the disaggregated IO table. Results are shown in Table 15.

Table 15. Employment multipliers (in full-time jobs for each additional € 1,000 spent in final demand)

Sector	Employment multiplier
Artisanal fishing fleet	0.0286
Rest of fishing and aquaculture	0.0240
Average Economy	0.0172
Fisheries (Whole)	0.0255

The employment multiplier for the artisanal fishing fleet is higher when compared with the rest of fishing and aquaculture. This result can be interpreted as follows: if final demand in the artisanal sector increased by 100,000 euros, employment in the whole regional economy would grow by about 3 jobs. This value is above the multiplier for the whole “Fisheries and aquaculture” sector, for the average regional economy and for the rest of fisheries and aquaculture subsector.

[34] The multipliers here reported are the so-called “backward” multipliers. Since the main research objective was to estimate potential economic impacts of shock in the final demand of the artisanal fleet, this research focuses on these types, not reporting the “forward” ones. These can be calculated by summing up over the rows of matrix $\boldsymbol{L}$.

Finally, GVA multipliers for the sectors of interest are determined by applying the expression (3) and they are reported in Table 16:

Table 16. Value added multipliers (in € for each additional € spent in final demand)

Sector	GVA multiplier
Artisanal fishing fleet	0.8181
Rest of fishing and aquaculture	0.7284
Average Economy	0.7176
Fisheries (Whole)	0.7579

Results show that artisanal fishing fleet has a GVA multiplier of approximately 0.82: if the final demand increases in this sector in a monetary unit, the GVA of the whole economy increases by 0.82 units. This value is above the average for the whole economy and largely overcomes the corresponding multiplier for the rest of fishing and aquaculture subsector. This can be interpreted as a signal that an increase in the final demand of the artisanal fishing fleet generates comparatively more value added in the regional economy than if this increase is experienced by the rest of fishing activities. This result is not surprising, since output (sea products) from artisanal fishing has, in general, higher quality and first-sale prices (i.e., larger value added) than those produced by the rest of the sector.

II.5 DISCUSSION

II.5.1 Interpreting artisanal fleets´ sustainability under the CFP: their contribution to local economies as a key issue

In 2012 the European fishing fleet (excluding Bulgary) generated € 3.3 billion of GVA and around 151,000 direct employments (120,000 FTE) (STECF, 2014), with some coastal communities where more than 50% of total local jobs depending on the fishing sector (European Union, 2014), and, especially, on vessels under 12 m of total length (small-scale fleets). Even when it only accounted for 8% of the total gross tonnage, the small-scale EU fishing fleet generated in 2012 48% of the total employment and 16% of the total GVA, with an output (weight) of 6% of total landings and 12% of landed value (STECF, 2014). In Spain, 71% of the national fishing fleet (6,512 from 9,172 vessels) was less than 12 m of total length in 2013 according to the National Census of Operating Fishing Fleet (CFO). Although the segmentation criteria applied in the present research indicate that the artisanal fleet represented 83.5% of the total regional fleet, other recent studies have shown that in South–European Atlantic regions these fleets can represent up to 84%-92% of the total fleet, depending on the region (García-Flórez et al., 2014). Additionally, artisanal fisheries represent a strategic sector due to their continuous spatial distribution along the whole coastline and their concentration on coastal communities, and they play a fundamental role in stabilizing population, providing economic growth and driving activity at a local scale (Arthur et al., 2011; CETMAR, 2008; Natale et al., 2013). But despite their importance, the reduction of European artisanal fleets appears to be unstoppable and, over the period 2002-2012, the economic performance of European small-scale fleets has deteriorated (STECF, 2014) and their decline is expected to continue in the near future.[35]

Since 2014, some principles and approaches supported by the new European CFP are based on sustainability: with more emphasis than never before, CFP explicitly acknowledges that environmental and socioeconomic issues need to play a key role in fisheries management. As the EU Commission recently recognized (DG MARE, 2013), this reform is also expected to increase the demand of socio-economic data to include certain (new) parameters in fisheries management, being some of the most important ones for fishing fleets the employment and the so-called *regional reliance on fishing activities.* At this point, the current text of the Regulation EU No 1380/2013 on the CFP must be underlined as a milestone, as it clearly reflects these principles in Article 17 by stating that Member States shall use environmental, social and economic criteria to allocate the fishing opportunities available, including the contribution to the local economy. Obviously, this issue directly connects with the problem of fishing rights over marine stocks in the EU and the process and criteria to allocate fishing quotas among artisanal and industrial fleets within Member States and regions.

Although these new principles constitute an unique opportunity for artisanal fleets, putting them into practice implies, in essence, two requirements: on the one hand, available and accurate information about the activity of artisanal fleets and their socioeconomic profile, which requires the previous adoption of an European standardized definition of *artisanal fleet* and the implementation of systematic data collection frameworks by Member States (particularly for vessels under 10-12 metres of total length). On the other hand, addressing novel socio-economic research aimed at identifying and quantifying the linkages between artisanal fisheries and local maritime economies.

[35] Other Spanish studies have also outlined the intense decline suffered by artisanal fisheries in the last years (Florido del Corral, 2008; Gómez et al., 2006).

The motivation of this Chapter II is related to this second condition, taking into account the practical problems that derive from the first one.

Empirical exercises as the one carried out in this Chapter show the importance of quantifying the impact of artisanal fishing fleet at a local scale and comparing it with other fishing activities (as industrial fisheries). Although the artisanal fishing fleet of Asturias only supplied 33% of the total fisheries output in the region in 2010, it embodied 38% and 37% of sectoral employment and GVA respectively. As the artisanal fishing fleet requires a higher number of jobs per total output, an increase of € 100,000 in the artisanal fleet´s final demand results in about 3 (2.8) additional jobs in the whole regional economy according to the estimates, which is comparatively higher than the rest of fishing activities (2.4) and the average of the whole regional economy (1.7) in 2010. The multiplier effects on GVA are particularly revealing: firstly, it is interesting to note that GVA at basic prices represents 68% of artisanal fleet´s total output, while for the rest of fishing and aquaculture subsector almost 57% of total output corresponds to gross value added. Additionally, even when artisanal fleet´s production in Asturias is characterised by lower technological levels than the industrial fleet (which is the activity that mainly embodies the rest of the regional fishing sector), it can be seen that the potential to generate value added is very similar in both cases (€ 25,981 against € 27,165 of GVA per direct job). Reflecting this higher capacity of income generation, the estimates concerning GVA multipliers for the artisanal fishing fleet (0.82) largely overcome the rest of fishing and aquaculture subsector (0.73) and the average regional economy (0.72). These outcomes are coherent with the strengths that characterise most of European artisanal fishing fleets: products with higher first-sale prices as reflection of their quality and environmental sustainability, as well as relative higher labour demands than industrial fisheries.

II.5.2 Considerations on the application of input-output (IO) disaggregation techniques

Input-output (IO) techniques arise as a suitable framework for performing sectoral studies and quantifying the importance of a sector in the economy, but the lack of data on artisanal fishing has limited this type of analysis and empirical studies in marine and fisheries economics so far. Although some authors have applied IO models or social accounting matrices (SAM) to quantify the impact of the marine/fishing sector or certain marine industries (such as maritime transport, shipbuilding, harbors, fisheries, aquaculture, seafood processing, offshore energy, etc.) on their local and national economies, the socioeconomic relevance of artisanal fleets/fisheries has not been addressed (Allan et al., 2014; Hoagland et al., 2015; Jacobsen et al., 2014; Kwak et al., 2005; Morrissey and O'Donoghue, 2013; Patrick and Benaka, 2013; Vega et al., 2014; Waters et al., 2014).[36] Only a few studies using IO and SAM models have distinguished artisanal and small-scale fleets among the activities that integrate the fishing sector (Fernández Macho et al., 2006; Surís-Regueiro et al., 2014), but their main objective have been to estimate the importance of the whole fishing sector on the local and regional economy, so neither artisanal fishing multipliers were estimated nor they have addressed methodological issues concerning the decomposition of fisheries in a number of subsectors on the basis of the initial IO framework[37].

The methodological approach here applied can be considered as a useful tool to evaluate artisanal fisheries´ role in a broader maritime economy. Firstly, it can be replicated in other fisheries and sectoral economic studies in the future, providing results integrated with the regional accounts. Secondly, even though exercises based on exact disaggregation require detailed data on artisanal fleets´ activity, this approach can be applied in contexts of scarcity of socioeconomic information (as it usually occurs when analysing artisanal fisheries) or high costs of data collection, as authors can also opt for an inexact disaggregation based on Wolsky´s methodology (Wolsky, 1984). At this point, some challenges arise concerning future disaggregation exercises in fisheries economics and artisanal fisheries studies: on the one hand, further research is required to know in detail commercial channels and intermediate/final uses of artisanal fish products at a regional scale, as well as to quantify intra-industry flows inside the fisheries sector itself (i.e. output from artisanal fishing fleets consumed by the rest of the fisheries sector, and vice versa). On the other hand, even when most of information is available, an important previous effort must be carried out to draw together many (disperse) sources of information; usually, administrative and statistical primary data need for further processing to extract those economic aggregates just referred to artisanal fleets, and afterwards, they must be analysed according to IO table requirements and structure.

[36] Kwak et al. (2005) applied IO analysis to estimate the contribution of the marine industry to the national economy between 1975 and 1998 by aggregating four marine industries (maritime transport, shipbuilding, harbors, fisheries, aquaculture, seafood processing, offshore energy) that had been previously considered as independent sectors in the Korean IO framework; artisanal fisheries were not specifically distinguished and multipliers were not calculated. Recently, Morrissey and O'Donoghue (2013) analysed the effects and inter-sectoral linkages of the Irish marine sector on the national economy by disaggregating the 52-sectors Irish IO table in 2007 to include 10 additional marine sectors; the disaggregation process in based on a partitioned IO model that doesn´t differentiate artisanal fisheries either (only a "Fisheries and aquaculture" marine sector). An interesting review of multipliers for eight marine industries across different regions have just been addressed by Jacobsen et al. (2014), but once again artisanal fisheries were not specifically considered.

[37] For example, Surís-Regueiro et al. (2014) linked magnitudes from the (aggregated) fisheries sector in the regional IO table 2005 of Galicia to a number of fishing subsectors in the area of study (Ría de Vigo) to estimate their impact on the local economy in 2010.

In addition to this, the methodological framework proposed allows to estimate the linkages between artisanal fleets and the rest of the key sectors in maritime economies (harbours, transport, shipbuilding, tourism, etc.), as well as potential impacts of policy measures on their socioeconomic performance and sustainability objectives. Finally, it allows the comparison of the generation of GVA and employment between industrial and non-industrial fisheries (multipliers). This last question is considered particularly important, as studies based on IO models foster the combination and integration of ecosystem/environmental and economic models to evaluate fisheries global sustainability (Crilly and Esteban, 2013; Huang et al., 2015; Kaplan and Leonard, 2012).

II.6 CONCLUSIONS

Artisanal fishing fleets develop an activity of strategic importance for many European coastal communities due to their size (number of boats), local concentration and dependent jobs. However, the continuous decline of European artisanal fleets reflects a failure of social objectives as result of both deep changes in fishing industry and policy effects. This fragile situation is motivated, among other causes, by the dependence on overfished stocks and the competence with industrial fleets and recreational fishing, so they can be considered to be the most vulnerable fishing segment to employment loss in Europe in the mid and long-term.

Under the new Common Fisheries Policy (CFP), sustainability principles should be translated into higher fishing rights and more efficient incentives for those fleets that grant low environmental effects on marine ecosystems and high socioeconomic impacts on their economies. In this context, one of the key issues will be going further in fisheries performance analysis, with assessments that compare the impacts of artisanal and non-artisanal fleets, starting by quantifying the contribution of artisanal fisheries to their local economy and identifying the linkages between them and maritime economies. Unfortunately, few empirical quantifications of this type have been carried out and no methodological approaches have been proposed to specifically analyse this question, most probably due to the low availability of information that usually characterises artisanal fisheries and the need of techniques replicable/transferable to all European regions.

This Chapter was aimed at applying an Input-Output (IO) approach to carry out a quantitative assessment of the contribution of artisanal fishing fleets to regional economies in Europe, particularly in terms of gross value added and employment generation. The method proposes, at a first stage, identifying and isolating the artisanal fishing fleet´s activity from the whole “Fisheries and aquaculture” sector observable on the IO tables. To do so, the disaggregation procedure proposed in Wolsky (1984) is applied, given that this approach is conceived to solve the problems present in the case of artisanal fishing: describing subsectors from aggregated industries in regional IO tables under poor data contexts. Indeed, IO models usually consider an aggregated fisheries sector which embodies data from very heterogeneous subsectors with significant economic and environmental differences (i.e. aquaculture, shellfishing, industrial fishing, small-scale and artisanal vessels). At a second stage, once artisanal fishing is disaggregated as a new (additional) sector of the IO table, different multiplier estimations can be carried out to quantify its relevance.

An innovative application of the methodology proposed is illustrated by the case of the artisanal fishing fleet of Asturias (Northwest Spain), by splitting the aggregated “Fisheries and aquaculture” sector of the Asturian IO tables 2010 in order to obtain data for this fleet by using Wolsky´s technique. At a previous stage, it has required an exhaustive compilation of primary data from different administrative and statistical sources concerning total output, exports, employment, intermediate demands, value added and distribution of sales, as well as a specific process to estimate the economic aggregates required by the IO table structure. The results achieved confirm research hypothesis: although the artisanal fishing fleet of Asturias only supplies one third of total fisheries output in the region and embodies 37-38% of sectoral employment and GVA, it exerts higher multiplier effects on regional employment and income than the whole economy and the rest of the fisheries sector (basically, the industrial fleet). Estimates also reveal that the potential of the artisanal fishing fleet is particularly important in the generation of gross value added, if compared with the rest of fisheries and the remaining sectors in the regional economy.

The proposed Input-Output (IO) approach can be useful to evaluate artisanal fisheries´ global sustainability and their role in a broader maritime economy. Apart from providing quantitative assessments on their contribution, it allows for carrying out other interesting exercises: to compare socioeconomic impacts between different marine and coastal sectors, to estimate linkages between artisanal fisheries and other maritime activities, or to evaluate potential effects of policy measures on the performance and sustainability of artisanal fisheries. Nevertheless, the traditional lack of accurate and reliable data on social and economic issues concerning artisanal fleets may represent the main limitation to implement the proposed approach, as analyses based on exact disaggregations require detailed data about the activity. Despite these requirements, in contexts of severe scarcity of socioeconomic information researchers can also explore the inexact disaggregation as a second best option, which is proposed in Wolsky (1984) as well.

CHAPTER III. COMPARING THE CONTRIBUTION OF COMMERCIAL AND RECREATIONAL MARINE FISHING TO THE REGIONAL ECONOMY

III.1 INTRODUCTION AND LITERATURE REVIEW

Marine recreational fishing (MRF) represents a form of recreation and leisure with growing importance in coastal areas around the world, with high social roots and millions of enthusiasts, and with an interesting capacity to create added value and employment in coastal areas. Cisneros-Montemayor and Sumaila (2010) estimated that around 58 million marine recreational fishermen worldwide generated an expenditure of approximately $ 39.7 billion in 2003, helping to support more than 954,000 jobs. Pawson et al. (2008) described the specific regulatory framework of MRF and Hyder et al. (2018) quantified the volume of enthusiasts in Europe as 9 million, generating an expenditure of € 6 billion per year. Added to its size (in terms of fishermen) is the fact that MRF shares and competes with marine commercial fisheries (MCF) both for resources and space (EFTEC, 2015; Monkman et al., 2015; Pawson et al., 2008), particularly in areas like the south-west Atlantic Europe (Pita et al., 2017). This explains the growing awareness of managers, decision-makers and researchers of the need for MRF to be incorporated into sustainable management plans for coastal space and marine resources, as well as other recreational marine coastal activities.

In Europe, recreational and commercial catches are jointly considered only for the stock assessments of three species in certain ICES areas (Hyder et al., 2018); a challenge in the short term is to strengthen the mechanisms for monitoring and obtaining reliable and homogeneous data on MRF in Europe, to enable joint and comparable management with commercial fisheries (Pita et al., 2017), and even in the near future an ecosystem approach that balances the wide range of benefits arising form both fishing activities (Roberts et al., 2017). In fact, in coherence with an ecosystem-base approach to fisheries management (García et al., 2003), impact analyses should cover all the services linked to fisheries (recreational use, food provisions, cultural services). In parallel to professional fishing, the European Commission has promoted through different standards a European framework for collecting data (DCF) on recreational fisheries for Member States (EU Parliament and Council, 2017, 2014; European Commission, 2016; European Union, 2008). In this policy context, economic data collection and methodologies to assess and compare the contribution[38] of MRF and MCF to the economies and to robustly quantify the economic impact

[38] As Lovell et al. (2013) stated in their research, this Chapter focuses on the economic activity supported by MRF and MCF, and the terms "economic contribution", "economic impact" or "economic effect" are used interchangeably.

of certain policies adopted by fishing authorities arise as useful tools for better informing about the consequences of management decisions on these two competing activities (EFTEC, 2015). This implies not only contrasting MRF and MCF as alternative activities, but also considering a combined management which is aware of their joint impacts and economic importance for coastal regions (as opposed, for example, to other uses of marine space). Additionally, professional-recreational analyses should refer to the common species (Dunn et al., 1995; Galeano et al., 2004; Indecon International Economic Consultants, 2003); in some cases this may lead to consider artisanal fishing (MCAF) as the most relevant commercial sector with which to compare MRF on a regional or national scale.

Regarding marine commercial fisheries in Asturias (Table 12, page 60), the output at basic prices of the "03_Fisheries and aquaculture" industry was € 74.3 million (SADEI, 2012b), creating almost € 45 million of gross value added and 1,684 jobs in the Principality of Asturias. This industry also registered negative net taxes, that is to say, subsidies to production valued at approximately € 1 million, and made intermediate purchases to the rest of industries of € 27.3 million, of which € 15 million corresponded to domestic supplies. Concerning the destination of the fishing output, MCF supplied fish and other sea products to other industries valued at € 23.4 million and to the final domestic demand valued at € 50.9 million in 2010, distributed between final private consumption (€ 35 million) and exports (€ 15.8 million). In addition to this, García-Flórez et al. (2012) identified the main species or groups of species caught by recreational fishermen in Asturias. Although the list is extensive and differs according to the modality, these include: seabream (mainly *Diplodus sp* and *Spondyliosoma cantharus* and less frequently *Pagellus erythrinnus, Sparus aurata* and *Dentex dentex);* some labrid (*Labrus bergylta, Labrus mixtus, Symphodus melops, Coris julis*); sea bass (*Dicentrarchus labrax*); garfish (*Belone belone*); squid (*Loligo vulgaris*) and conger eel (*Conger conger*). Likewise, data on the first sales of commercial species landed in the regional fishing guilds in 2010 (tonnes of landings according to Table 12) show that, for many of these species or groups of species, the artisanal fleet is the one that landed most of the total weight caught in 2010: *Diplodus* sp. (52%), *Labrus bergylta* (78%), *Dicentrarchus labrax* (59%), *Belone belone* (56%), *Conger conger* (58%); *Pagellus erythrinnus* (67%) and *Dentex dentex* (88%) [39]. It means that the species targeted by the recreational fishermen in the region are mostly caught by the Asturian artisanal fleet, so both activities compete for the same resources.

[39] In addition to this, a very relevant proportion of other species of high value for regional recreational fishermen, such as squid, black seabream and gilthead seabream, were also landed by artisanal vessels (*Loligo vulgaris* 34%; *Spondyliosoma cantharus* 40% y *Sparus aurata* 31%).

Economic impact assessment of MRF focuses on the economic activity associated only with tangible expenditures of recreational fishermen on a gross basis (Gislason, 2013). Most of the existing literature has used Input-Output models (IO) (Leontief, 1936; Miller and Blair, 2009), as they make it possible to quantify the total effects of intersectoral relations derived from the final demand for goods and services which arise from MRF. But as is the case with leisure activities, MRF lacks a formal economic definition and is strongly associated with private final consumption distributed by different industries (mainly services), so IO models depend on primary information provided by recreational expenditure surveys that may hamper analyses.

Institutions from North-America[40] have traditionally measured the economic relevance of MRF by applying IO[41], and some studies in northern Europe have also provided punctual estimates, but this question remains unknown in southern European Atlantic countries and regions (Pita et al., 2017). Gentner and Steinback (2008) estimated the contribution of marine angler expenditures to the U.S. economy in 2006, and Lovell et al. (2013) expanded this assessment to all the coastal states in 2011 by using different versions of the IMPLAN software; Borch et al. (2011) estimated the economic impact of MRF specialised business in Norway (charters and lodging all inclusive) using a tool called PANDA. Radford et al. (2009) assessed the economic impact of recreational sea angling in Scotland by using DREAM®. Other sea angling studies have directly used IO models (instead of IO-based commercial tools and analytical packages), but they show considerable time lags between the reference year of the IO matrices and the recreational expenditures: Roberts et al. (2017) assessed the contribution of recreational expenditures to the English economy in 2012-2013 by using the 2004 IO framework, while Monkman et al. (2015) applied the 2007 IO framework of Wales considering expenditure data collected in 2003. Steinback (1999) had problems with trade margin accounting when analysing marine recreational party and charter boat fishing in Maine (USA), and Roth and Jensen (2003) acknowledged problems to quantify the economic impact of saltwater recreational fisheries in that country due to the use of data not specifically collected for IO analyses.

Likewise, comparing the economic contribution of MRF and MCF is a difficult exercise (Steinback et al., 2004) that needs to overcome the methodological limitations derived from their different nature (EFTEC, 2015; Gislason, 2013): while MCF is a formal renewable resource extraction industry (output measured in terms of fish harvested), MRF is an outdoor recreation

[40] Examples can be found in https://asafishing.org/reports-and-trends/

[41] Some reports also appear to have used IO techniques to obtain economic impact indicators of MRF, although they do not provide methodological details (Armstrong et al., 2013; GSGislason & Associates Ltd., 2011, 2009).

dependent on a natural resource base that is not usually reflected in official economic statistics (output measured in terms of fisher-days). In this context, the use of IO models allows measures of MRF impact to be in line with macroeconomic indicators and with the main figures of the national or regional accounts, permitting direct comparisons with the economic aggregates of other formal sectors of the economy (such as the MCF) that are explicitly included in the IO framework. IO studies dealing with the comparative relevance of MRF and MCF for an economy are particularly scarce, and only a few non-European studies have addressed this issue. Gislason (2013) focused on the chinook salmon in Pacific Canada: although impact assessment appears to have been based on the use of IO models, no explicit mention or methodological details are provided. Gentner (2009) used the aforementioned IMPLAN package to estimate the economic impact of commercial and recreational grouper fisheries in the Gulf of Mexico (United States), in order to assess the effect of possible changes in the allocation of the resource between both sectors.

This Chapter aims to compare the contribution of recreational and commercial fisheries, particularly artisanal fisheries, to the final output, gross value added and employment of a European regional economy. To achieve it, a general IO model that uses data on recreational fishing expenditure from surveys specifically designed for this objective was applied, dealing with methodological issues poorly addressed so far and limiting MRF impact studies. The comparison with artisanal fisheries was possible thanks to the sectoral dissagregation of the fishing industry carried out in Chapter II. Section III.2 describes how the demand IO model can be applied to estimate the impact of MRF and MFC on a regional economy as the Asturian one by using IO tables from official accounting; then, IO operations are carried out based on primary information from recreational expenditure surveys in Asturias; methodological contributions include guidelines to transform values and obtain domestic impact measures, to obtain the MRF private final consumption vector that allows for direct comparisons between recreational and commercial fishing, and to design surveys that provide recreational expenditure data usable in this type of IO exercises. Section III.3 describes the data collection process and the design of a specific survey to collect recreational expenditure data in Asturias to be used in the IO model. Section III.4 shows the average and aggregated expenditure of recreational fishing, quantifies and compares the economic contribution of each recreational modality and the whole MRF to commercial fishing (MCF) and also to the artisanal fleets (MCAF) separately, including sectoral effects and multipliers of final consumption for both activities. Section III.5 discusses the method under a context of decision-making, the opportunities of the European Data Collection Framework (DCF) to improve economic information in the future and reflects on the meaning of the results achieved. Finally, conclusions are summarized in Section III.6.

III.2 METHODOLOGY

III.2.1 Using IO models to compare the contribution of MRF and MCF to the regional economy

Impact assessment using IO models focuses on studying the effects of any change in the magnitude of the different elements of the economy (i.e. the final demand) on economic aggregates (i.e value added, employment). The most popular type of IO model is the so-called demand driven model described in Section II.2.1 The basic IO model. The central idea that characterises the application of these models is that variations in the final demand stimulate the entire productive system and not only the sectors directly affected: shocks on the final demand are transmitted and multiplied throughout the framework of productive relations of an economy.

Focusing on marine recreational fisheries (MRF) and according to this model, an increase in fishermen's recreational expenditure will generate, firstly, a direct effect on the suppliers that satisfy this final demand. Additionally, to satisfy this consumption, productive agents will increase purchases from their suppliers, and these in turn to theirs, generating another sequence of indirect effects on the economy. To estimate the effects of the final demand of MRF (resident and non-resident fishermen) by using the model described in Section II.2.1 The basic IO model, $\mathbf{A}$ represents the matrix of domestic technical coefficients and $\mathbf{y}$ is the vector containing the domestic recreational expenditure generated by recreational fishermen. In order to estimate the economic impact of recreational expenditure in a region, it is necessary to build its vector of exogenous demand $\mathbf{y}$, that is, the aggregate domestic expenditure (ADE) generated by recreational fishermen. Vector $\mathbf{y}$ (ADE) is the total aggregate expenditure (TAE) minus the value of those purchases made outside the region (imports). The recreational ADE in the reference year of the IO model is estimated by taking the average individual expenditures obtained from surveys and extrapolating them to the population (resident and non-resident licensed fishermen in the region that year).

Marine commercial fishing (MCF) refers to the professional fisheries (harvesting activity), a formal industry that is usually included (explicitly) in regional IO models and economic statistics. In the IO framework, the intermediate purchases of the fishing industry, together with the rest of inputs, are used in the harvesting activity to produce a final output that is valued at basic prices (as well as other aggregates such as GVA). It should be noted that final demand associated with the MRF basically represents private final consumption, while MCF is a productive activity motivated by the intermediate demand for sea products (from fish processing industries, restaurants, etc.) and the final demand for fish (private consumption by households and exports). Therefore for comparative purposes, vector $\mathbf{y}$ of commercial fishing in equations (1) to (3) (page 50) should also reflect the value of the private final consumption of fish and sea products that is satisfied with the MCF´s domestic output.

To compare MRF and MCF contribution to the regional final output, GVA and employment, the model described in equations (1) to (3) has been also applied to the industry that represents the harvesting sector of commercial fisheries ("03_Fisheries and aquaculture") in the TIOA 2010 (SADEI, 2012b) and to the segment that represents the artisanal fleet (MACF), on the basis of the sectoral dissagregation into 67 industries carried out in Chapter II.

Concerning the final domestic demand of fish products satisfied by the MCF, the TIOA 2010 distributes its value between final consumption expenditure by households and exports, but it is unknown which part of fish exports is destined to private final consumption abroad. Given this limitation, in the present research the value of vector $\mathbf{y}$ for the commercial fishing had to reflect just the final consumption by households, excluding exports; consequently, the value of vector $\mathbf{y}$ for the MRF also had to be adjusted (last step of Figure 18) to reflect only the final consumption of resident recreational fishermen (excluding non-residents´ expenditure, considered an export). This adjustment assures the consistency of the estimates and comparisons, although it excludes from the model a little part of the final demand (the exports) for both activities.

III.2.2 A socioeconomic survey on MRF: specific design in Asturias to provide data to be used in the IO model

As in other tourism and leisure activities, economic and social data on MRF only can be gathered from surveys that provide primary information on expenditures, social profiles or fishing effort, for example. Between 2012 and 2015 the regional fishing authority commissioned the design of specific samplings to collect socioeconomic data on recreational marine fishing in Asturias. A key issue at the stage of designing the questionnaires was the type of expenses on which to report information, depending on the main three groups of fishermen under study (anglers from the shore, anglers from recreational boats and spearfishermen).

Two major groups of expenses were considered in the surveys: i) personal and fishing expenses and ii) expenses linked (where appropriate) to own a recreational boat to go fishing. The first group included operating expenses necessarily incurred by these fishermen; in some cases, they corresponded more to an investment than to a current expenditure (as fishing equipment, clothing, etc.), while in other cases they were current expenses directly linked each year to fishing (bait, gears, insurances, licenses, etc.) and other personal expenses derived from the activity (transport, food and lodging, etc.). In the second case, owners of recreational boats who used them for fishing had another long list of expenses, ranging from their purchase to their maintenance (moorings, fuel, insurance, etc.).

With the aim of using this information to assess the economic contribution of MRF on a regional economy, the questionnaires (see Appendices C, D and E) were specifically designed to provide data be used in the IO model. This implied the following:

- Vector $\mathbf{y}$ should faithfully reflect the total recreational expenditure in the reference year, since this type of economic operations will have been conveniently recorded by the IO framework at the time of their accounting. Thus, the reference year for which expenditures were reported was the closest to the year when regional IO tables were built (2010).
- In order to reduce recall bias, it was requested that declared expenses were referred to the same year or the immediately preceding year to the time of the survey.
- The expenses of the boats owned may be very important to the total expenditure of the recreational fishermen who use them. If vessels were used for both fishing and sailing, only the proportion that corresponds to the intensity of their use for fishing was charged as an expense of the MRF. To this end, the survey included specific questions, such as for example the percentage of sailing days in which the vessel has been used to fish during the year.
- Together with the variety of expenditures declared in the reference year, the respondent had to provide additional information about no expenses:

- Reasons for no expenditure: respondent had to clarify the reason by choosing from 3 options, namely: "No use" (these are real zeros for the purposes of economic analysis), "It was given to me" or "It was lent to me". This last question offered very relevant information for the estimation of the aggregate expenditure and the economic impact of the activity, since the last two options implied that a person other than the respondent has made the expenditure.
- Declaration of purchases made outside the region or the country, indicating the amount and year if applicable. This type of expenditure had to be deducted from the average expenditure when calculating the domestic consumption of the MRF for the IO analysis.
- If the reference year for which expenditures were reported did not coincide with the year of the IO tables, fishermen were asked to remember any sporadic expenditure or gifts specifically occurred in the year of the IO framework (basically clothing, fishing equipment and gear, or, where appropriate, the purchase of the boat).

III.2.3 Adjusting recreational expenditure to be used in the regional IO framework of Asturias

Since MRF is not a formal sector of the economy, disaggregated information of different concepts of recreational expenditure need to be integrated within the IO framework. To do that, a detailed analysis was made to match the different types of expenses identified in the surveys with their formal industries considered in the IO model. Concerning the valuation of $\mathbf{y}$ (ADE), expenditure figures from fishermen´s responses use to be valued at purchaser´s prices; however, economic operations related to production are valued at basic prices in IO tables, which implies the need to adjust expenditures in each industry: (i) by discounting the Value Added Tax (VAT) paid by recreational fishermen while consuming, as well as taxes on products and services net of subsidies, and (ii) by reallocating trade and transport margins to the corresponding industries according to the sectoral structure and valuation criteria of the IO tables.

The vector $\mathbf{y}$ of MRF aggregate expenditure in Asturias to be used in the IO model was built by using the information gathered from the recreational surveys, and considering the characteristics of the regional the TIOA 2010 (Figure 18).

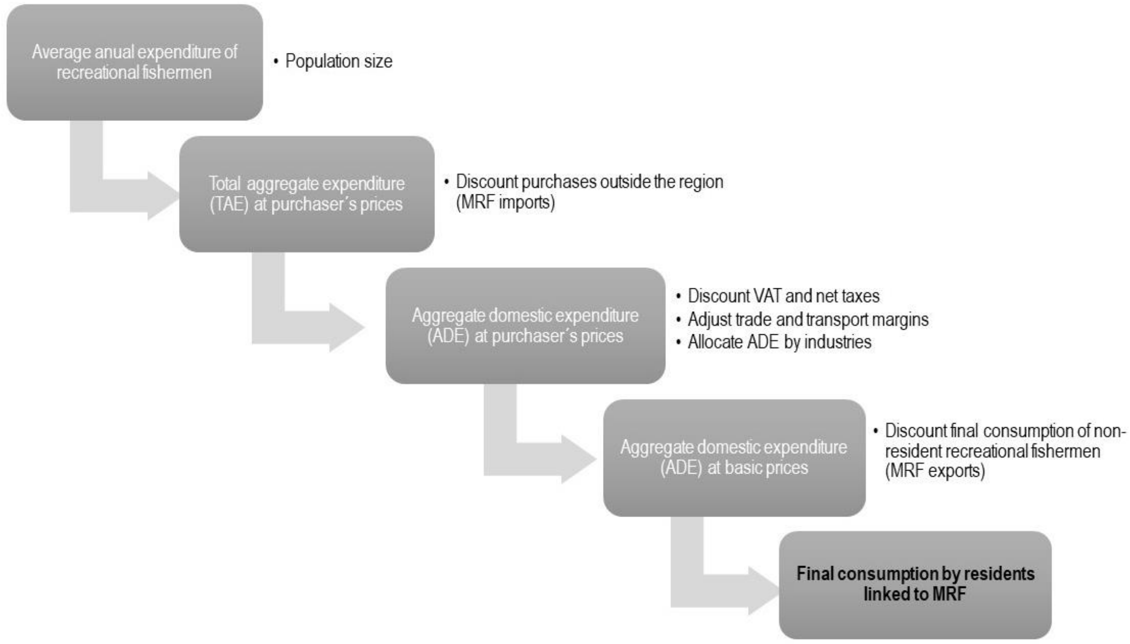

Figure 18. Steps followed to obtain the vector y of aggregate expenditure of MRF in Asturias to be used in the IO model

The total aggregate expenditure (TAE) of the MRF (at purchaser´s prices, in € 2010) was initially obtained for the different economic profiles of recreational fishermen: the average for each expenditure category was multiplied by the estimated population size and by the percentage of the sample that declared such expenditure[42]. In a second step, the TAE was obtained for the three main MRF modalities. The cost of the boats purchased in 2010 was incorporated, given that they represent an actual transaction that will have been recorded in the regional TIOA. According to recreational surveys, total recreational fishing days in 2010 were estimated at between 1.9 and 2.7 million of angler-days (1.73 - 2.42 from shore fishing; 0.10 - 0.12 from boat fishing; 0.06 - 0.12 from spearfishing)[43]. In order to isolate which part of the TAE has remained within the region, purchases made outside (imports) were discounted (sampling results indicated that only 9% of the TAE was made in other regions).

[42] The presence of biases was checked before scaling average expenditures to the recreational populations (Armstrong et al., 2013; Pita et al., 2018). Face-to-face interviews with boat owners and spearfishermen served to validate the representativeness of post respondents in terms of age and fishing activity. Concerning shore anglers, the final returned sample replicated the age structure of the population, but it was confirmed that data on recreational expenditure were mostly provided by active fishermen during the reference year. Information provided by shore anglers in Asturias at the time of renewal of their licence in 2011 (García-Flórez et al., 2012) indicated that 18% of them were inactive. Thus, overestimation of their aggregate expenditure was avoided by scaling the average expenditure of shore anglers to 82% of the population.

[43] The lowest value of the intervals was obtained by multiplying the recreational population of each modality by the average number of fishing days in 2010 obtained from the sample of licensed fishermen in the region. the highest values were obtained by considering the average number of fishing days estimated by (García-Flórez et al., 2012) from an on-site sampling of recreational fishermen in the region between 2009-2011.

Concerning the vector $\mathbf{y}$ (ADE) valuation, expenditure figures from fishermen's responses are valued at purchaser´s prices; however, economic operations related to production are valued at basic prices in tables IO, which implies the need to adjust the valuation of expenditures in each industry by discounting the Value Added Tax (VAT) paid by recreational fishermen while consuming, as well as other taxes on products or services net of subsidies.

To allocate recreational expenditure into the categories (formal industries) of the Input-Output framework, a detailed analysis was made to match the different types of expenses identified in the surveys with their formal industries considered in the TIOA 2010 (Table 17). To facilitate this linkage, the correspondence between expenses in the surveys and formal industries was carried out taking into account the disaggregation of industries and products of the TIOA 2010 (SADEI, 2012b). Most of the MRF expenditures (in fishing equipment and gear, bait, clothing, etc.) represent final private consumption in diverse retail trades (fishmonger´s, shops specialised in fishing and sports activities, hardware stores, clothing and footwear stores, etc.) that the regional IO tables 2010 agglutinate in an undifferentiated single industry called *Retail trade*. Nevertheless, it is frequent that each expenditure declared in the survey corresponds to more than one formal industry for two reasons:

- Certain products are purchased online directly from manufacturers and wholesalers. In the case of spearfishermen belonging to regional clubs and associations, sometimes the entity itself buys outside the retail circuit collectively for its members. Based on the responses obtained, it was estimated that 2% of the purchases of fishing equipment and dissemination materials (such as journals, magazines, books, CD and videos) were made directly from producers.
- Expenditure is spread over more than one industry in the same proportion of fishermen who have declared a certain consumption habit (i.e. public transport *versus* own car; mooring in public ports or in private marinas).

Table 17. Main categories of MRF expenditure and their correspondence with the disaggregation of industries in the regional Input-Output 2010 framework (TIOA based on 66 industries)

	EXPENDITURE CATEGORIES IN THE SURVEYS	INDUSTRIES ACCORDING TO THE TIOA-2010 CLASSIFICATION	
Boating	**Purchase of boat (new and second-hand)**	23	*Manufacture of other transport equipment*
		25	*Repair and installation services of machinery and equipment*
		30	*Trade and repair services of motor vehicles and motorcycles*
		31	*Wholesale trade services*
	Rentals	51	*Rental and leasing activities*
	Moorings	36	*Warehousing and support activities for transportation*
		62	*Creative, arts, entertainment, sports, amusement and recreation activities*
	Fuel and oils	14	*Manufacture of coke and refined petroleum products*
		15	*Chemical industry*
	Vessel insurances	43	*Insurance, reinsurance and pension funding (except compulsory social security)*
	Repairs and maintenance	25	*Repair and installation services of machinery and equipment*
		32	*Retail trade (except of motor vehicles and motorcycles)*
	Technical inspection	47	*Architectural and engineering activities.*
	Fees	55	*Public administration and defense*
	Warehousing and garages	36	*Warehousing and support activities for transportation*
	Transport of the boat to ports	32	*Retail trade (except of motor vehicles and motorcycles)*
		14	*Manufacture of coke and refined petroleum products*
	Staff and other services	52	*Employment activities*
		54	*Security and investigation, services to buildings and other business support activities*
Fishing	**Transport to fishing sites**	14	*Manufacture of coke and refined petroleum products*
		32	*Retail trade (except of motor vehicles and motorcycles)*
		33	*Land transport and transport via pipelines*
	Food, drink and lodging	6	*Meat industry*
		7	*Dairy industry*
		8	*Manufacture of other food products*
		9	*Manufacture of beverages and tobacco products*
		38	*Accommodation; food and beverage service activities*
		32	*Retail trade (except of motor vehicles and motorcycles)*
	Fishing journals, magazines, books, CD and videos	13	*Printing and reproduction of recorded media*
		32	*Retail trade (except of motor vehicles and motorcycles)*
		39	*Motion picture, video and television programme production, sound recording and music publishing activities.*
	Clothing and fishing tackle	10	*Manufacture of textiles, clothing and leather products*
		32	*Retail trade (except of motor vehicles and motorcycles)*
	Bait	3	*Fisheries and aquaculture*
		24	*Manufacture of furniture; other manufacturing*
		32	*Retail trade (except of motor vehicles and motorcycles)*
	Fishing gears	10	*Manufacture of textiles, clothing and leather products*
		32	*Retail trade (except of motor vehicles and motorcycles)*
		24	*Manufacture of furniture; other manufacturing*
	Purchase of fishing equipment	24	*Manufacture of furniture; other manufacturing*
		32	*Retail trade (except of motor vehicles and motorcycles)*
	Memberships/federative fees and licenses	55	*Public administration and defense*
		62	*Creative, arts, entertainment, sports, amusement and recreation activities*
	Fishing insurances	43	*Insurance, reinsurance and pension funding (except compulsory social security)*
	Medical check-ups	58	*Human health market activities*

In this research, due to the methodology used to build the regional TIOA 2010 (SADEI, 2012b)[44], MRF expenditure allocated to the industries *30_Trade and repair services of motor vehicles and motorcycles, 31_Wholesale trade services* and *32_Retail trade (except of motor vehicles and motorcycles)* just represents trade[45] margins. The ADE allocated to primary and manufacturing industries was adjusted by discounting 4% of its value in terms of net taxes and 1% by transport margins[46] (average percentages that represent these concepts on the value of the total supply at purchasing prices of manufactured products, according to the table of origin at basic prices of the TIOA 2010). The ADE allocated to services different to the industries coded 30-33 was adjusted by reducing the purchase value by 4% in terms of net taxes on these services. For the adjustment of the VAT paid by consumers, the general rates in Spain in 2010 and 2011 are applied, except for the payment of taxes, fees and licenses (exempt of VAT) and food and hotel expenses (taxed at the reduced rate).

Finally, domestic TAE linked to MRF was adjusted again to obtain a vector $\mathbf{y}$ directly comparable to the one available for the MCF and to be used in the IO model: non-residents´ expenditure was excluded (exports are not considered). As result, vector $\mathbf{y}$ represents in this case study the final consumption of resident recreational fishermen, distributed along the regional industries of the TIOA 2010.

III.3 DATA SOURCES

As mentioned before, between 2012 and 2015 several samplings were implemented to address a socioeconomic characterisation of recreational marine fishing in Asturias. There are three types of administrative licenses to practise MRF in this region: i) boat fishing (rod and line angling from recreational boats), ii) spearfishing and iii) shore fishing (angling and shellfish harvesting). There is hardly any market services specifically associated with MRF, as lodges or charters, so the typical profile of an angler is that of an independent local fisher who enjoys this

[44] In the Use Table at purchasers' prices, retail and transport margins are incorporated in the value of the products being traded, so demand for these products does not include any value as a margin. The total figures for wholesale and retail margins coincide almost exactly with the output value of the corresponding industries.
[45] According to the *Structural Business Statistics: Trade sector* (National Statistics Institute – INE: https://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica_C&cid=1254736176902&menu=ultiDatos&idp=1254735576799), the estimated gross commercial margins in 2010 in Spain for the industries with codes *30, 31 and 32* were 10%, 22% and 28% respectively.
[46] According to the Supply Table at basic prices of Asturias 2010, these transport margins are accounted within the industry *33_Land transport and transport via pipelines*.

outdoor recreation for his or her own. Given the large size of the population under study (about 75,000 MRF licences), the socioeconomic sampling had to be addressed in two stages (Table 18).

In 2012 two samplings addressed the nautical activity and spearfishing, aimed at owners of recreational boats registered and moored in ports of Asturias (2,600 boats) and spearfishermen (2,650 licenses) respectively. Information on recreational fishing carried out, where appropriate, from these vessels[47], was also collected from the nautical sample. To minimize avidity and non-response biases, the surveys sent by mail to the homes (more than 5,200) were combined with face-to-face interviews with recreational boat anglers in the biggest port of Asturias (city of Gijón) and the main spearfishing clubs in the region.

In 2014-2015 the sampling of shore fishing was carried out, aimed at people with a recreational shore fishing license (71,246 licences). The size of these populations reflects the number of licensed fishermen according to the official registers in 2011. While samples for nautical activity, boat fishing and spearfishing were exhaustive for the entire population, sampling to the shore fishing randomly covered 28% of people with this type of license: firstly, 10,000 surveys were sent to the homes of licensed fishermen, and to minimize non-response bias, another 10,000 surveys were sent some months later.

Table 18. Sizes of the population under study, samples obtained and weight of the different economic profiles of recreational fishermen

	Licenses of shore fishing	**Owners of recreational boats (*)**		**Licenses of spearfishing**		
Population size (number)	71,246 (**)	2,600 (***)		2,650 (***)		
Sample size (number)	1,905	519		281		
Percentage of residents	87%	90%		88%		
Economic profiles in the sample	*With license for shore angling and shellfishing*	*Owning the boat exclusively for boat angling*	*Owning the boat for boat angling and sailing*	*From the shore, without boat*	*From shore and/or from not their own boat*	*From shore and/or from their own boat*
	100%	*61.8%*	*27.8%*	*62.5%*	*20%*	*17.5%*
Estimation of recreational fishermen per economic profile (number)	*71,246*	*1,606*	*723*	*1,656*	*530*	*464*

(*) 9.4% of the sample was excluded for the analysis of the MRF expenditure, either because it corresponded to people who only sail (9.1% of recreational boat owners do not fish) or to those who use their boat only for spearfishing (1.3% of owners), an activity from which information has been obtained in the sampling of people licensed to spearfish. (**) Situation at the end of 2010. (***) Situation at the beginning of 2011.

47 This means that the only group not covered by this study were anglers who did not use their own vessel to go boat fishing.

The questionnaires were divided into different sections concerning the social profiles of fishermen, the characteristics of their recreational activity (including fishing effort) and fishing expenditures (the economic data requested are provided in the Appendices C, D and E). To minimize potential problems of recall bias, fishermen were asked to report their recreational expenses in the last year, according to the categories mentioned in Section III.2.2 A socioeconomic survey on MRF: specific design in Asturias to provide data to be used in the IO model. Nevertheless, the sampling sought to obtain figures as representative as possible of the domestic recreational expenditure generated in Asturias in 2010, which was the base period of the regional IO framework used. For this reason, together with the expenditures annually declared in the different concepts of expenses, the respondent had to include additional information about the periodicity of each item of expenditure: annual expenses are directly attributable to 2010 (with an adjustment based on the consumer price index evolution since 2010), while sporadic investments (like clothing or the purchase of equipment as rods, reels, hooks or baskets) are also considered to be true in 2010 if this is inferred from the periodicity declared by each respondent. In addition to this, when fishermen did not spend because someone else had made the expenditure, the false zeros were replaced by the average expenditure of the category, obtained from the positive responses in the sample. Finally, the surveyed fishermen were asked about purchases frequently made outside the region (indicating the amount and year if applicable) and specific purchases or important expenditures made in 2010 (in particular, the purchase of the boat).

As a result of the sampling, a total of 2,705 valid questionnaires were collected (Table 18), with response rates ranging between 21% and 10% depending on the group, and coverage of the target population of between 20% (recreational boat owners) and 3% (shore fishermen). As a result of the economic data provided by recreational fishermen, sampling errors were estimated at € 16.32 per shore fishing license, at € 60.33 per angler using their own boat to fish and at € 65.23 per spearfishing license.

As described in Chapter II, the IO framework used belongs to the Regional Accounts of Asturias 2010 (TIOA 2010), which includes the Input-Output Tables (SADEI, 2012b) according to the European System of National and Regional Accounts of 1995 (ESA-95). The TIOA 2010 is integrated by the supply, use and symmetric tables dissagregated into 66 industries and 86 products, as well as the matrices derived from the symmetric table (technical coefficient and Leontief inverse). This research focuses on the economic operations that took place during 2010. MCF and MCAF figures were described in Section II.4.1 The activity of the artisanal fishing fleet dissaggregated in the IO table for Asturias (2010) (Table 12).

III.4 RESULTS

III.4.1 Economic profiles and average annual expenditure of recreational fishermen

An initial but still important result for the estimation of recreational fishing expenditure was related to the link between sailing and fishing: sample information confirmed the strong linkage between navigation and recreational fishing in Asturias. More specifically, 91% of the sampled boat owners used their boat to fish and recreational fishing is the main leisure activity for 69% of them. This means that a substantial part of the nautical activity of the owners of recreational vessels is inseparable from fishing, the latter being the main hobby and motivation to have a boat. Consequently, the question of owning a boat to fish and the allocation of the boat owner´s expenses to recreational fishing was key for the analysis of MRF expenditure and to identifiy economic profiles of fishermen with average consumption levels and patterns significantly different.

In the case of boat fishing, two profiles were differentiated. The first one corresponded to those who owned the boat only to go fishing (61.8% of the sample), for which the nautical expenditure motivated by fishing was considered for all purposes as fishing expenditure. The second profile was defined by boat owners who sail and sometimes fish (27.8% of the sample), who use the vessel to fish an average of 21 days out of a total of 39 that go sailing. In other words, 54% of trips with their vessel are for fishing (54% of nautical expenditure was considered attributable to fishing). In relation to spearfishing, three economic profiles were also relevant: those who had their own boat and used it only for spearfishing, those who undertook this modality from other vessels (rental and borrowed boats), and those who fished from the shore (without a boat). Finally, there are two modalities of shore fishing that can be undertaken using the same license: angling and shellfish harvesting, the former being the more predominant (85% of licenses).

All these things considered, the average annual personal expenditure of the MRF in Asturias was estimated for the three described modalities of practice and the six economic profiles of recreational fishermen, valued at purchaser´s prices (in euros 2010) and including consumption outside the region[48]. Boat anglers owning the boat registered an average annual cost of € 3,423

[48] Personal and fishing expenses present an uneven occurrence according to their type: bait, fishing tackle, equipment and transport represent frequent consumptions (only 8-9% of anglers did not spend on these items during the year). Concerning expenses linked to clothing, food/drink and maintenance 25-31% of anglers declared not having spent

per license, while this amount is reduced to € 943 for spearfishermen and € 694 for shore anglers. Likewise, there are great differences in the annual personal expenses depending, basically, on owning or not recreational boat to fish (Figure 19). Those who own a boat just for angling registered the highest average annual cost, of € 3,545; costs derived from owning the boat represent 68% of this amount. The second highest average expenditure was reached by spearfishermen who also have a boat to undertake this modality, with an average outlay of almost € 3,000 per license and year and where the costs of owning the boat represent the 61% of their total fishing expenditure. At the other extreme, fishermen who do not use a boat, such as anglers and spearfishermen from the shore, registered an average annual cost of € 694 and € 498 respectively. The difference between both of them is due, to a large extent, to the fact that spearfishermen have no bait costs and seem to accrue lower maintenance and travel costs. The weighted average of the annual personal expenditure of the MRF in Asturias was € 777 in 2010.

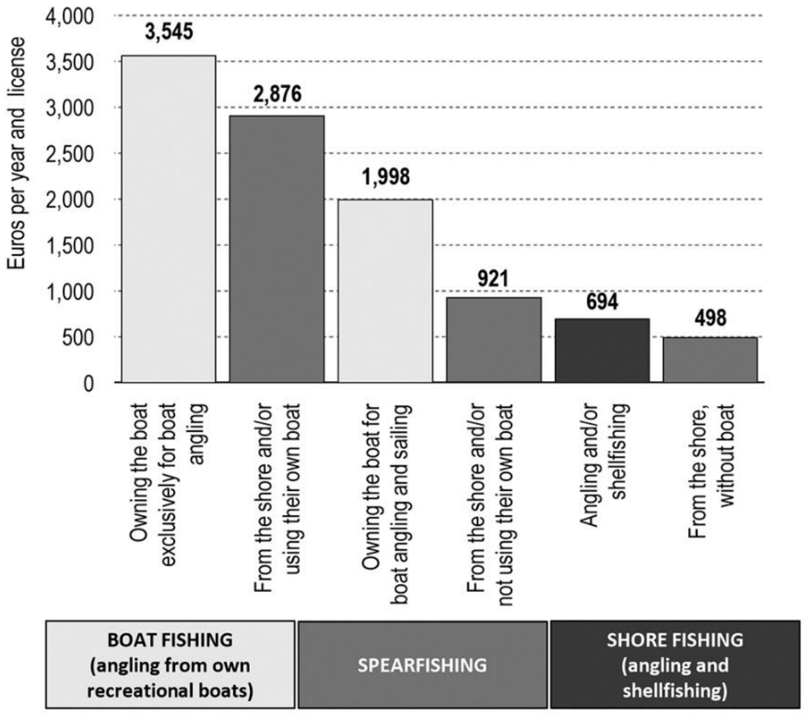

Figure 19. Averages of total annual expenditure of recreational fishermen in Asturias, according to fishing modalities and economic profiles

anything. Finally, for a third group of consumptions linked, for example, to the purchase of books, magazines, payment of subscriptions and fees, hiring or renting, the percentage of anglers without expenditures ranged between 56-96%.

When a recreational boat is required to go fishing, the expenditure linked to it represents the main cost to the fisher (between 61-68% of total fishing expenditure)[49]. The most important expense concepts each year are the payment of the moorings[50] and the fuel consumption to go angling with rod/line or spearfishing. Fishing expenditure itself (here referred to as *personal and fishing expenses*[51]), which includes the cost of transport, food and lodging of fishermen, rises above € 1,100 per year among those who have their own boat exclusively for angling. For those who do not own a boat, the personal and fishing expenses range between € 500 and € 900 approximately, depending on the profile.

Expenditures for transport, equipment, bait, fishing tackle, clothing and gear account for approximately 90-97% of the average total expenditure of recreational anglers (from boats or from the shore). The remaining small percentage is divided between various consumptions of low importance (maintenance/repair of equipment, payment of fees and insurance, purchase of didactic materials, etc.). In the case of spearfishermen, other types of expenses reach a certain importance, such as insurance payments, medical examinations, federal fees and boat rental.

III.4.2 Total aggregate expenditure of the MRF

TAE of the licensed recreational fishermen in Asturias at purchaser´s prices has been estimated at € 53.4 million in 2010 (Table 19). In global terms, 15.3% of this amount (€ 8.2 million) corresponds to expenses associated with the ownership of boats based in Asturias for angling purposes, while the largest volume of TAE (€ 45.2 million) is due to personal and fishing expenses, with special weight of those relating to travel to the fishing sites (€ 11.6 million), the purchase of fishing equipment, clothing and fishing tackle (€ 9.9 million) and board and lodging during the fishing days.

Results also confirmed that the activity derived from MRF in Asturias predominantly stimulates domestic consumption and regional businesses: only 9% of purchases value represented imports and the aggregate domestic expenditure (ADE) in 2010 was € 48.9 million (Table 19). By modalities, shore fishing is clearly the activity with the greatest economic weight in 2010 and it generated € 37.4 of the € 48.9 million of the ADE (76.5%). The second modality with the highest economic weight is boat fishing from owned recreational boats based in Asturias, which

[49] It does not include the purchase of the boats.
[50] It includes the cost of anchorages and, where appropriate, ground care or storage in garages.
[51] Table 2 shows the categories of recreational expenses included under this concept.

with an annual volume of € 8.9 million provides almost 16% of the expenditure of all regional MRF. In this case, approximately three quarters of that expenditure (€ 6.8 million) are actually due to expenses associated with the ownership of the boat used to fish. Finally, it has been estimated that spearfishing generates an annual ADE in Asturias of € 2.5 million, with a volume of personal and fishing expenses (€ 1.8 million) only slightly lower than the previous modality (€ 2 million), but with a much lower weight of expenses linked to navigation for fishing.

Once the expenditure of non-residents was excluded (exports estimates of € 4.9 million), the vector *y* of final consumption of resident recreational fishermen was obtained (Table 20). Its total value (at basic prices) in Asturias 2010 was € 35.2 million. MRF consumption is heavily concentrated in two industries: retail trade and other manufacturing. Both industries are the main target sectors of recreational expenditure, with an estimate of € 7.2 and € 7.0 respectively (40%), because they comprise the purchasing and manufacturing of materials, equipment and accessories for fishing; other industries concerning clothes and textiles, consumption of fuel to travel in a private vehicle to fishing sites, and expenditure in hotels and restaurants also concentrate 31% of the total private consumption.

Table 19. Importance of each expenditure category in the average total expenditure (per modality and economic profile) and aggregate expenditure of the MRF in Asturias in 2010

		DISTRIBUTION (%) OF TOTAL AVERAGE PERSONAL EXPENDITURE OF RECREATIONAL FISHERMEN						**AGGREGATE EXPENDITURE OF THE MRF IN ASTURIAS (in millions of €, at purchaser´s prices)**							
		Boat fishing (1)		**Spearfishing**			**Shore fishing (2)**	**Total Aggregate Expenditure (TAE)**				**Aggregate Domestic Expenditure (ADE)**			
		A (3)	**B (4)**	**C (5)**	**D (6)**	**E (7)**	**F (8)**	**Boat fishing (1)**	**Spear-fishing**	**Shore fishing(2)**	**TOTAL MRF**	**Boat fishing (1)**	**Spear-fishing**	**Shore fishing(2)**	**TOTAL MRF**
Expenses incurred by the recreational boat to go fishing	Purchase	-	-			-		2.7	0.0		**2.7**	2.4	0.0		**2.5**
	Moorings	20%	26%			8%		1.5	0.1		**1.6**	1.4	0.1		**1.5**
	Fuel	18%	11%			19%		1.2	0.3		**1.4**	1.1	0.2		**1.3**
	Vessel insurance	7%	8%			8%		0.5	0.1		**0.6**	0.5	0.1		**0.6**
	Oils	3%	2%			3%		0.2	0.0		**0.3**	0.2	0.0		**0.3**
	Maintenance	9%	8%			8%		0.6	0.1		**0.7**	0.6	0.1		**0.7**
	Technical inspection	5%	5%			5%		0.3	0.1		**0.4**	0.3	0.1		**0.4**
	Fees	0.3%	0.3%			1%		0.0	0.0		**0.0**	0.0	0.0		**0.0**
	Warehousing and garages	1%	1%			3%		0.1	0.0		**0.1**	0.1	0.0		**0.1**
	Transport	0.5%	0.3%			3%		0.0	0.0		**0.1**	0.0	0.0		**0.1**
	Staff and other services	0.8%	0.4%					0.0	0.0		**0.0**	0.0	0.0		**0.0**
	Other current expenses	3%	5%			4%		0.2	0.1		**0.3**	0.2	0.1		**0.3**
Personal and fishing expenses	Food, drink and lodging	3%	6%	14%	13%	7%	19%	0.3	0.3	7.6	**8.2**	0.2	0.3	6.7	**7.2**
	Fishing journals, magazines	1%	0%	4%	3%	1%	2%	0.1	0.1	0.9	**1.1**	0.1	0.1	0.9	**1.1**
	Transport to fishing sites	5%	3%	33%	24%	13%	26%	0.3	0.6	10.7	**11.6**	0.3	0.5	9.8	**10.6**
	Bait	10%	8%				14%	0.7	0.0	5.5	**6.2**	0.6	0.0	5.1	**5.7**
	Fishing gear	4%	6%				10%	0.3	0.0	3.9	**4.2**	0.3	0.0	3.6	**3.9**
	Fishing equipment, clothing and fishing tackle	8%	9%	26%	17%	7%	22%	0.6	0.4	8.9	**9.9**	0.5	0.4	7.9	**8.8**
	Other expenses (9)	0.4%	0.4%	20%	18%	10%	7%	0.0	0.3	3.3	**3.6**	0.0	0.3	3.2	**3.5**
	Medical examinations			4%	3%	1%		0.0	0.1		**0.1**	0.0	0.1		**0.1**
	Rental (boats, equipment)				22%		1%	0.0	0.1	0.2	**0.3**	0.0	0.1	0.2	**0.3**
	TOTAL	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	**9.8**	**2.7**	**41.0**	**53.4**	**8.9**	**2.5**	**37.4**	**48.9**

(1) Rod and line angling from own recreational boats. (2) Angling and shellfishing. (3) Owning the boat exclusively for boat angling. (4) Owning the boat for boat angling and sailing. (5) From the shore, without boat. (6) From the shore and/or not using their own boat. (7) From the shore and/or using their own boat. (8) With license for shore angling and shellfishing. (9) As fishing insurance, equipment maintenance, membership/federative fees and licenses, etc.

Table 20. Vector y (final consumption of residents) linked to MRF in Asturias 2010 by industries, according to recreational modalities (at basic prices, in million of €)

INDUSTRIES		Boat fishing	Spearfishing	Shore fishing	TOTAL MRF	
32	*Retail trade (except of motor vehicles and motorcycles)*	0.4	0.2	6.5	7.2	20%
24	*Manufacture of furniture; other manufacturing*	0.4	0.2	6.4	7.0	20%
14	*Manufacture of coke and refined petroleum products*	0.9	0.4	4.9	6.3	18%
38	*Accommodation; food and beverage service activities*	0.1	0.1	2.7	2.9	8%
10	*Manufacture of textiles, clothing and leather products*	0.2	0.0	1.4	1.6	5%
3	*Fisheries and aquaculture*	0.2	0.0	1.3	1.5	4%
62	*Creative, arts, entertainment, sports, amusement and recreation activities*	0.5	0.1	0.7	1.3	4%
25	*Repair and installation of machinery and equipment*	1.2	0.1	0.0	1.3	4%
36	*Warehousing and support activities for transportation*	0.6	0.1	0.0	0.7	2%
43	*Insurance, reinsurance and pension funding (except compulsory social security)*	0.3	0.2	0.1	0.6	1%
6	*Meat industry*	0.0	0.0	0.5	0.5	1%
7	*Dairy industry*	0.0	0.0	0.5	0.5	1%
8	*Manufacture of other food products*	0.0	0.0	0.5	0.5	1%
9	*Manufacture of beverages and tobacco products*	0.0	0.0	0.5	0.5	1%
23	*Manufacture of other transport equipment*	0.5	0.0	0.0	0.5	1%
33	*Land transport and transport via pipelines*	0.0	0.0	0.2	0.3	1%
39	*Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting*	0.0	0.0	0.2	0.2	1%
13	*Printing and reproduction of recorded media*	0.0	0.0	0.2	0.2	1%
47	*Architectural and engineering activities.*	0.2	0.0	0.0	0.3	1%
31	*Wholesale trade services*	0.3	0.0	0.0	0.3	1%
51	*Rental and leasing activities*	0.0	0.1	0.1	0.2	1%
55	*Public administration and defence*	0.0	0.1	0.1	0.2	1%
30	*Trade and repair services of motor vehicles and motorcycles*	0.2	0.0	0.0	0.2	1%
15	*Chemical industry*	0.1	0.0	0.0	0.2	1%
54	*Security and investigation, services to buildings and other business support activities*	0.0	0.0	0.0	0.1	0.3%
58	*Human health market activities*	0.0	0.0	0.0	0.01	0.1%
52	*Employment activities*	0.02	0.00	0.00	0.02	0.1%
TOTAL		**6,4**	**1.8**	**27.0**	**35.2**	**100%**

(*) Industries named and coded according to the regional IO tables 2010.

III.4.3 Economic contribution of MRF and MCF to the regional economy

The contribution of the MRF to regional final output, taking into account the direct and indirect effects generated throughout the entire economic system from the final consumption of resident recreational fishermen (€ 35.2 million) was € 48.4 million in 2010 (Figure 20). Its contribution to regional gross value added (GVA) has been estimated at € 22.0 million in 2010, while the effect on regional employment (including self-employed) was 570 jobs. By modalities, shore fishing (angling and shellfish harvesting) is largely responsible for this impact on the economy of Asturias: of the total contribution that MRF makes to the regional economy, 77% of the effect on final output and GVA is due to shore anglers, as well as 80% of the impact on employment.

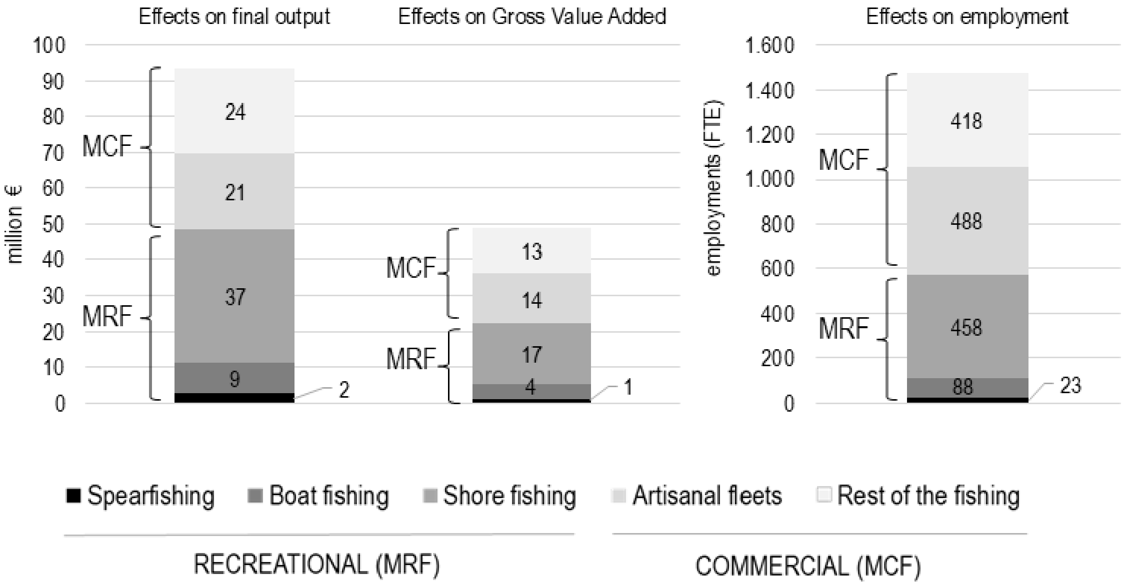

Figure 20. Direct and indirect effects on final output, gross value added and employment of the expenditure linked to recreational and commercial fishing (final consumption of residents) in the Asturian economy 2010.

In 2010, the final consumption by households of fish and sea products in Asturias (€ 35 million) was the same as the final consumption of resident recreational fishermen (€ 35.2 million), but in spite of this, MCF supported more GVA (€ 26.7 million) and jobs (906) than MRF. Likewise, although the final consumption by households of fish and sea products from artisanal fishing amounted to only € 16.8 million in 2010, its contribution to job creation is not far from the estimated effect of MRF (MCAF accounted for 488 jobs in the region). Multipliers of final consumption (Table 21) show that in 2010 the MRF had a capacity to induce the final output of the economy slightly higher than that of the MCF: increases of 1 € in the private consumption of resident recreational fishermen led to an increase in the value of the regional output of 1.4 €, while for each additional euro allocated to the final consumption by households of fish and sea products in Asturias, this output increases by 1.3 €. Likewise, the private consumptions associated with the MRF and MCF have a similar multiplier effect on GVA, the highest being that linked to the MCAF. It is in job creation that the private consumption for MCF products shows the clearest advantage: for every € 100,000 increase, 2.55 jobs are created, compared with the 1.63 jobs that this same increase would generate through the recreational expenditure of residents. In addition to this, artisanal fisheries have another comparative advantage over MRF, because the former are labour-intensive (they depend largely on traditional knowledge, local crews and relatively low-tech fishing metiers) and are specialised in sea products of high relative value at first sale (for their freshness, handling, type of species). Consequently, the value of the GVA multiplier for the MCAF (0.82) already exceeds that of the MRF (0.63), and the employment multiplier is also notably higher (2.86 compared to 1.63): € 61,350 of final consumption made by resident recreational fishermen are needed to generate employment in Asturias, while this same effect is achieved with only € 34,965 on final consumption of fish from artisanal fishing made by the regional households.

Table 21. Multiplier effect of final private consumption linked to recreational and commercial fishing on the Asturian economy in 2010

		Output multipliers *(in € for each additional € spent in final demand)*	**Value added multipliers** *(in € for each additional € spent in final demand)*	**Employment multipliers** *(in full-time jobs for each additional € 100,000 spent in final demand)*
Private consumption of recreational fishermen (*)		1.38	0.63	1.63
Private consumption of fish and sea products from commercial fishing (**)	**Total**	1.29	0.76	2.55
	Only products from artisanal fleets	1.27	0.82	2.86

(*) Final consumption of residents. (**) Final consumption by households.

Given their joint importance in Asturias, the final consumption by residents linked to MRF and the MCF generated added value of € 48.8 million in 2010 (0.25% of the total regional income) and directly and indirectly induced the regional economic system to produce a final output of goods and services of € 93.4 million (0.23% of the total). Similarly, final consumption derived from all sea fishing activity in Asturias generated direct and indirect employment needs of 1,476 full-time jobs in 2010 (0.38% of regional employment).

From a sectoral point of view, all these effects have a very different reflection on the regional economic structure. As a result of the intersectoral relations between industries, the IO model captures how the direct and indirect effects of the MRF and the MCF are dispersed (Figure 21). Final consumption of residents linked to MRF, which initially only affects 25 industries, finally has effects on 61 of them, although the effects remain strongly linked to retail (which accounts for 22.1% of the GVA and nearly one third of the jobs created), manufacturing and hotels/restaurants. Final consumption by households linked to MCF and MCAF output (fishing and aquaculture industry) results in direct and indirect effects on 60 industries, although in this case the effects are strongly linked to the fishing industry itself: 80% or more of the GVA and the employment are located in the fishing industry (harvesting activity), and only a small proportion goes to other industries such as "Repair and installation of machinery and equipment".

Figure 21. Distribution of the total GVA and employment supported in Asturias by marine recreational fishing (final consumption of resident fishermen) in 2010.

INDUSTRIES		Gross Value Added			Employment		
		MRF	MCF	MCAF	MRF	MCF	MCAF
3	*Fisheries and aquaculture*	4.1%	79.3%	82.8%	6.0%	87.5%	90.5%
10	*Manufacture of textiles, clothing and leather products*	3.4%	0.0%	0.0%	4.7%	0.0%	0.0%
24	*Manufacture of furniture; other manufacturing*	12.7%	0.0%	0.0%	15.5%	0.0%	0.0%
25	*Repair and installation of machinery and equipment*	4.8%	4.4%	3.7%	4.4%	3.1%	2.5%
31	*Wholesale trade services (except of motor vehicles and motorcycles)*	1.9%	0.8%	0.4%	1.8%	0.6%	0.2%
32	*Retail trade (except of motor vehicles and motorcycles*	22.1%	2.2%	1.0%	30.8%	2.3%	1.0%
33	*Land transport and transport via pipelines*	2.4%	0.6%	0.4%	1.9%	0.3%	0.2%
38	*Accommodation; food and beverage service activities*	7.6%	0.1%	0.1%	6.5%	0.0%	0.0%
54	*Security and investigation, services to buildings and other business support activities*	2.6%	1.1%	1.1%	4.0%	1.3%	1.2%
62	*Creative, arts, entertainment, sports, amusement and recreation activities*	3.9%	0.0%	0.0%	3.1%	0.0%	0.0%
--	Rest of primary	1.2%	0.1%	0.1%	2.3%	0.1%	0.1%
--	Rest of industry	12.9%	2.1%	1.7%	7.8%	0.7%	0.6%
--	Construction	1.2%	0.4%	0.4%	1.0%	0.2%	0.3%
--	Rest of services	19.4%	8.9%	8.4%	10.2%	3.9%	3.5%
	TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

III.5 DISCUSSION

III.5.1 Considerations on the method, in the context of decision-making and fisheries policy design

Many European regions are facing reduction in commercial fisheries, particularly the activity of artisanal fleets, as well as a gradual increase in the MRF and recreational fleets (Roth and Jensen, 2003), with frequent tension between both sea users to access physical space and biological resources. Certain decisions that often have to be made by fisheries authorities, such as reconverting fishing ports into recreational marinas, developing recreational fisheries by changing their regulation, or promoting demand for commercial species that are also targeted by recreational fisheries, may need to be based on an adequate knowledge of how both activities contribute to a regional economy, or may require to examine which industries in a region will be harmed by or will benefit from each decision and to what extent (Gentner, 2009). Economic impact analysis based on a demand IO model traces the effects on income and employment associated with an initial MRF expenditure through the economy (Gislason, 2013; GSGislason & Associates Ltd., 2011, 2009; Lovell et al., 2013; Steinback et al., 2004). That is the context of this research. In the most restrictive scenario for the year 2010, in which the assessment did not consider commercial and recreational fishing exports, results suggest that final consumption of residents linked to the MCF had a greater effect on the regional economy than that linked to the MRF, both in gross (GVA and total employment generated) and relative terms (multiplier effect of private final consumption). More information on the Asturian case study would allow additional simulations based on the IO model. A first option would be to re-estimate the impacts taking into consideration the domestic final consumption by including non-resident recreational fishermen and the part of commercial fishing exports also destined for final consumption. Another interesting scenario for decision-makers concerns the marginal impact of a management policy that considers substitution effects, rather than the gross contribution of the sectors (Cappell and Lawrence, 2005). In a context of reduction of stocks shared between recreational and commercial artisanal fisheries, the model could be applied to ascertain if a reduction in the final consumption of a certain species would produce a greater regional impact than a reduction in the recreational activity around it (taking into account possible price changes and substitution effects, respectively).

Whatever the valuation scenario (gross economic contribution of MCF and MRF or net economic impacts of MRF), Input-Output represents a cost-efficient methodology[52] with clear advantages of interpretation, coherence of results and comparability with the formal economy. However, research into the economic impact of tourism activities and MRF have also pointed out IO limitations. Concerning the demand IO model with fixed coefficients, Valdés Peláez et al. (2010) and Briassoulis (1991) have remarked that assumptions such as considering production and demand functions of fixed proportions (Leontief's technologies) or constant technical coefficients (structural permanence) introduce an unrealistic rigidity in the analysis. Furthermore, not allowing the substitutability in time of those factors or output that have become more expensive in relative terms becomes a factor of greater distortion and representativeness of the results when the date of elaboration of the IO framework and the date of elaboration of the impact study are different. Zhou et al. (1997) and Dwyer et al. (2004) have pointed out the possible risks of overestimating the economic impact if displacement effects are ignored (Adams and Parmenter, 1991; Blake and Sinclair, 2003; Dwyer et al., 2003) or the effects of strongly seasonal recreational activities and large events with short duration are not analysed. Likewise, when recreational activities are strongly oriented to visitors or mainly developed by non-residents, substitution effects must be taken into account (Radford et al., 2009).

Despite all this, some of the limitations detected in previous studies on the impact of MRF using IO can be overcome with some decisions on the study design. In general, economic information and data on recreational expenditure represent a challenge for Europe (Hyder et al., 2018), and one of the most limiting issues when applying IO models to sectors such as MRF is to have a data collection framework on recreational expenditures specifically designed for this aim (Gentner et al., 2000; Roth and Jensen, 2003). EU has the opportunity to consider it within a future Data Collection Framework and to follow the path of bodies such as NOAA's National Marine Fisheries Service in the U.S., that have designed questionnaires and implemented periodic samplings specifically aimed at estimating the economic impact of MRF using IO (Gentner, 2009; Gentner and Steinback, 2008; Lovell et al., 2013; Steinback et al., 2004). Likewise, regions and EU Member States could make some progress in this direction by establishing formulas for the

[52] A methodological alternative with clear virtues is based on general equilibrium models, highly suitable for analysing the economic impacts of tourism activities in large regions or multi-regions (Valdés Peláez et al., 2010), but they require great efforts and are usually costly for local and regional applications (Kauppila and Karjalainen, 2012).

systematic reporting of data on recreational fishing expenditure, for example, when fishermen renew their licences.

Finally, decision-making regarding the distribution of access rights for resources with concurrent uses is relevant for the future of fishing in Europe; if recreational catches for new species are considered together with the commercial catches to determine total allowable catches and maximum sustainable yields, or extraction possibilities are limited or conditioned, participation rates will change and fishermen´s expenditure may be reduced, with consequent effects on the coastal economies. Nevertheless, given the assumptions implicit in the IO model used here, alternative methods based on the net economic value of MRF that explicitly account for its non-market benefits (Arlinghaus, 2004; Cantrell et al., 2004; Cappell and Lawrence, 2005; Crabtree et al., 2004; Dunn et al., 1995; Hicks and Gautam, 2000; Paulrud, 2004; Toivonen et al., 2004; Wheeler and Damania, 2001)[53] could complement the analysis.

III.5.2 Considerations arising from the results

No previous studies in Europe have compared the economic contribution of MRF and MCF by means of IO techniques. Although some articles have assessed the impact of MRF in different European areas, only a few contain results that can be compared with the Asturian regional case[54]. In Asturias MRF is a non-tourism activity with very high rates of local participants, which basically translates into final consumption by residents and where charter and all inclusive lodging services were almost inexistent in 2010.

This is not the common case in most of the literature: estimates in Radford et al. (2009) are referred to a MRF with certain importance of charter services and high presence of non-local fishermen and visitors from the rest of the UK, whereas Borch et al. (2011) analysed the economic impacts of MRF tourism based on charters and lodging all inclusive in Norway. Roth and Jensen (2003) opted for an approach based on residents´ consumption (foreign tourist anglers visiting Denmark were excluded from the study); nevertheless, their employment multiplier amounted to 1.52 persons per million DKK of private consumption on recreational fishing (around 1.14

[53] This approach implies a rather microeconomic approach with limitations when being used to compare the MRF and the MCF: non-market goods valuation techniques, such as contingent valuation, must be applied to estimate both consumers and producers´ surpluses of commercial sea products, and their market income (benefits), which adds complexity and leads to estimates of welfare less intuitive and difficult to interpret in macroeconomic terms.
[54] In Spain only two studies used this methodology to know the impact of the marine recreational fleet on employment (Pérez-Labajos, 2001) and output and GVA (Zarauz et al., 2013).

employments for every € 100,000[55]), estimation lower than ours because their analysis only considered variable costs (purchases of long lasting items and investments like boats were excluded).

The comparison between MRF multipliers from other estimates suggests that sectoral distribution of MRF impacts depends not only on the economic structure of the regions, but also on the extent to which they supply the increased recreational demands from the local economy and the importance to tourism of recreational fishing. Employment generated by sea angling in England (Roberts et al., 2017) shows a comparatively lower impact on the primary and manufacturing sectors than the Asturian case, while the effect on other services (transport, businesses, other services) is double, "Finance, business, public and other services" being the most impacted industry. In Wales (Monkman et al., 2015) "Wholesale and retail" and "Hotels, bars and restaurants" was the most impacted sector in 2013, with a stronger effect of sea angling expenditure than in Asturias, while support to primary and manufacturing industries was once again comparatively lower. In contrast to the Asturian case, in both the English and Welsh studies recreational consumption by non-resident visitors was considered and the average annual expenditure on hiring fishing recreational services was relevant.

However, there are far more cases in the literature that have quantified the individual average annual expenditure (per fisherman, per licence) and TAE as proxies of the economic importance of MRF[56] (Artetxe et al., 2011; Crabtree et al., 2004; Gordoa et al., 2004; Herfaut et al., 2013; Hyder et al., 2018; Indecon International Economic Consultants, 2003; Ministerio de Agricultura, 2006; Nautilus Consultants, 2000; Pawson et al., 2007; Radford et al., 2009; Smit et al., 2004; Soliva, 2006; TRAGSATEC, 2005). Estimates of individual average annual expenditure in Asturias are close to those obtained for the Atlantic area of Spain by Hyder et al. (2018) and other regions of northern Spain such as Galicia (Pita et al., 2018); in particular, estimates are in line with results regarding fishing from recreational boats in the Basque Country (Artetxe et al., 2011) and the three major recreational modalities in Catalonia (Soliva, 2006). However, values for Asturias are very different to estimates concerning other Spanish areas (mostly the Canary Islands and the Mediterranean) and southern Europe (Gordoa et al., 2004; Ministerio de Agricultura, 2006; TRAGSATEC, 2005), with much higher individual values due to the characteristics of the practice and associated navigation (Lloret et al., 2008).

[55] 1 euro was equivalent to approximately 7.5 DKK at the time of their study.

[56] Galeano et al. (2004) opted for the estimation of more complex variables such as net returns of charter and private recreational fishing.

A methodological approach adopted by some studies is to exclude the costs of purchasing fishing vessels (depreciation) to be used in the MRF from the calculation of annual average expenditure and TAE indicators (Gordoa et al., 2004; Ministerio de Agricultura, 2006; Pawson et al., 2007; Roth and Jensen, 2003; TRAGSATEC, 2005). This criterion should be revised when an IO model is used; at the time of converting recreational TAE into a vector of aggregated expenditure by industry (ADE vector), it is considered that this and any other expenses specifically made by fishermen in the reference year of the IO framework should be included.

Another question refers to the variable expenses of the MRF when estimating average expenses or the aggregated expenditure, even in the context of a comparison between MRF and MCF (Pawson et al., 2007), generally with the aim of avoiding the allocation of expenses that can be shared with other activities (such as navigation, freshwater fishing, etc.). This research decided to introduce into the socioeconomic surveys some questions that make it possible to ascertain to what extent boats, fishing equipment or clothing are used for other recreational and sporting activities, asking, where appropriate, how many days the fisherman spends on each of them outside the MRF. The criterion to be followed would then be to allocate proportionally to the MRF the percentage of expenditure corresponding to the intensity of use for each shared activity. Note, for example, the relevance that this issue may have in the case of boat fishing: thanks to this type of question, in the present case study it was shown that the MRF is the hobby that motivates, in most cases, owning or renting a recreational vessel, and a high percentage of owners own a boat exclusively for fishing, so that most of the nautical expenditure should actually be allocated to MRF.

Finally, the comparison here made excludes environmental and social impacts of both sectors. Findings can be completed with considerations on the social sustainability and the role they play in the local development of coastal areas. In fact, MCAF´s potential impact on the economy could be somewhat underestimated, due to the fact that ecosystem services strongly related to cultural heritage (García et al., 2003; Johnson et al., 2018; Santos-Martín et al., 2015) were not explicitly included in the IO analysis (food provision was the only service considered).

Effects from MRF and MCF reflect very differently on the structure of the regional economy. Therefore both of them can be seen as complementary industries whose effects can be considered in a joint and integrated manner, and not only as competing activities for the same resource and coastal space. This means that regulation and management of the formal sector (MCF, with special attention to the MCAF) must take into account the impact of the MRF on the resource and space, according to the dimension that it reaches, and vice versa: the regulation of the MRF must converge in many aspects with that of the MCF, as Arlinghaus (2005) and Pita et al. (2017) have pointed out.

III.6 CONCLUSIONS

Marine recreational fishing (MRF) is not a formal sector of the economy, which makes it difficult to compare its economic relevance with that of commercial fishing (MCF). Studies dealing with the comparative relevance of MRF and MCF for an economy are particularly scarce, and to date inexistent in Europe. Nevertheless, the sustainable management of these two competing activities needs to be supported by an adequate knowledge of how they contribute to a regional economy and what the economic consequences are of certain management decisions and interaction between commercial artisanal fleets and recreational fishing. Although Input-Output (IO) models make it possible to quantify the economic relevance of MRF and to make a direct and consistent comparison with commercial fishing, some methodological issues that may hamper results from IO techniques require specific consideration when addressing MRF impact studies.

This Chapter has assessed and compared the contribution of recreational and commercial fisheries, particularly artisanal fisheries, to the final output, Gross Value Added and employment of a European regional economy by applying an demand IO model that uses data on recreational fishing expenditure from surveys specifically designed for this objective. It outlines the importance of connecting basic IO operations with primary information from expenditure surveys. Some of the criteria applied to obtain the MRF vector of final consumption include adjusting trade and transport margins, discounting taxes and purchases outside the region, setting the year of expenditure reporting as close as possible to the year when the IO tables are built, including fixed costs and recreational investments occurred in the reference year, allocating to MRF only the proportion of vessels´s fixed costs that corresponds to the intensity of fishing use, and accounting for no expenditure responses (if another person makes the purchases instead of the interviewed recreational fisherman).

In the Principality of Asturias MCF represents a formal industry of the regional accounts (harvesting), whose final demand is linked to the consumption of fish and seafood products by households and exports. The IO tables of Asturias 2010 (TIOA 2010) used are the closest to the period in which the socioeconomic recreational surveys were carried out. Although recreational and commercial fishermen do not operate on the same species, those mainly targeted by recreational fishermen in Asturias are mostly caught by the regional artisanal fleets. Thus, the objective was to know the relevance of this activity for the regional economy and its sectoral and multiplier effects at a specific time (2010) considering its competition with a declining commercial artisanal fleet (273 small-scale vessels): almost all enthusiasts (75,000 licenced fishermen) are resident and MRF is a local leisure activity without tourism orientation. Due to the need to introduce directly comparable recreational and commercial final demand estimates in the IO model, and to the limitations of data provided by the regional accounting on the destination of commercial fishery exports, the estimates were based on residents' final consumption (excluding commercial and recreational exports) rather than final domestic demands.

MRF had a relevant contribution to the regional economy in 2010 and shore fishing of resident anglers was largely the modality responsible for most of the MRF impact. Although final consumption by households of fish and sea products from MCF (€ 35 million) was the same as the final consumption of resident recreational fishermen (MRF) in 2010 (€ 35.2 million), commercial fishing was responsible for (directly and indirectly) more Gross Value Added (€ 26.7 million) and jobs (906) than recreational fishing (€ 22.0 million and 570 employments). Unlike the recreational sector, MCF is a net recipient of production subsidies, the support that can be justified by its higher capacity for job creation (particularly, the MCAF), by being key in the provision of an indispensable food such as fish. Although the final consumption by households of fish and sea products from MCAF amounted to only € 16.8 million in 2010, its contribution to job creation (488 jobs) is not far from the estimated effect of MRF. Multipliers of final consumption show that MRF had slightly higher potential than MCF to induce the final output of the regional economy, and both of them show a similar effect on GVA; nevertheless, the multiplier effect on employment is greater in the professional sector, especially in the artisanal fleets. The comparison between MRF multipliers from other estimates suggests that sectoral distribution of MRF impacts depends not only on the economic structure of the regions, but also on the extent to which they supply the increased recreational demands from the local economy and the importance to tourism of recreational fishing.

MRF and MCF private consumption jointly supported 0.25% of the regional GVA and 0.38% of the employment in 2010; however, both activities have a very different effect on the structure of the regional economy. On the one hand, MRF represents a mix of basically final consumption in businesses located in Asturias, motivated by the recreational enjoyment of saltwater fishing by residents. The contribution of MRF expenditure to GVA and employment remains strongly linked to retail, manufacturing and hotels/restaurants; retail and bars/restaurants are essential industries for the economy of coastal villages. On the other hand, final consumption by households of seafood is intensely concentrated in the primary sector (the harvesting activity of the fishing industry), and, to a much lesser extent, it supports machinery and capital goods and port operation services.

MRF and MCF should be seen as complementary industries to be considered in a joint and integrated manner: not only as competitors for resource and coastal space, but also as the pillar of the maritime economies. Due to the dimension reached by MRF, regulation and management of the formal sector, particularly of MCAF, should take into account their impact on the economy, resources and space (and vice versa). Better economic information on artisanal fleet activity would allow to use the model to, for example, assess the impact of demand-side policies that influence the final consumption of fish provided by MCAF´s domestic output and MRF final domestic expenditures. Nevertheless, economic information and data on recreational expenditure represents a challenge for Europe (EU, Member States and regions), that has the opportunity to consider it within a future Data Collection Framework; it would cover data requirements for impact assessments to support fisheries decision-making based on IO techniques.

CHAPTER IV. CONSIDERING SAMPLE SELECTION BIAS IN EFFICIENCY STUDIES OF ARTISANAL FLEETS BASED ON STOCHASTIC FRONTIERS

IV.1 INTRODUCTION AND LITERATURE REVIEW

In Chapter I it was concluded that a particular feature of artisanal multi-gear vessels is the way in which they can make their participation decisions in certain fisheries, given their economic-operational flexibility and capacity to alternate métiers. This information, in addition to specific data on employment on-board obtained in the regional sampling, served to investigate the relevance of this behaviour in the context of productivity and technical efficiency analyses of fisheries.

Part of the Asturian artisanal fleet is based on eight fishing harbors located in western Asturias[57] (Figure 22) with an ancient tradition in the octopus fishery; vessels operating this fishery target exclusively a single species, the common octopus (*Octopus vulgaris*), and they use artisanal traps to catch it (a highly-selective fishing gear that barely generates by-catches or discards).[58]

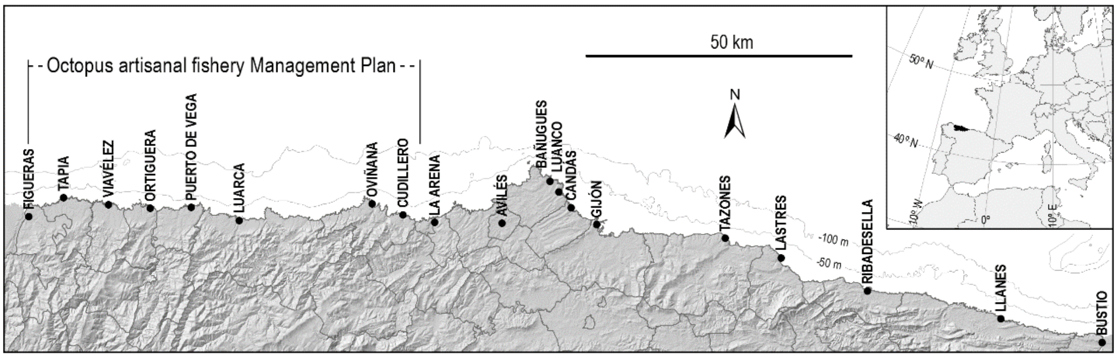

Figure 22. Fishing ports in Asturias (north-west Spain) and scope of the Management Plan for the octopus artisanal fishery (western part of the regional coast)

The octopus is a very attractive species for western artisanal vessels in the region (Fernández-Rueda and García-Flórez, 2007), because it reaches significantly higher first-sale prices than those registered by most sea products commercialized in the regional fishing guilds (Table 22). Due to its importance, the regional fishing authority approved in 2000 an *Octopus Management Plan* (hereinafter OMP) for this fishery; its target was to secure environmental (stock) and socioeconomic sustainability (increasing profitability levels and first-sale prices). According to the OMP regulation, the fishery remains open seven months a year (from 15th December to 15th July), when vessels are allowed to fish octopus under prior request to the fishing authority.

[57] Namely *Cudillero*, *Oviñana*, *Luarca*, *Puerto de Vega*, *Ortiguera*, *Viavélez*, *Tapia de Casariego* and *Figueras*.
[58] Recent technical references on the environmental sustainability of this fishery can be seen at https://fisheries.msc.org/en/fisheries/western-asturias-octopus-traps-fishery-of-artisanal-cofradias/about/

Measures to control the fishing effort consist of an annual catch limit of 10,000 Kg per vessel and year[59], a minimum capture weight of 1 kg per specimen caught and a maximum number of 125 traps allowed per crewmember (limit of 350 per vessel). The fishery is mainly operated by small-scale multi-gear boats that catch octopus in shallow waters close to the coastline on fishing trips of a few hours (returning to port on the same day) in winter and spring. But, as it has been described in Chapter I, during these months they are also able to alternate octopus traps with other artisanal fishing métiers to exploit hake (*Merluccius merluccius*), red mullet (*Mullus surmuletus)*, mackerel (*Scomber scombrus*), or goose barnacle (*Pollicipes pollicipes*). Octopus is a strategic resource for this western fleet and for the entire region: in terms of landings, octopus catches in the west coast of Asturias represented on average 77% of total octopus first sales in local fishing guilds of Asturias between 2007 and 2014. Previous studies (Álvarez Ballesteros, 2018; Pascoe and Herrero, 2004) have characterised in a very similar way the artisanal octopus fishery in Spanish Atlantic waters.

Due to the evolution of this fishery, in 2014 the regional fishing authority considered some new sustainable management measures to be promoted and commissioned a TE study of this fishery to guide decision-making on possible measures to be taken, based on a better knowledge of the determinants of octopus catches within the OMP, their importance in the yield and the efficiency of the different local fleets. Most of the vessels in the fishery are small-scale multi-gear boats (average total length 2007-2014 of 9 metres) registered as "multi-gear in the Cantabrian and Northwest fishing ground -CNW[60]" according to the Spanish Census of Active Fishing Fleet (CFO) (Table 22). Since 2000, about 130 different vessels have participated in the octopus artisanal fishery on the west coast of Asturias; both total landings of octopus and annual boats within the OMP are continuously decreasing year after year, especially since 2007. Although part of this negative trend is due to breaking-up processes, the general socioeconomic decline of artisanal fisheries in the region and the probable progressive reduction of the Atlantic stock[61] (Álvarez Ballesteros, 2018; Pascoe and Herrero, 2004), some active vessels remain in the fishery each season, while others have left it after some years fishing octopus, and other boats simply participate some years (expectations about "how good" has been octopus recruitment is a powerful driver for some vessels to enter the fishery[62]).

[59] This level has never been reached by any boat.
[60] Category originally named *Artes menores en Cantábrico y Noroeste* in the Spanish census, corresponding to a large extent to the "only passive gears" European census category.
[61] There are no population estimates of octopus for the region, as further studies are needed to clarify the status of the species and interconnections between subpopulations in this part of the Atlantic.
[62] A 3-year cycle characterises the abundance of octopus, so that a first successful fishing season is usually followed by moderate and low annual octopus catches respectively.

Table 22. Information on the octopus artisanal fishery on the west coast of Asturias

Fishing season	No of vessels	% of artisanal multi-gear boats	Technical characteristics of the fleet (average)			Octopus landings (kg)	Octopus first-sale price (current €/kg)	Average first-sale price of landings (current €/kg)
			Total length (m)	Gross tonnage (GT)	Power (kW)			
2007/08	61	98%	9.2	4.5	46.7	298,687	4.65	2.45
2008/09	39	97%	9.3	4.5	45.7	60,775	4.84	1.96
2009/10	39	97%	8.9	4	46.6	130,637	3.95	2.67
2010/11	49	98%	9.1	4.4	48.3	163,776	5.22	2.39
2011/12	44	98%	9.2	4.6	47.7	84,639	5.39	2.39
2012/13	44	95%	8.8	4.2	45.4	59,636	4.37	2.28
2013/14	38	95%	8.8	4.2	47.2	47,116	5.22	2.09

A first measure to be introduced after 2014 was stronger restrictions on the fishing effort, by reducing the maximum number of fishing days per vessel and year to improve the environmental sustainability of the fishery. A second policy consisted of improving commercial profitability, by increasing first sale prices of octopus and the economic sustainability of the fishery; this measure involved supporting (with public resources) the most efficient fleets throughout the process of designing and implementing an eco-label. A third management instrument considered new ways of improving the productivity and working conditions of crewmembers, as artisanal fisheries based on pots and traps have traditionally relied heavily on workforce and physical strength on-board (octopus fishery requires enough workforce to cast and haul the traps from the sea and to quickly harvest and re-bait). This action sought to improve socioeconomic sustainability.

From the early article published by Farrell (1957), the study of sectoral efficiency has played a key role in economic analysis (Fried et al., 2008). Many studies on technical efficiency (TE) and fishing capacity in fisheries economic literature have applied frontier functions, particularly parametric stochastic frontier analysis (SF) as proposed by Aigner et al. (1977) and Meeusen and van Den Broeck (1977). These functions explain the deviations from the frontier for every productive unit by distinguishing between stochastic exogenous effects and operating inefficiency of vessels; knowing the determinants of catch levels in a fishery, the productivity of fishing factors, the importance of technical inefficiency to explain the variability of catches and their causes are some examples of issues directly connected with the design and implementation of regulation measures and policies for the sustainable management of fleets and stocks. As Álvarez (2001) pointed out, after Schmidt and Sickles (1984) established the advantages and possibilities of estimating SF, TE studies in fisheries were developed (particularly analyses based on stochastic frontiers).

Heckman (1979) pioneered the problem of non-representative samples: some selection bias may appear when data do not come from randomly selected samples due to self-selection and selection decisions taken by analysts. In both cases, regression functions confuse the parameters explaining the studied behaviour and the determinants of the probability of being in the sample, causing systematic differences between the characteristics of the units selected in the sample and non-selected individuals. More recently, Greene (2010) remarked the need to control for sample selection bias in efficiency analyses, specifically in those based on non-linear models such as SF, for which he proposed a new estimator based on maximum simulated likelihood. Some productivity studies have dealt with sample selection bias in different ways: while Kaparakis et al. (1994) and Collins and Harris (2005) simply acknowledged the problem of this bias in their articles, Kumbhakar et al. (2009) and Lai et al. (2009) carried out different corrections, and Bradford et al. (2001) and Sipiläinen and Lansink (2005) opted for a correction based on Heckman´s two-stage estimation procedure (Heckman, 1979). More recently, Wollni and Brümmer (2012) and Bravo-Ureta et al. (2012) have followed Greene´s correction to solve this bias.

Within fisheries literature, the sample selection bias has been taken into account in some articles about different fishing topics, but so far have focused on TE, even when some outstanding studies (Kirkley et al., 1998; Squires and Kirkley, 1999) show the authors´ awareness of the problem of non-representative samples and selection bias. Kitts et al. (2000) dealt with selection bias problems in their study about vessel owners participation in a fishing vessel buyout program in the U.S.A. Eggert and Lokina (2010) corrected the selection bias in the sample they used to analyse regulatory compliance of Tanzanian artisanal fishermen on Lake Victoria. Bucaram and Hearn (2014), focusing on the Galapagos lobster fishery, showed the importance of controlling and correcting this bias when modelling the variables that explain entry–exit decisions and intensity of participation in a fishery. Flores-Lagunes and Schnier (2012) proposed a correction for sample selection problems in models to estimate spatial dependence of fishing production. Nevertheless, literature on SF applied to fisheries (Álvarez et al., 2003; Eggert, 2000; García Del Hoyo et al., 2004; Grafton et al., 2000; Kirkley et al., 1998, 1995; Oliveira et al., 2016, 2015; Sharma and Leung, 1998) has paid little or no attention to the potential impact of sample selection bias.

This part of the research focuses precisely on the susceptibility of fishing TE analyses to be affected by sample selection bias that needs control, particularly when non-technical determinants (fishermen´s attributes) are not subject to analysis and SF-based models are applied to guide sustainable policies for fisheries operated by highly flexible and adaptive multi-gear vessels (as is inherent in many artisanal and small-scale fisheries - SSF). If potential sample selection bias is not tested and, if so, corrected, estimates of marginal factors productivities will be biased, and global and individual TE indexes will also be affected; likewise, this bias will be transferred to other closely connected models, such as those proposed by Battese and Coelli (1995) or Squires and Kirkley

(1999), which will hinder a correct knowledge of the causes of technical inefficiency. In a context of designing policies and regulatory measures for a fishery, this can lead to incorrect conclusions concerning the type of measures to be introduced or the effectiveness of those already implemented to reduce the existing previous inefficiency. Situations of this type may arise, for example, in SF cross-section analyses in poor-data fisheries, that frequently in the literature have concerned coastal, artisanal and SSF (Esmaeili, 2006; Kim et al., 2011; Oliveira et al., 2016; Sesabo and Tol, 2007; Squires et al., 2003), and where multi-gear vessels may have undergone self-selection processes that determine their participation. Likewise, SF models using panel data to analyse TE are not free of sample selection problems either, above all if multi-gear vessels or boats belonging to different fishing census are involved.

This last Chapter aims to analyse the potential incidence of sample selection bias on fisheries TE modelling, a topic not specifically addressed in this literature to date, and how this may affect the design of sustainable fisheries management policies. Technical determinants of an artisanal fishery in Northwest Spain were examined and a correction method to the SF production function was applied in a similar way to previous studies in non-fisheries contexts (Bravo-Ureta et al., 2012; Wollni and Brümmer, 2012). The Chapter is structured as follows: Section IV.2 presents the model developed by Greene (2010) to correct non-linear models for sample selection bias, jointly with the specification of an SF model to quantify TE for the octopus artisanal fishery on the West coast of Asturias in 2008-2009 considering sample selection problems. In Section IV.3, data sources are described. Section IV.4 compares the results of quantifying input productivities and TE indexes from a corrected and an uncorrected SF model. Section IV.5 evidences the significance of unbiased results for the choice of sustainable management measures in the studied fishery; the importance of detecting and correcting sample selection bias in TE models for artisanal fisheries is also discussed, as well as the interest of extending this correction to other studies. Finally, conclusions are provided in Section IV.6.

IV.2 METHODOLOGY

IV.2.1 A stochastic frontier corrected for sample selection bias

What underlies non-random missing data is the existence of a systematic pattern, depending on unobservable variables, which explains that an individual i (i.e., a person, firm, or any observational unit in the analysis) is sampled or not. In his seminal work, Heckman (1979) raised this bias as a specification error, pointing out its most frequent sources and proposing a correction procedure that has been widely applied since then in socioeconomic studies that estimate behavioural relationships. Assuming that the structure of interest can be written as $y = X\beta + \varepsilon$, but data for the dependent variable y are only observable when another latent variable d takes the value $d = 1$, then the previous expression can be written as (17):

$$\begin{aligned} &\text{if } d = 1\ ;\ \ y_i = x_i\beta + \varepsilon_i\ \ (y_i \text{ observed}) \\ &\text{if } d = 0\ ;\ \ y_i \text{ unobserved} \end{aligned} \tag{17}$$

In this situation, residuals ε will be correlated with d, and the estimation of β will be biased (Heckman, 1979). Heckman´s general approach sets an objective equation (19) that usually represents a function whose dependent variable y is not observed under certain conditions, and in a selection/participation equation (18) that encompasses a discrete choice model to measure the probability p_i of individual i being sampled and z_i is a set of observables that explain the probability of being included in the sample. The residuals are assumed to distribute as $w \sim N(0,1)$ and $\varepsilon \sim N(0, \sigma)$, being $corr(w, \varepsilon) = \rho$. When $\rho \neq 0$ missing data on y are not random and the regression equation for the observed sample in (19) will produce biased estimates if standard regression techniques are used.

$$p_i = z_i\delta + w_i \tag{18}$$

$$y_i = x_i\beta + \varepsilon_i\ ;\ \ \text{if } p_i > 0 \tag{19}$$

In its simplest form, the SF originally developed by Aigner et al. (1977) represents a function such as (20), with an error structure ε_i based on two components: v_i is a symmetric disturbance which is assumed to be independently and identically distributed as $N(0, \sigma_v)$; this error component captures the random effects affecting an economic activity but out of the firms' control (such as luck, climatic events, etc.) and measurement errors in the dependent variable y. Additionally, u_i is an asymmetric disturbance ($u_i \geq 0$) for all *i*; it is assumed that u_i is distributed independently of v_i.[63] According to Aigner et al. (1977), this component of the error makes the productive units position on the frontier (the efficient units when $u_i = 0$) or below it (the inefficient units).[64] Finally, y_i is the output of each firm *i* and x_i is a vector containing the inputs.

$$y_i = x_i\beta + \varepsilon_i \qquad \varepsilon_i = v_i - u_i \qquad i = 1, \dots, n. \tag{20}$$

Greene (2010) drew the attention to the sample selection problems in non-linear models and he extended Heckman´s proposal for the specific case of estimating SF functions affected by sample selection: bias arises when the unobservables (v_i) of the production function (22) are correlated with the unobservables (w_i) in the selection equation (21).

$$d_i = 1\ [z_i\delta + w_i > 0] \qquad w_i \sim N[0,1] \tag{21}$$

$$y_i = x_i\beta + v_i - u_i, \quad \text{being } y_i \text{observed only when } d_i = 1 \tag{22}$$

$$v_i = \sigma_v V_i\,,\ where\ V_i \sim N[0,1] \qquad \text{and} \qquad u_i = |\sigma_u U_i| = \sigma_u |U_i|,\ where\ U_i \sim N[0,1] \tag{23}$$

$$(w_i, v_i) \sim N_2[(0,1)\,, (1, \rho\sigma_v, \sigma_v^2)] \tag{24}$$

Assuming that w_i and v_i follow a bivariate normal distribution as shown by (24), the parameter ρ informs of the presence or absence of selectivity bias. Greene (2010) suggests a two-step estimation procedure using maximum simulated likelihood (ML), where the variances estimated are adjusted by applying the Murphy–Topel correction to the variance-covariance matrix (Murphy and Topel, 1985). Given that observations with d_i=0 do not provide information about the parameters to the simulated log likelihood, the form of the function to be maximized is simplified as shown in (25):

[63] The most frequently assumed distributions are a truncated at zero normal or an exponential distribution, but other one-sided distributions such as the exponential are also possible.
[64] As Schmidt and Sickles (1984) have later pointed out, while v_i disturbance is uncorrelated with regressors x_i, this is not necessarily assumed for u_i.

$$logL_{S,C}(\beta,\sigma_u,\sigma_v,\rho)=\sum_{d_i=i} log\frac{1}{R}\sum_{r=1}^{R}\left[\begin{array}{c}\dfrac{exp\left(\dfrac{-\frac{1}{2}(y_i-x_i\beta+\sigma_u|U_{ir}|)^2}{\sigma_v^2}\right)}{\sigma_v^2\sqrt{2\pi}}\\ \text{x}\ \Phi\left(\dfrac{\rho(y_i-x_i\beta+\sigma_u|U_{ir}|)/\sigma_\varepsilon+a_i}{\sqrt{1-\rho^2}}\right)\end{array}\right] \quad (25)$$

where $a_i = z_i\hat{\delta}$.

IV.2.2 A model to quantify technical efficiency for the octopus artisanal fishery in Asturias considering sample selection

A cross-section stochastic frontier model (Aigner et al., 1977) for the season 2008-2009 (from 15th December 2008 to 15th July 2009) was initially specified using the sample of $n = 39$ small-scale vessels that participated in the octopus fishery during that period (the only season for which precise data on the number of crewmembers on-board to fish octopus were available).

The captures frontier reflects the maximum potential output (kilograms of octopus) that can be achieved given the productive inputs, the technology of production and the stock conditions. A relevant reason to select a stochastic frontier for this specific case study is that SF methodology results highly suitable to capture the effect of changes in the exploited stock; this is especially relevant for fisheries such as the one here analysed, whose target species abundance shows a high variability between different fishing months and within the annual season (from December to July). In this case a Cobb-Douglas production function has been assumed as follows[65]:

$$ln\, y_i = \beta\, ln\, x_i + (v_i - u_i); i = 1, \dots, n \quad (26)$$

Under this SF, TE for each unit *i* can be measured by the ratio between its real output and the output at the frontier level as:

$$TE_i = \frac{y_i}{\exp(x_i\beta+v_i)} = \frac{\exp(x_i\beta+v_i-u_i)}{\exp(x_i\beta+v_i)} = exp(-u_i) \quad (27)$$

[65] Pascoe and Herrero (2004) also assumed a Cobb-Douglas standard production function for the octopus artisanal fishery in South Atlantic Spanish waters. In addition to this, the relatively small sample size, together with the introduction of several explanatory variables in the model, make the estimation of a translog function for this case study difficult.

For those vessels located on the frontier technical efficiency equals 1 (vessels operating efficiently). The SF function was initially constructed to model octopus total landings (kg) per vessel *i* in the 2008-2009 fishing season as a function of four independent variables: three technical fixed inputs that represent fishing power (vessels' overall length, in metres; gross tonnage, in GT units; power, in kW), and fishing effort (the product of crewmembers times days at sea, in number) per vessel in 2008-2009.[66] The SF (28) has the classic structure with a symmetric error term (which represents stochastic factors affecting captures, v_i) and an asymmetric non-negative error term that accounts for inefficiency (u_i), for which an exponential distribution has been assumed.

$$ln\, y_i = \beta_0 + \beta_1\, ln\, CrewDays_i + \beta_2\, ln\, Lenght_i + \beta_3\, ln\, Tonnage_i + \beta_4\, ln\, Power_i + v_i - u_i \quad (28)$$

However, once this model was constructed, some questions affecting this fishery were considered as potential sources of underlying sample selection problems that could also affect decision-making on new management measures for this fishery. As already described, inter-annual variations in the number of vessels operating this fishery are not random and combine different causes that may be influencing their participation in the OMP each season (self-selection). Thus, an alternative SF model to (28) was set out to quantify the octopus artisanal fishery´s technical efficiency on the west coast of Asturias taking into account potential sample selection problems. Accordingly, a Probit model was estimated first to recover the probability of a vessel participating in the 2008-09 OMP by using data of the entire population: 90 vessels that have operated this fishery at least one season between 2000 and 2014 and were active during 2008-09. The dependent variable in the participation equation (18) shows the individual probability of participating in the octopus fishery in the years 2008-09. The Probit equation includes as regressors (z_i) some observables determining the fact that vessel i belongs or not to the sample, but not influencing directly y_i: previous experience in the OMP (number of octopus fishing seasons participated from 2000-01 to 2007-08), difference in first-sale prices (in percentage) between octopus and the rest of catches of a vessel[67] and economic dependence on the octopus fishery (ratio, in percentage, between vessel's income 2006-2008 from octopus and its total income from fishing).

[66] The possibility of introducing days at sea and crewmembers as two separate variables was ruled out, due to the low variability of workforce in the sample (values of 1, 2, 3 or 4 fishermen).

[67] It can be considered an indicator of fishing strategy. Octopus first-sale prices in 2006, 2007 and 2008 are averaged *per* vessel and compared (as ratio) to the average price reached by the rest of its landings over January-July 2009: percentages near or over 100% represent vessels focused on medium-priced commercial species (like octopus), while low percentages correspond to those dedicated to high-priced species (with higher first-sale prices than octopus).

Once the Probit was estimated, a new version of (28) was specified to control for potential self-selection in the sample of vessels that participated in the octopus fishery during the period 2008-09 by ML, according to Greene (2010) and calculating the variances of the estimates by applying the Murphy-Topel correction.

IV.3 DATA SOURCES

Different data sources have been used for this study. Firstly, as mentioned in Section IV.1 Introduction and literature review, the OMP is a co-management tool for the objective species, so that local fishing guilds and regional authorities cooperate to define regulatory measures and to monitor key parameters in the octopus fishery. Thus, every season small-scale boats officially registered as “multi-gear in the Cantabrian and Northwest fishing ground – CNW” (and, exceptionally, some bottom longliners) based on the aforementioned eight fishing ports applying to the regional fishing authority for a license to operate in the OMP; as a result, information on vessels participating this fishery since 2000 was provided by the General Directorate of Maritime Fishing. OMP monitoring and control activities carried out by the fishing regional authority enabled to access specific data on octopus landings (kilograms) and days at sea per vessel for the 2008-2009 season.

Secondly, technical information of vessels in the OMP since 2000 was obtained from the Spanish Census of Active Fishing Fleet (CFO). Thirdly, information on registered workers on-board regional fishing vessels in 2009-2010 was provided by the Marine Social Institute (ISM). Nevertheless, these figures had to be revised because artisanal vessel crews usually vary during the year, depending on the fishing métier carried out; the only information to check and complete ISM data for the octopus fishery came from the socioeconomic information on artisanal vessels interviewed during the regional survey[68] described in Chapter I.

Finally, a database on sea products first-sales auctioned in the quayside local fish markets of Asturias are annually compiled by the fishing regional authority, registering rich information on each transaction (vessel, species, first-sale price, weight auctioned, etc.). As these micro-data are not public, monthly data for this research were requested to the fishing authority concerning the 2006-2009 period.

[68] As mentioned in Section I.2.1 Global approach, this regional survey was carried out in the context of the European project PRESPO.

IV.4 RESULTS

Firstly, an SF function was estimated to explain individual levels of octopus landings $\hat{y}_i$ (kg per vessel in 2008-09 season) and to quantify the TE of the octopus artisanal fishery on the West coast of Asturias without considering sample selection bias (Table 23). Statistics of global adjustment (Log likelihood) show that the model is valid; the null hypothesis H0: $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2) = 0$ is rejected at 1% of significance, showing that technical inefficiency exists and that is stochastic. The estimated value for the parameter gamma (0.85) indicates that the effects associated with inefficiency contribute significantly (rather than luck, stock variations, sea and weather conditions, etc.) to the observed variability of octopus catches, so it is relevant to introduce management measures to improve efficiency. Three of the four regressors are relevant to explain vessel´s landings. The elasticity corresponding to fishing effort ($\hat{\beta}_{lnCrewDays}$ = 1.0034) is the largest and positively significant at 1%. Technical inputs such as total length or tonnage were statistically significant (*p*-values under 10%), but contrary to what was expected (total length is supposed to be the main parameter that determines the number of fishing traps that can be transported on the boat during a trip), the estimated parameters had a negative sign for the length and a positive sign for the gross tonnage. As expected in this type of métiers, the engine power of the vessel is not relevant to explain octopus catches.

Table 23. Estimation results of the stochastic frontier model without correction for sample selection bias (Initial_SF)

Variables	Coefficients [a]	S.E.
constant	5.5282***	1.1121
ln_CrewDays	1.0034***	0.0001
ln_Length	-1.0641*	0.6252
ln_Tonnage	0.3594*	0.2117
ln_Power	0.0054	0.0913
Log likelihood	-43.8197	-
σ	0.6015***	0.0045
γ	0.8531***	0.6784
N	39	-

[a] Model adjusted by ML (dependent variable: kilograms of octopus landed per vessel n the season 2008-09, in logarithm). Legend: * if p<0.1; ** if p<0.05; *** if p<0.01.

Secondly, an alternative SF function that considered potential selectivity problems in the sample was estimated. At a first stage, a maximum likelihood estimation of a vessel´s probability of participating in the 2008-09 OMP was carried out (Table 24): statistics of global adjustment show that the model is valid and the regressors are relevant to explain a vessel´s probability of operating in the fishery. Two of the three regressors considered in the Probit were statistically significant (*P*-

values under 1% or 10%). Thus, previous experience fishing octopus (*Prev_seasons*) and the difference in the first sale prices of octopus compared to other species (*Price_dif)* had a positive influence on a vessel´s probability of participating in the western octopus fishery during 2008-09.

Table 24. Probit model: vessel´s probability of participating in the octopus fishery during the season 2008-09.

Variables	Coefficients [a]	S.E.
constant	-1.5456***	0.3412
Prev_seasons	0.2075***	0.0607
Price_dif	0.7974*	0.4513
Econ_depend	0.0032	0.0095
Log likelihood	-47.6019	-
Pseudo R^2	0.2270	-
N	90	-

[a] Binomial Probit model adjusted by ML (dependent variable: fish octopus).
Legend: * if p<0.1; ** if p<0.05; *** if p<0.01.

These results evidence underlying selection problems for the application of the initial TE model, so the estimated Probit was used to obtain participation probabilities ($\hat{p}_i$) per vessel and, in order to test and control this bias, the corrected SF model was re-estimated (Table 25). The first noticeable result is that the estimate of ρ is statistically significant at 1%, showing evidence of sample selection bias. Re-estimated regressors (except engine power) were statistically significant at 1%. The estimated coefficient for vessel length substantially differs between the original and the corrected SF equation ($\hat{\beta}_{lnLength}$ = 0.6927) and has a positive influence on octopus catches, as expected, while gross tonnage registers the lowest elasticity and negative sign, which would appear to be more coherent. The interaction of workforce size and fishing days now has an even lesser influence than before on the level of catches, although fishing effort is confirmed as the most determining input in the yield.

Table 25. Estimation results of the stochastic frontier model with correction for sample selection bias (Adjusted_SF)

Variables	Coefficients [a]	S.E.[b]
constant	3.5167***	0.2761
ln_CrewDays	0.8181***	0.0128
ln_Length	0.6927***	0.1774
ln_Tonnage	-0.2263***	0.0547
ln_Power	-0.0214	0.0237
Log likelihood	-53.1353	-
σ_u	1.1795***	0.0112
σ_v	0.0456***	0.0089
$\rho_{(w,v)}$	0.9999***	0.0021
N	39	-

[a] Model adjusted by ML (dependent variable: kilograms of octopus landed per vessel in the season 2008-09, in logarithm). Legend: * if p<0.1; ** if p<0.05; *** if p<0.01.
[b] Adjustment based on Greene (2010) and standard errors correction according to Murphy and Topel (1985).

These outcomes suggest that selection bias will also affect the measurement of TE in this fishery, so individual and global TE indexes were calculated and compared between the original (Initial_SF) and the corrected stochastic frontier (Adjusted_SF). Sample selection bias was leading to a noticeable overestimation of the global technical efficiency in the octopus fishery for the season 2008-2009 (Table 26): an average score of 0.613 if the initial SF is used and 0.492 when the model is adjusted to control for selectivity bias according to Greene (2010).

Table 26. Local fleets´ average TE indexes when SF model is adjusted to control for sample selection bias.

Fishing port	Original TE (Initial_SF)	Corrected TE (Adjusted_SF)	Place in the ranking (Initial_SF)	Place in the ranking (Adjusted_SF)
Cudillero	0.361	0.324	7	6
Figueras	0.430	0.256	6	7
Luarca	0.663	0.522	3	6
Oviñana	0.701	0.638	2	1
P. Vega	0.707	0.593	1	2
Tapia	0.524	0.389	5	4
Viavélez	0.554	0.588	4	3
Average TE in the fishery	**0.613**	**0.492**	-	-

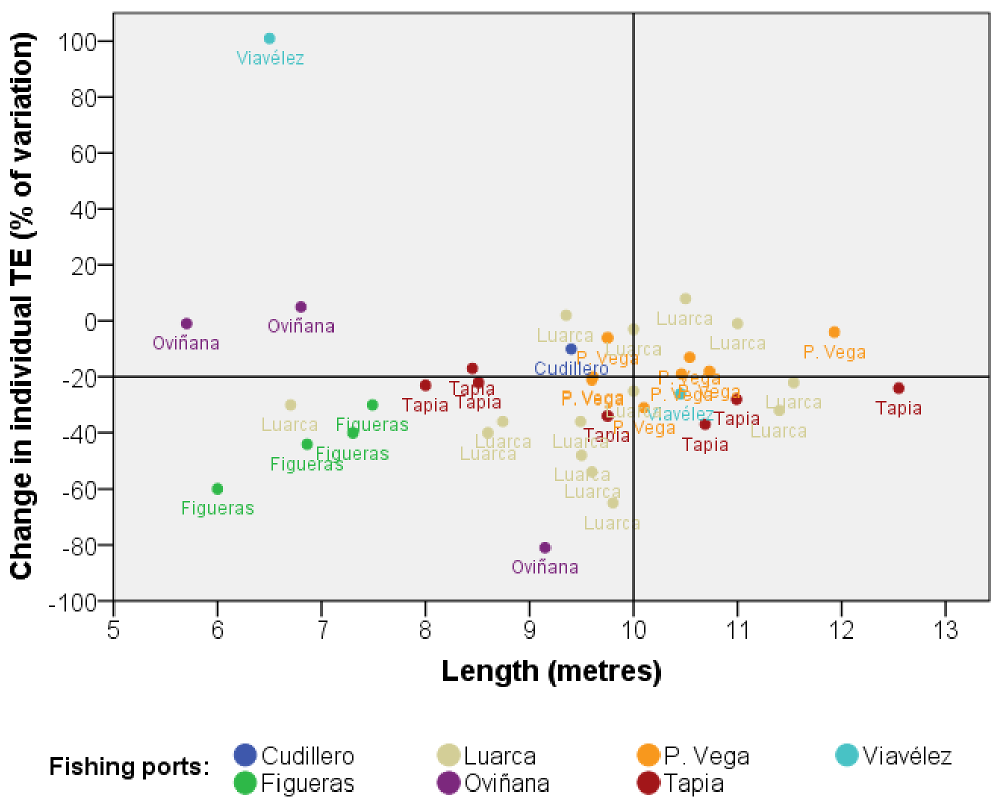

Figure 23. Intensity of adjustment in individual TE indexes after correcting for sample selection bias, by total length and fishing port.

According to both models, no boat is placed on the production frontier, although the two most efficient vessels keep their first and second place, respectively, and increase their TE scores until almost 1 under the corrected model (TE scores of 0.98 and 0.94). Nevertheless, individual TE has varied considerably for most of the vessels: 18 of the 39 boats dropped positions in the TE ranking before adjusting the SF, while 14 improved their initial positions.

Finally, TE reduction has been more intense for the smaller boats (Figure 23), as due to selection bias the efficiency of the shorter boats was overestimated: on average, TE scores for vessels under 10 metres of overall length were reduced 25%, compared to an average variation of -18% for vessels ≥ 10 metres. The original SF model was also promoting TE indexes of some local fleets with moderate efficiency, such as those based in the fishing ports of Luarca, Figueras and Tapia (Table 26). The local fleet based in the port of Oviñana clearly became the most efficient in the octopus fishery 2008-2009 after correcting the stochastic frontier (overtaking the local fleet of Puerto de Vega, apparently the most efficient under the original SF model).

IV.5 DISCUSSION

IV.5.1 Relevance of unbiased estimates in the sustainable management of the fishery

The correction here applied has been useful to control selectivity bias in two key elements of the TE model: the relevance of certain fixed inputs to determine catch levels and the measurement of the TE of global and local fleets. This approach is considered to be a versatile solution when non-technical determinants of productivity are not the object of the analysis; it also can be extended to TE analyses of artisanal and SSF based on DEA, as for example those developed by Tingley et al. (2003) and Idda et al. (2009). The model used in this study, based on cross-section data, may present some limitations to achieve consistent estimates of individual TE (Schmidt and Sickles, 1984), but this case study truly reflects the reality of poor data contexts characterising some artisanal small-scale fisheries where availability of time series of reliable information is seriously limited (Filous et al., 2019; Ruano-Chamorro et al., 2017)[69]. Nevertheless,

[69] Unlike industrial and large-scale vessels, the sampled boats lacked vessel monitoring systems (VMS) or on-board logbooks which provide basic, continuous and detailed information on their fishing activity.

although future improvements in the level of information can be used for more robust exercises such as those based on panel data, the main objective is to evidence the susceptibility of selectivity bias in TE studies, and how this may have implications for policy design and sustainable fisheries management.

The main purpose of efficiency estimates in this empirical case was to guide sustainable fleet management decisions and the choice of new measures at a local-regional level. Sample selection bias would cause a noticeable underestimation of the importance of total length for this artisanal fishery, which is just the key fix input (octopus daily catches do not require having large tonnage, but rather sufficient length to transport dozens of traps). On the other hand, SF correction has avoided an overestimation of fishing effort (workforce productivity in fishing days) for this fishery. As expected[70], fishing effort in terms of crew_days is the most determining factor of the volume of catches in the case study, which discouraged the adoption of management measures based on reducing the fishing days allowed, but correcting the bias implies a reduction in the estimate of labour productivity. Although both models suggest that limiting the number of fishing days per season could have a strong negative impact on catches and income derived from this fishery, according to the corrected SF model labour elasticity is lower than one, so there is a margin to increase productivity by improving labour productivity and crewmember conditions (i.e., by supporting or subsidising the installation of mechanic haulers on-board, or the use of artificial bait).

Additionally, the corrected SF pointed to productivity derived from a physical characteristic such as vessel length being almost as determinant in the level of catches as fishing effort, an issue that had been remarkably underestimated by the initial model. Nevertheless, length is a fixed productive factor that cannot be modified in the short-medium term, so market-based policies emerged as the best option to improve global sustainability in this fishery.

Thus, in order to provide public support to implement an eco-label for this artisanal fishery, the most efficient local fleets had to be identified. The local fleet of Puerto de Vega had been traditionally considered the most productive, and apparently, it also proved to be the most efficient fleet under the original SF model. Nevertheless, the adjusted SF provided an unbiased interpretation of local fleets´ efficiency, as the local fleet of Oviñana achieved the first place in the local ranking of TE, followed by the ports of Puerto de Vega (second position) and Viavélez (third position). In view of that, the Fisheries Local Action Group (FLAG) to which the ports of Viavélez and Puerto de Vega belong to, jointly with the Regional Government, decided in 2015 to support

[70] Crewmembers are key for the yield of many artisanal fisheries, particularly those consisting of pots and traps métiers that highly depend on workforce, as Tingley et al. (2005) have pointed out.

these fleets to certificate this fishery under the renowned Marine Stewardship Council (MSC) standard of environmental sustainability[71]. Vessels belonging to three of the four most inefficient local fleets according to the corrected SF estimates (Cudillero, Luarca and Figueras) decided not to join the eco-labelling certification in 2015.

IV.5.2 Susceptibility to sample selection problems in technical efficiency models for artisanal fisheries

The empirical case studied in this Chapter showed that the fleet participating in the octopus artisanal fishery during 2008-2009 had undergone a self-selection process. It reflects a typical scenario characterised in Chapter I, where changes in the biological or economic conditions of species results in a rapid redistribution of vessels´ fishing effort among an optimal combination of métiers. Previous artisanal fisheries TE studies using cross-section datasets for SF models could have been also affected by self-selection problems in the samples used (Esmaeili, 2006; Kareem et al., 2012; Kim et al., 2011; Sesabo and Tol, 2007; Squires et al., 2003). Some artisanal and small-scale vessels make short-term fishing decisions in a different manner: highly flexible and adaptive multi-gear vessels alternate their annual activity between different métiers depending on market prices or stock size (in case of cyclic stocks, some seasons only the most efficient vessels decide to participate in the fishery).

Despite the advantages of carrying out SF modelling by using panel data (Schmidt and Sickles, 1984), very few SF studies concerning poor-data artisanal multi-gear fisheries have been able to follow this approach, as availability of long time series with reliable information about output, inputs and fishing effort is sometimes seriously limited. In fact, in some of the few examples based on panel datasets (Fousekis and Klonaris, 2003; Lokina, 2008) authors admit that the available time series is so short that the model actually has a marked cross-section dimension. Complexity and data limitations to model TE and fishing capacity in some of these fisheries have been well described by Tingley et al. (2003) and Idda et al. (2009), among others. Even in the present case study, an artisanal fishery which has been monitored in recent times, detailed information on fishing effort (i.e. number of hauls per fishing trip, real number of traps used per vessel) and vessel specific

[71] In February 2016 the *Western Asturias Octopus Traps Fishery of Artisanal Cofradias* became the first octopus fishery in the world to be certified under the MSC ecolabel for sustainable fishing (https://fisheries.msc.org/en/fisheries/western-asturias-octopus-traps-fishery-of-artisanal-cofradias/@@view)

time-varying inputs (i.e. consumption of bait and fuel, daily distance covered between the port and the fishing area) were unknown; data at trip level were not available neither.

Nevertheless, outcomes suggest the interest of testing sample selection bias in TE studies of fisheries operated by multi-gear vessels where panel data are available (Griliches et al., 1978). Frequently, the output of some units in the sample is not registered for the whole period involved due to definitive or temporal attrition of the fishery (Heckman, 1979)[72], but regardless of whether the attrition rate is high or low, the randomness of missing data should be firstly ensured. Noteworthy examples that illustrate this risks can be found in García Del Hoyo et al. (2004) and Oliveira et al. (2015), again related to artisanal and small-scale fisheries. Another interesting situation, similar to the empirical case addressed in this research, was described by Pascoe and Herrero (2004) when using DEA and a panel dataset to obtain fish stock indexes for the octopus artisanal fishery in the south of Spain; the small artisanal vessels involved had changed their fishing strategy to adapt to the decrease of octopus stock, so that they progressively reduced their participation and diversified fishing effort to alternative fisheries. In all these examples, if vessels do not leave the panel dataset in a random way (i.e., the vessel is out of service, undergoing repair work, skipper´s illness, etc.), a systematic pattern depending on unobserved characteristics is affecting disturbances in the model, so exogeneity assumptions will fail and the effect of sample selection bias will grow (Hausman and Wise, 1979). Alternatively, any attempt to obtain a balanced dataset (by dropping *attriters* from the sample) will imply selectivity bias in the sample used.

Finally, other reasons to control for sample selection bias go beyond aspects exclusively linked to multi-gear artisanal and SSF. A first relevant question is to prevent a ripple effect distorting the results of other connected models. The use of SF estimates resulting from a selection-biased panel data sample to model inefficiency effects [in a simultaneous estimation as proposed by Battese and Coelli (1995) or to explore managerial determinants -so-called *skipper´s skill*- according to Squires and Kirkley (1999)] will lead to mistaken conclusions about the causes of fishing technical inefficiency and the possibilities of its reduction. A second key question is that sources of underlying selectivity bias are not exclusive to artisanal fisheries. SF using cross-section data have been widely applied by fisheries researchers to analyse TE of fisheries operated by vessels belonging to different census and métiers; in situations such as those studied by Grafton et al. (2000), Jamnia et al. (2015), Pascoe et al. (2001) or Sharma and Leung (1998), self-selection problems could also have been present; in fact, Pascoe et al. (2001) eliminated vessels under 10

[72] They may leave the fishery during some time and take it up later.

metres of total length from the samples because they were considered to be "*highly opportunistic*" (they switch the gear regularly).

IV.6 CONCLUSIONS

This Chapter has been focused on the susceptibility of fishing technical efficiency (TE) analyses to be affected by sample selection bias, its sources and consequences when models based on stochastic frontiers (SF) are applied to guide sustainable policies for fisheries operated by highly adaptive multi-gear vessels, as it is inherent in many artisanal fisheries To date, this particular topic has not been specifically addressed in fisheries literature. Selectivity bias was examined for the artisanal octopus fishery in Asturias, an empirical case where TE analysis aims to guide the adoption of sustainable management measures. To do that, a model developed by Greene (2010) was used to correct for sample selection bias non-linear models as stochastic frontiers, and this correction was applied to a cross-section SF for the fishing season 2008-2009, a similar approach followed by previous studies in non-fisheries contexts.

Results showed that participant vessels had undergone a self-selection process: unobservable elements were rising simultaneously the participation probability and the productivity in this case of study. The corrected SF function has been able to control selectivity bias in two key elements: inputs productivities and the measurement of the TE of global and local fleets. Sample selection bias was leading to a noticeable overestimation of the global technical efficiency in the octopus fishery for the season 2008-2009: an average score of 0.613 if the initial SF is used and 0.492 when the model is adjusted to control for selectivity bias according to Greene (2010). The unbiased SF avoided a noticeable underestimation of the importance of vessel length and an overestimation of fishing effort to explain catch levels. These findings led to identify the improvement of on-board conditions of crewmembers and a market-based measure of eco-labelling as the preferable policies among other possible actions (such as reducing fishing days allowed per vessel and season). Unbiased TE indexes also allowed for a correct knowledge of local fleets´ efficiency at port level, which was used to identify the most efficient local fleets as potential beneficiaries from public aid to support the eco-labelling process. Findings suggest that, in general, fishing TE studies should pay attention to sample selection bias if multi-gear artisanal or small-scale vessels are involved in a fishery.

CONCLUDING REMARKS

The Principality of Asturias represents a paradigmatic case study on marine artisanal fishing due to the high weight that this type of fleet has in the whole regional fishing sector and the number of linked employments located in a few coastal villages. Despite this, like many other regions of the world and Europe, traditionally there has been a lack of knowledge regarding its economic and social importance. The lack of data typical of these fleets has often prevented us from knowing their real dimension and importance for the economy and the communities of the coastal regions, despite the fact that they are very well aligned with the principles of environmental sustainability that prevail in our society today. This research has been eminently applied and empirical, taking advantage of new regional data sources in Asturias and applying statistic analyses and economic models commonly used in other research contexts. Findings provide a novel and detailed knowledge that can be linked to the implementation of specific management measures to improve artisanal fisheries sustainability in this area.

Findings have outlined the strong coastal, close-to-port character of the Asturian artisanal fleet; the high annual rotation between fishing métiers and gear types confirms its polyvalence, as well as the low levels of capital investments, family-based work and a high importance of traditional knowledge. In fact 21 fishing métiers has been identified, 16 of which remain active nowadays, confirming the heterogeneity of a sector (the artisanal one) that is classified within an only and undifferentiated census category, which usually has been taken as a reference for management and planning public policies. Such heterogeneity has traditionally complicated their management and the availability of accurate data on fishing effort and incomes. This question directly connects with the design of specific sustainable management measures in the context of South-Europe: when highly heterogeneous artisanal vessels represent a relevant part of the whole fleets, management and planning measures should be designed taking into account this high level of internal complexity, avoiding grouping these vessels together within a uniform category (i.e. named *Artes menores* in Spain, category of “Only passive gears” at a European scale, etc.). In the Asturian case, métiers show significant differences in output (landed weight and value) and demands of productive inputs (and costs), suggesting that each métier or groups of similar métiers probably have different needs of support in terms of subsidies, training activities or security requirements.

In addition to this, the Asturian case illustrates a productive activity that cannot be defined only by operational and technical parameters (length under 12 metres and absence of towed gears) by the regulatory framework: definition of artisanal or small-scale fisheries must be clarified at EU´s level on the basis of a multi-criteria system that considers social and economic indicators that properly differentiate artisanal fleets from non-artisanal ones. Despite regional variability, this thesis has found clear similarities between the Asturian and other European artisanal fleets for most of the socioeconomic parameters analysed, so a coherent and consistent segmentation of them can be achieved at national and European level, enabling the development of specific measures for these fisheries.

Results have also reported interesting information on how Asturian artisanal vessels are making their strategic (long-term) fishing decisions: a progressive disappearance of certain artisanal métiers with low economic profitability (although high level of environmental sustainability) is happening in parallel to a concentration of activity on net gears (mainly, trammel nets). This suggests new sustainable management challenges: it should be evaluated the social and environmental role of artisanal métiers with low economic profitability in order to support them, whereas artisanal net métiers should be increasingly monitored to preserve the environmental sustainability of artisanal coastal fisheries. This trend, together with the lack of generational replacement of local fishermen, also affects the cultural dimension of artisanal fisheries: local and traditional knowledge, passed down from generations, is rapidly decreasing; ultimately, it may hamper the long-term social sustainability of artisanal fisheries and implies a loss of the culture and idiosyncrasy of the linked coastal communities.

Artisanal fishing have been often described as an unproductive activity, with low levels of inputs remuneration and added value rates. Economic indicators on small-scale fisheries in Europe highlight these issues. Results indicate that realistic estimates for artisanal fleets have to take into account a certain level of unreported sales (sales outside the officially established fish-market channel), which raises productivity and returns of inputs as labour to acceptable levels, although lower than in other sectors. This acts as an entry barrier for new artisanal vessels, and, basically, it is the consequence of the low first-sale prices, rigidities and commercialization constraints at local markets. Furthermore, findings concerning labour remuneration and cost schemes for the Asturian case make the classic concept of profit questionable in many fishing contexts and requires reinterpretation (i.e. for the analysis of artisanal fisheries performance): the Asturian fleet shows a very adaptive and adjusted cost structure, where the aim is not to maximise profit but rather wages and fishing opportunities (as ship-owners use to work on the vessels and are paid like any other crewmember); this is an already unusual example of the solidarity-based distribution of risk that gives these productive units a nature closer to the social economy, than to a normal business activity. In addition to this, substitution possibilities between métiers are not total, so there are seasonal and technical productive rigidities that limit artisanal fishing possibilities for part of the vessels in periods of very adverse weather or under the reduction of certain stocks; in such a context, low-profitable or highly spatially-restricted métiers (as goose barnacle recollection, glass eel fishing, etc.) play a fundamental role to maintain fishing activity and employment, which should be considered for management and public economic support. Finally, given the very low degree of economic diversification of artisanal fishermen in Asturias, their cultural heritage, including traditional local knowledge, arises as an interesting source of business for artisanal fishermen to be encouraged throughout direct institutional and administrative support and financing.

Similarly, most economic and financial indicators concerning artisanal and small-scale fisheries fail to reflect both the social dimension implicit in the principles of sustainability and their contribution to the local and regional economies, particularly in terms of gross value added and employment generation, as proposed by the Common Fisheries Policy (CFP). This research provides an alternative vision of the socioeconomic contribution of artisanal fleets, according to the aforementioned principles, by using a structural model of the economy (Input-Output framework) whose matrices have been disaggregated to isolate artisanal fishing values and to measure the dimension and effect of this industry on the economy. Evidences from the Asturian artisanal fleet confirmed that although it only supplies one third of total fisheries output in the region and embodies 37-38% of sectoral employment and GVA, it exerts higher multiplier effects (direct and indirect) on regional employment (2.8 additional jobs due to increases of € 100,000 in the artisanal fleet´s final demand) and income (0.82) than the average economy (1.7 and 0.72, respectively) and the rest of the fishing sector (2.4 and 0.73, respectively). Additionally, the potential to create gross value added (measured as GVA/direct employment) is particularly important for the artisanal fishing, and estimates (almost € 26,000 per job in 2010) are very close to those of the rest of the fishing sector (€ 27,000). These outcomes are reflecting the higher quality and first-sale prices of most artisanal sea-products, as well as higher labour demands than industrial fisheries.

In the future, on the basis of the sustainable and Common Fisheries Policy principles, governments should definitely build new management scenarios that translate these strengths into higher fishing possibilities and more efficient economic incentives for those fleets that grant low environmental effects on marine ecosystems and high socioeconomic impacts on their economies. All in all, findings suggest that management estrategies and resources from the future European Maritime and Fisheries Fund (EMFF) should minimise artisanal fleet´s dependence on direct subsidies and give priority to new measures. Economic incentives for the artisanal fleets should be based on the recognition of their lower environmental impacts, their socio-cultural heritage and their strategic role in maintaining employment and income in certain coastal areas. Based on a greater recognition of artisanal fishermen as an integral part of the marine (social-ecological) systems, changes should also reinforce co-management schemes and the engagement of local fleets, as well as organizational improvements, in parallel to greater control over labeling and traceability procedures, enhancing the valorization of their catches in markets. It would incentive artisanal fishermen to increase their level of declared sales.

Another topic addressed in this thesis is that, for many regions as Asturias, small-scale fishing is the main user of a coastal space where other users are currently widespread (recreational fishing) or are expected to become so in the near future (i.e. off-shore energy). The sustainable management of competing activities sharing resources and space should also be supported on an adequate knowledge of how they contribute to a regional economy, or what are the economic consequences of certain management decisions and interaction. This task remains difficult in cases like marine recreational fishing (MRF), as it is a non-market outdoor activity that neither represents a formal sector of the economy nor provides available information to be used in economic analyses. But decision-making regarding the distribution of access rights for resources with concurrent uses is relevant for the future of fishing in Europe (for example for the implementation of key legal European instruments such as the Marine Spatial Planning Directive –MSP- or the Marine Strategy Framework Directive –MSFD); the lack of updated and complete knowledge on artisanal fleets may be a vulnerability that lead to underestimate their economic and social importance with respect to other marine competing uses.

This thesis has tried to overcome these problems by using again Input-Output analysis to know the relevance of this activity for the regional economy and its sectoral and multiplier effects considering its clear competition (75,000 recreational licenced fishermen) with a declining commercial artisanal fleet. Focusing the assessment on residents' final consumption (excluding commercial and recreational exports), rather than final domestic demands, results have confirmed that consumption linked to marine commercial fishing (MCF) has a greater effect on the regional economy than that linked to the marine recreational fishing (MRF), both in gross (GVA and total employment generated) and relative terms (multiplier effect of private final consumption). But it is especially noteworthy that the GVA multiplier for artisanal fishing (MCAF) (0.82) exceeded MRF´s multiplier (0.63), and the employment multiplier was also notably higher (2.86 compared to 1.63). This is particularly relevant if we also assume that MCAF´s potential impact on the economy could be somewhat underestimated due to the fact that ecosystem services strongly related to cultural heritage were not addressed in the IO analysis (food provision was the only ecosystem service considered).

Nevertheless, both commercial and recreational fishing can be seen as complementary industries with different roles in maritime economies´growth: while GVA and employment linked to MRF expenditure remains strongly linked to retail, manufacturing and hotels/restaurants, final consumption by households of seafood is intensely concentrated in the harvesting activity of the fishing industry (including artisanal fleets), and, to a much lesser extent, it supports machinery and capital goods and port operation services. Recreational fishing can be also seen as an emerging sector (i.e. market opportunities for angling recreation) to promote the economic diversification of the artisanal fishing.

This dissertation has also tried to outline the importance of considering certain economic characteristics of artisanal fleets when applying econometric models commonly used to advice fishing policies. The multi-gear character of many artisanal vessels and their ability to alternate between different métiers imply that their decisions to participate in fisheries may be influenced by issues that are not relevant in other fishing contexts; in addition to this, fishing opportunities and effort (days at sea) are lower as their technical characteristics are reduced, and vessels´ size limits the capacity of performing certain métiers. As a consequence, sometimes observed samples of artisanal vessels in a fishery may not be random and be affected by unobservable variables that are influencing their fishing decisions, resulting in sample selection bias. This is not trivial when models are oriented towards management decisions or the design of fleet measures. That is the case of technical efficiency models, widely applied in productivity analysis of industries as fishing. Data from the octopus fishery and the Asturian artisanal vessels that seasonally participate in it were used to estimate a stochastic frontier model that confirmed the existence of a self-selection process concerning the vessels observed in the sample (fleet participating in the fishery). The most interesting issue is that the biased and the corrected model led to very different conclusions from the point of view of the management measures to be adopted in this fishery, as the latter one provided quite different estimates of inputs productivities and technical efficiency.

Finally, the improvement of information, especially on socio-economic data, is an essential condition for further progress in artisanal fisheries research and management. Knowledge-based policies are essential for the fishing industry, one of the most regulated sector worldwide, that in the case of artisanal fisheries must also be aware of the complex linkage between economic-social-environmental-cultural aspects. The European Data Collection Framework (DCF) for fisheries, to which EU Members and regions report information, should pay attention to these questions in the future, by deepening the systematic sampling of these vessels and offering much more disaggregated and representative indicators of their economic and social situation. On the other hand, more collaborative and participatory approaches as the cooperation between artisanal fishermen and researchers are essential to achieve higher level of transparency that provides reliable and realistic information to carry out accurate economic analyses of artisanal fleets. Fortunately, data collection methods based on new technologies are also advancing rapidly; at the regional level, the growing implementation of real-time monitoring systems for Asturian vessels under 12 metres and the implementation of a systematic framework for the collection of socio-economic information through direct surveys will be valuable sources of information that will make it possible to refine and extend in the near future the research that has begun with this thesis.

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APPENDICES

A. QUESTIONNAIRE TO MASTERS OF FISHING GUILDS

GOBIERNO DEL PRINCIPADO DE ASTURIAS
CONSEJERÍA DE MEDIO RURAL Y PESCA

ENCUESTA SOBRE LA SITUACIÓN SOCIO-ECONÓMICA DE LAS PESQUERÍAS ARTESANALES EN ASTURIAS



A RELLENAR POR EL ENTREVISTADOR:

Código de calidad……………………

Código de entrevista...................... Entrevistador…………………………..

INFORMACIÓN GENERAL

Nombre………………………………………………………………………………………

Edad…………… *Nivel de estudios*………………………………………

Puerto base al que pertenece………………………………………………………………

Características de la embarcación:

Nombre de la embarcación…………………………………………………………………..

Antigüedad de la embarcación………………. *Eslora total*………………………

Arqueo (GT)……......... *Potencia declarada (Kw)*……………...

Potencia real…………...

RECURSOS BIOLÓGICOS Y ESFUERZO PESQUERO

1.-Modalidad de pesca en la que está inscrita la embarcación en el censo nacional………………………

2.-Media anual de días parado / varado (cuantos días al año permanece la embarcación parada por motivos de reparaciones, varado obligatorio, mal tiempo, etc. SIN INCLUIR FINES DE SEMANA)

……...……….……..días de media parado

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CONSEJERÍA DE MEDIO RURAL Y PESCA

PRESPO

3.- Por favor, indique de forma breve qué **técnicas, aparejos o artes de pesca utiliza** a lo largo del año, así como **la época aproximada del año** y **las principales especies objetivo** capturadas con cada una de ellas:

Técnica o aparejo de pesca	**Temporada en que se utiliza** (de forma general, por ejemplo: entre noviembre y diciembre)	**Principales especies objetivo**	**¿Qué porcentaje del total desembarcado se captura con dicho aparejo?**	**¿El aparejo se levanta diariamente? En caso contrario indicar tiempo en el mar.**

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Gobierno del Principado de Asturias

Consejería de Medio Rural y Pesca

4.- De forma general, ¿podría indicarme los **en qué zonas desarrolla su actividad pesquera**? (puede ser más fácil indicar zonas de pesca en el mapa de caladeros. Explicitar distancia a la costa y diferencias según temporadas o técnicas de pesca utilizadas)

Observaciones...
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5.- Basándose en su experiencia personal, **¿podría describir** lo más detalladamente posible **los principales cambios que se han producido en los recursos pesqueros que usted pesca habitualmente**?

Nos interesa conocer de primera mano si a lo largo de los últimos años ha percibido cambios en los recursos pesqueros de su zona habitual de pesca: si ciertas especies han disminuido / incrementado; si ha notado cambios en la localización geográfica de los stocks de peces o cambios en la temporada de año en que capturan ciertas especies

6.- De forma general, ¿cómo valora **las perspectivas de futuro de los recursos pesqueros**?

:

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Especie	Cambios en stock (reducción/ incremento stock o peso medio de las capturas)	Cambios en la localización (situación geográfica de los stocks)	Cambios temporales (ciertas especies aparecen antes, más tarde, etc.)	¿Desde cuándo se percibe dichos cambios? (últimos 5 años, últimos 10, etc.)	¿Cuáles cree que han sido las causas que han motivado estos cambios?

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PRESPO

INFORMACIÓN SOCIO-ECONÓMICA

7- Respecto a la **tripulación de la embarcación**,

Es usted propietario de la embarcación: Si ☐ No ☐ Trabaja en la embarcación: Si ☐ No ☐

Número de tripulantes: Tripulantes autónomos……..… Tripulantes por cuenta ajena………………

¿Alguno trabaja a tiempo parcial?……………………...

¿Hay alguna mujer entre la tripulación?.......... ¿Alguno proviene de fuera de España?...........

En tal caso, ¿cuál es el país o países de origen?..

Alguno es familiar suyo: Si ☐ No ☐ Grado de parentesco……………………………

¿Existe alguna persona en su familia que desee continuar con la actividad pesquera? (Perspectivas de relevo generacional)..

8.- En relación al **régimen de propiedad** de la empresa,

- Es usted el único propietario ☐ Son varios copropietarios ☐ ¿Cuantos copropietarios?…….
- El tipo de empresa (régimen jurídico) es:

Persona Física ☐ Comunidad de bienes ☐ Sociedad civil ☐
Armadores asimilados a cuenta ajena ☐ Otro ☐ Especificar…………………………………..

9.- ¿Cómo se **organizan para llevar las cuentas** y gestionar la empresa?

No llevan cuentas ☐ Se encarga usted personalmente ☐ Se encarga otro copropietario ☐
Las lleva una asesoría / gestoría ☐ Otro ☐ Especificar……………………………………
Algunas cosas las lleva una gestoría y otras usted (u otro copropietario) ☐

Observaciones…………………………………………………………………………………………
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10.- ¿Cómo se lleva a cabo **el sistema de retribución y reparto de beneficios**?

Los ingresos brutos por la venta de capturas se reparten entre armador y tripulación ("a la parte") ☐

Explicar cómo se distribuyen los beneficios………………………………………………………

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La tripulación por cuenta ajena percibe un salario fijo e independiente de las capturas ☐

Sistema de retribución mixta: salario fijo más comisiones variables en función de las capturas ☐

En tal caso, ¿cómo funcionan las comisiones?…………………………………………………………

11.- ¿Podría **indicar que ingresos aproximados obtuvo por la venta de pescado durante el 2008**?

Indicar de forma aproximada los ingresos medios anuales provenientes de ventas de pescado no declaradas / fuera de lonja.

¡ESTA INFORMACIÓN ES CONFIDENCIAL Y NO VA SER DIFUNDIDA A NINGÚN ORGANISMO!

Tan solo queremos hacernos una idea de las ventas reales de pescado

Importe de ventas de pescado facturadas en lonja (€) en el 2008	Importe medio aproximado de las ventas no declaradas

Observaciones………………………………………………………………………………………

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- ¿Ha vendido parte de las capturas en una **lonja diferente a la del puerto base** de la embarcación? ¿Y en alguna lonja **fuera de Asturias**? (Indicar en qué lonjas y porcentaje/volumen aproximado subastado en cada una)……………………………………………………………………………

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12.- ¿Ha recibido algún tipo de **subvención de organismos públicos** para la adquisición o modernización de la embarcación?

Año	Cuantía	Concepto	% Subvencionado sobre el coste total	Organismo Responsable

13.- ¿Dispone de alguna otra fuente de ingresos? ¿Desarrolla algún tipo de actividad económica complementaria? Especificar cual qué % de sus ingresos representa...
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- ¿Sabe si algún miembro de su tripulación desarrolla alguna actividad económica complementaria?
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PRESPO

14.- Intente hacer un repaso a las **principales fuentes de gastos** de la embarcación durante el año 2008

CONCEPTO		2008	Observaciones
Costes de producción / explotación	Retribuciones tripulación		
	S. Social tripulación		
	Combustible		
	Carnada		
	Reparaciones y mantenimiento		
	Adquisición de instrumental / medidas seguridad		
	Seguros de la embarcación		
	Licencias / Revisiones		
	Otros gastos de funcionamiento (Indicar cuáles)		

15.- ¿Está actualmente **pagando la devolución de algún préstamo**? Si ☐ No ☐

Montante inicial del préstamo		**Cuota mensual/anual**		**Montante que queda por pagar**	

Motivo del préstamo...

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16.- ¿Cuál fue **el importe de la embarcación en el momento de comprarla**?

………………………………. Euros ☐ Pesetas ☐

17.- Si en este momento vendiese la embarcación con todos los aparejos e instrumentos de navegación, **¿Por cuánto dinero estaría dispuesto a venderla?**

………………………………. Euros

Observaciones ……………………………………………………………………………………………
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NORMATIVA Y ORDENACIÓN DE LOS RECURSOS PESQUEROS

18.- ¿Con cuál de las siguientes afirmaciones referidas a la actual normativa y ordenación de los recursos pesqueros está más de acuerdo?

- Es muy eficaz y promueve una explotación sostenible de los recursos pesqueros ☐
- En general es eficaz, aunque debería mejorar en ciertos aspectos ☐
- No es eficaz, pero dada la dificultad del sector es el único aplicable ☐
- En general es ineficaz y deberían cambiarse muchos aspectos del mismo ☐
- Es completamente ineficaz y habría que replanteárselo totalmente ☐

Observaciones ……………………………………………………………………………………………
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19.- Brevemente, ¿cuáles cree que son los principales **aspectos positivos** y los **aspectos a mejorar** de la actual normativa u ordenación de los recursos pesqueros?

Positivos:……………………………………………………………………………………………

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Negativos:……………………………………………………………………………………………

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- ¿Qué cree que se debería hacer para mejorar los aspectos negativos?

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20.- ¿Cree que actualmente la administración tiene dificultades para aplicar y hacer cumplir la normativa existente? En tal caso, ¿cuáles son estas dificultades?

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PRESPO

PROBLEMÁTICA DEL SECTOR Y SOLUCIONES DE GESTIÓN

17.- ¿Cuáles considera qué son los **principales problemas / retos a los que se enfrenta el sector pesquero artesanal en Asturias**?

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18.- ¿Qué **medidas** cree que se podrían poner en marcha para **mejorar la situación actual del sector pesquero artesanal** y solventar dichos problemas?

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19.- ¿Cree que sería necesario **mejorar la comercialización y potenciar la diversificación** del sector con vistas a mejorar la rentabilidad? (Ejemplo: Creación de etiquetado que reconozca la calidad, frescura y sostenibilidad ambiental del arte empleado, otras alternativas de diversificación como pesca turismo, etc.)

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- ¿Sabe si en esta cofradía se han llevado a cabo o planteado medidas encaminadas en dicha dirección?

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20.- ¿Cree que podría ser útil y conveniente disponer de un órgano regional de consulta y discusión, que sirva como punto de encuentro, foro de discusión y transferencia de información entre la Administración, Organismos de I+D, el sector pesquero artesanal y demás organismos interesados?

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- ¿Estaría dispuesto a participar de una forma directa y continua con un organismo como el mencionado con el objetivo de mejorar la gestión y explotación de los recursos pesqueros?

Si ☐ No ☐ En tal caso, ¿por qué?

¿Le gustaría añadir algo más que no ha sido comentado durante esta entrevista?

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¿Podría facilitarme el contacto de algún otro armador al que pudiera dirigirme para recopilar información sobre el estado de las pesquerías artesanales en Asturias?

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B. QUESTIONNAIRE TO SHIP OWNERS

GOBIERNO DEL PRINCIPADO DE ASTURIAS
CONSEJERÍA DE MEDIO RURAL Y PESCA

ENCUESTA SOBRE LA SITUACIÓN SOCIO-ECONÓMICA DE LAS PESQUERÍAS ARTESANALES EN ASTURIAS - ARMADORES



A RELLENAR POR EL ENTREVISTADOR:

Código de calidad……………………

Código de entrevista...................... Entrevistador…………………………..

INFORMACIÓN GENERAL

Nombre……………………………………………………………………………………………

Edad…………… *Nivel de estudios*………………………………………

Puerto base al que pertenece………………………………………………………………………

Características de la embarcación:

Nombre de la embarcación………………………………………………………………………..

Antigüedad de la embarcación……………….. *Eslora total*…………………….…

Arqueo (GT)……........... *Potencia declarada (Kw)*……………...

Potencia real…………....

RECURSOS BIOLÓGICOS Y ESFUERZO PESQUERO

1.-Modalidad de pesca en la que está inscrita la embarcación en el censo nacional………………………

2.-Media anual de **días parado / varado** (cuantos días al año permanece la embarcación parada por motivos de reparaciones, varado obligatorio, mal tiempo, etc. SIN INCLUIR FINES DE SEMANA)

……...……….……..días de media parado

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PRESPO

3.- Por favor, indique de forma breve qué **técnicas, aparejos o artes de pesca utiliza** a lo largo del año, así como **la época aproximada del año** y **las principales especies objetivo** capturadas con cada una de ellas:

Técnica o aparejo de pesca	Temporada en que se utiliza (de forma general, por ejemplo: entre noviembre y diciembre)	Principales especies objetivo	¿Qué porcentaje del total desembarcado se captura con dicho aparejo?	¿El aparejo se levanta diariamente? En caso contrario indicar tiempo en el mar.

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4.- De forma general, ¿podría indicarme los **en qué zonas desarrolla su actividad pesquera**? (puede ser más fácil indicar zonas de pesca en el mapa de caladeros. Explicitar distancia a la costa y diferencias según temporadas o técnicas de pesca utilizadas)

Observaciones……………………………………………………………………………………………
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5.- Basándose en su experiencia personal, **¿podría describir** lo más detalladamente posible **los principales cambios que se han producido en los recursos pesqueros que usted pesca habitualmente**?

Nos interesa conocer de primera mano si a lo largo de los últimos años ha percibido cambios en los recursos pesqueros de su zona habitual de pesca: si ciertas especies han disminuido / incrementado; si ha notado cambios en la localización geográfica de los stocks de peces o cambios en la temporada de año en que capturan ciertas especies

Pasar a la hoja siguiente:

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PRESPO

Especie	**Cambios en stock** (reducción/ incremento stock o peso medio de las capturas)	**Cambios en la localización** (situación geográfica de los stocks)	**Cambios temporales** (ciertas especies aparecen antes, más tarde, etc.)	**¿Desde cuándo se percibe dichos cambios?** (últimos 5 años, últimos 10, etc.)	**¿Cuáles cree que han sido las causas que han motivado estos cambios?**

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INFORMACIÓN SOCIO-ECONÓMICA

6- Respecto a la **tripulación de la embarcación**,

¿Es usted propietario de la embarcación?: Si ☐ No ☐ ¿Trabaja en la embarcación?: Si ☐ No ☐

Número de tripulantes: Tripulantes autónomos.......... Tripulantes por cuenta ajena.................

¿Alguno de los tripulantes trabaja solo a tiempo parcial?...

¿Hay alguna mujer entre la tripulación?.......... ¿Alguno proviene de fuera de España?...........

Alguno es familiar suyo: Si ☐ No ☐ Grado de parentesco................................

¿Existe alguna persona en su familia que desee continuar con la actividad pesquera? (Perspectivas de relevo generacional)..

7.- En relación al **régimen de propiedad** de la empresa,

- Es usted el único propietario ☐ Son varios copropietarios ☐ ¿Cuantos copropietarios?.......
- El tipo de empresa (régimen jurídico) es:

Persona Física ☐ Comunidad de bienes ☐ Sociedad civil ☐
Armadores asimilados a cuenta ajena ☐ Otro ☐ Especificar.......................................

8.- ¿Cómo se **organizan para llevar las cuentas** y gestionar la empresa?

No llevan cuentas ☐ Se encarga usted personalmente ☐ Se encarga otro copropietario ☐
Las lleva una asesoría / gestoría ☐ Otro ☐ Especificar.......................................
Algunas cosas las lleva una gestoría y otras usted (u otro copropietario) ☐

9.- ¿Cómo se lleva a cabo **el sistema de retribución y reparto de beneficios**?

Los ingresos brutos por la venta de capturas se reparten entre armador y tripulación ("a la parte") ☐

Explicar cómo se distribuyen los beneficios..

....

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....

La tripulación por cuenta ajena percibe un salario fijo e independiente de las capturas ☐
Sistema de retribución mixta: salario fijo más comisiones variables en función de las capturas ☐
En tal caso, ¿cómo funcionan las comisiones?...

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10.- ¿Podría **indicar que ingresos aproximados obtuvo por la venta de pescado durante el 2008**?

Indicar de forma aproximada los ingresos medios anuales provenientes de ventas de pescado no declaradas / fuera de lonja.

¡ESTA INFORMACIÓN ES CONFIDENCIAL Y NO VA SER DIFUNDIDA A NINGÚN ORGANISMO!
Tan solo queremos hacernos una idea de las ventas reales de pescado

Importe de ventas de pescado facturadas en lonja (€) en el 2008	Importe medio aproximado de las ventas no declaradas

11.- ¿Ha recibido algún tipo de **subvención de organismos públicos** para la adquisición o modernización de la embarcación?

Año	Cuantía	Concepto	% Subvencionado sobre el coste total	Organismo Responsable

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Indurot — Gobierno del Principado de Asturias — Consejería de Medio Rural y Pesca — PRESPO

12.- Intente hacer un repaso a las **principales fuentes de gastos** de la embarcación durante el año 2008

CONCEPTO		Importe en €	Observaciones
Costes anuales de producción	S. Social tripulación		
	Combustible		
	Carnada		
	Reparaciones y mantenimiento de aparejos		
	Adquisición de instrumental / medidas seguridad		
	Seguros de la embarcación		
	Licencias / Revisiones		
	Otros gastos de funcionamiento (Indicar cuáles)		

13.- ¿Está actualmente **pagando la devolución de algún préstamo relacionado con la embarcación**?

Si ☐ No ☐

Cantidad inicial del préstamo		**Cantidad que queda por pagar**	

Motivo del préstamo..

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GOBIERNO DEL PRINCIPADO DE ASTURIAS
CONSEJERÍA DE MEDIO RURAL Y PESCA

14.- ¿Cuál fue **el importe de la embarcación en el momento de comprarla**?

.... Euros ☐ Pesetas ☐

15.- **Si en este momento vendiese la embarcación** con todos los aparejos e instrumentos de navegación, **¿Por cuánto dinero estaría dispuesto a venderla**?

.... Euros

PROBLEMÁTICA DEL SECTOR Y SOLUCIONES DE GESTIÓN

13.- ¿Cuáles considera qué son los **principales problemas / retos a los que se enfrenta el sector pesquero artesanal en Asturias**?

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14.- ¿Qué **medidas** cree que podría poner en marcha la administración para **mejorar la situación actual del sector pesquero artesanal** y solventar dichos problemas?

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C. ECONOMIC DATA REQUESTED IN THE QUESTIONNAIRE TO RECREATIONAL FISHING FROM ONE´S OWN BOAT

GASTOS DERIVADOS DE LA PESCA RECREATIVA DESDE EMBARCACIÓN PROPIA

Antigüedad de la embarcación _ _ _ _ _ *años* **Fecha de adquisición** *(indique el año)* _ _ _ _ _ _ _ _

Coste de adquisición de la embarcación *(en euros o en pesetas)* _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ ☐ *Euros* ☐ *Pesetas*

¿Comparte la propiedad de la embarcación con otros co-propietarios?

☐ Sí En caso afirmativo, ¿cuántos co-propietarios? _ _ _ _ _ _ _ _ _ _
☐ No

¿Cuántas personas, por término medio, participan con usted en una salida de pesca con la embarcación?

_ _ _ _ _ _ _ _ *personas* *(indicar el nº de personas más habitual, sabiendo que el nº puede variar en cada salida)*

GASTOS ANUALES CORRIENTES

*(Gastos que, posiblemente, tenga usted todos los años. Indique los **gastos totales de la embarcación**, aunque los comparta con otras personas, en los **últimos 12 meses**)*

Gastos totales de la embarcación

Amarre *(pantalán, fondeo, garaje, etc.)*	_ _ _ _ _ _ _ _ €	Almacenamiento e hibernaje	_ _ _ _ _ _ _ _ €
Combustible	_ _ _ _ _ _ _ _ €	Seguro/s de la embarcación	_ _ _ _ _ _ _ _ €
Transporte de la embarcación al puerto	_ _ _ _ _ _ _ _ €	Ida y vuelta al puerto	_ _ _ _ _ _ _ _ €
Personal contratado	_ _ _ _ _ _ _ _ €	Aceites y lubricantes	_ _ _ _ _ _ _ _ €
ITB y certificado de navegabilidad	_ _ _ _ _ _ _ _ €	Otras tasas administrativas	_ _ _ _ _ _ _ _ €
Otros gastos corrientes	_ _ _ _ _ _ _ _ €	*¿Cuáles?*	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Gastos personales de la actividad náutica

Gastos en manutención y hospedaje *(sólo gastos motivados por la práctica de la actividad náutica)*	_ _ _ _ _ _ _ _ €
Gasto en productos informativos/didácticos del sector náutico o pesquero *(revistas, DVD's, etc.)*	_ _ _ _ _ _ _ _ €
Gastos en ropa o utensilios y complementos náuticos *(ropa especializada, etc.)*	_ _ _ _ _ _ _ _ €

Gastos de la pesca recreativa

En carnada o cebo natural *(indique gasto por jornada de pesca o gasto total anual)*	_ _ _ _ _ _ _ _ €	☐ *por jornada* ☐ *total anual*
En aparejos de pesca *(anzuelos, nylon, plomos, etc.)*	_ _ _ _ _ _ _ _ €	
Otros gastos corrientes *(excluir la compra de equipos de pesca)*	_ _ _ _ _ _ _ _ €	*¿Cuáles?* _ _ _ _ _ _ _ _ _ _ _ _

INVERSIONES Y GASTOS OCASIONALES

(Son compras o gastos que no se producen todos los años, sino de forma ocasional. Por favor, indique los importes que recuerde y la fecha o periodicidad con la que generalmente se producen)

Inversiones y gastos ocasionales de la embarcación y la pesca recreativa

Compra de nuevo equipamiento para el barco *(electrónica, etc.)*	_ _ _ _ _ _ _ _ €	*¿En qué año?* _ _ _ _ _ _
Cambio de motor u otra reparación de relevancia	_ _ _ _ _ _ _ _ €	*¿En qué año?* _ _ _ _ _ _
Mantenimiento de la embarcación *(pintura, revisiones, etc.)*	_ _ _ _ _ _ _ _ €	*Una vez cada* _ _ _ _ _ _ *años*
Adquisición de equipos de pesca *(cañas, carretes, soportes, etc.)*	_ _ _ _ _ _ _ _ €	*Una vez cada* _ _ _ _ _ _ *años*
Adquisición de trajes y utensilios de pesca submarina	_ _ _ _ _ _ _ _ €	*Una vez cada* _ _ _ _ _ _ *años*

D. ECONOMIC DATA REQUESTED IN THE QUESTIONNAIRE TO SPEARFISHERMEN

GASTOS DERIVADOS DE LA PRÁCTICA DE LA PESCA SUBMARINA

De forma general, ¿qué modalidad de pesca submarina practica usted?

- ☐ Pesca submarina sin embarcación *(Si marca esta opción, no tiene que contestar a la pregunta siguiente))*
- ☐ Pesca submarina desde embarcación
- ☐ Alterno a lo largo del año la pesca submarina con y sin embarcación

¿A quién pertenece la embarcación que normalmente utiliza para pescar?

- ☐ Es de un familiar, amigo o conocido
- ☐ Es una embarcación alquilada
- ☐ Es de mi propiedad *(Si usted es el propietario y ya ha contestado a otra encuesta similar relacionada con la náutica y la pesca recreativa desde embarcación, a continuación indique* ***sólo gastos no relacionados con la pesca desde su embarcación****).*

Gastos anuales corrientes derivados de la práctica de la pesca submarina

(Gastos que normalmente tiene usted todos los años. Indique los ***gastos*** *que ha tenido en los* ***últimos 12 meses****. Si para practicar la pesca submarina utiliza una embarcación que no es de su propiedad, indique qué gasto le supone).*

Seguros	_ _ _ _ _ _ _ _ €
Cuotas federativas	_ _ _ _ _ _ _ _ €
Ida y vuelta al lugar donde practica la pesca *(gasolina, transporte público, etc.)*	_ _ _ _ _ _ _ _ €
Gastos por el uso de embarcación *(gastos compartidos con quien le cede o presta la embarcación, gastos de alquiler, etc.)*	_ _ _ _ _ _ _ _ €
Gastos en productos informativos/didácticos sobre la pesca submarina *(revistas, DVD's, etc.)*	_ _ _ _ _ _ _ _ €
Gastos en manutención y hospedaje *(sólo gastos motivados por la práctica de la pesca submarina)*	_ _ _ _ _ _ _ _ €
Otros gastos corrientes - *Especificar* _	_ _ _ _ _ _ _ _ €

Inversiones y gastos ocasionales de la pesca submarina

(Compras o gastos que no se producen todos los años sino de forma ocasional. Por favor, indique los importes que recuerde y la fecha o periodicidad con la que generalmente se producen).

Adquisición del equipamiento de pesca submarina *(trajes, fusiles, equipos de oxígeno, tubos, gafas, boyas, etc.)*	_ _ _ _ _ _ _ _ €	*Una vez cada* _ _ _ _ _ _ _ años
Reconocimientos médicos	_ _ _ _ _ _ _ _ €	*Una vez cada* _ _ _ _ _ _ _ años
Otros gastos ocasionales	_ _ _ _ _ _ _ _ €	*¿Cuáles?* _

E. ECONOMIC DATA REQUESTED IN THE QUESTIONNAIRE TO RECREATIONAL SHORE ANGLERS

GASTOS DERIVADOS DE LA PESCA RECREATIVA DESDE COSTA

Gastos

Para cada tipo de gasto indicado a continuación, elija primero qué opción de las 3 posibles (A, B ó C) refleja mejor su situación (piense cada cuánto tiempo suele estrenar o renovar los utensilios de pesca y gastarse dinero en ello).

Después intente rellenar la información que se solicita en la columna correspondiente. Recuerde que si practica otros tipos de pesca marítima (submarina, desde embarcación), en la página siguiente sólo debe reflejar los gastos derivados de la pesca a pie desde la costa.

Tipos de gastos	**Opción A.** Suelo gastar todos los años:	**Opción B.** Suelo gastar sólo algunos años:	**Opción C.** No suelo gastar dinero en esto, porque:		
			No uso	*Me lo regalan*	*Me lo prestan*
	(Importe anual)	*(Indique cada cuántos años y el importe más reciente)*	*(Marque con una "X")*		
En equipos *(cañas, carretes, ganchos, vadeador, cesta o mochila, truel, etc.))*	______ €	Cada __ años me gasto ______ €	☐	☐	☐
En ropa	______ €	Cada __ años me gasto ______ €	☐	☐	☐
En carnada y cebo natural	______ €	Cada __ años me gasto ______ €	☐	☐	☐
En aparejos *(anzuelos, nylon, plomos, señuelos, poteras, boyas, rapalas, etc.)*	______ €	Cada __ años me gasto ______ €	☐	☐	☐
En ida y vuelta al lugar de pesca *(gasolina, transporte, etc.)*	______ €	Cada __ años me gasto ______ €	☐	☐	☐
En comida, bebida, alojamiento *(motivados por la pesca)*	______ €	Cada __ años me gasto ______ €	☐	☐	☐
En mantenimiento de los equipos *(aceites, repuestos, reparaciones, etc.)*	______ €	Cada __ años me gasto ______ €	☐	☐	☐
En cuotas de socio y cuotas federativas	______ €	Cada __ años me gasto ______ €	☐	☐	☐
En material informativo y didáctico *(revistas, DVD's, etc.)*	______ €	Cada __ años me gasto ______ €	☐	☐	☐
En alquileres *(de equipos de pesca, accesorios, etc.)*	______ €	Cada __ años me gasto ______ €	☐	☐	☐
En otros gastos – *Indicar cuáles:* ____________ ____________	______ €	Cada __ años me gasto ______ €	☐	☐	☐

Marque con una "X" **si alguno de los gastos anteriores lo realiza fuera de Asturias** (incluyendo compras por internet a empresas de fuera de Asturias) y especifique, en caso afirmativo, el importe:

☐ No, todo lo gasto dentro de Asturias.

☐ Sí, algunos gastos los hago fuera de Asturias. *Indique por favor a continuación:*

En qué cosas: ____________________ *Importe gastado:* ______ € *Año:* ______

En qué cosas: ____________________ *Importe gastado:* ______ € *Año:* ______

En qué cosas: ____________________ *Importe gastado:* ______ € *Año:* ______

Para nosotros es especialmente importante el **año 2010**. En este sentido, **<u>si ha señalado anteriormente algún gasto o regalo marcando la opción B ó la opción C</u>** ¿recuerda si **alguna de estas compras o regalos** se produjeron concretamente **en 2010**? *(Si antes sólo declaró gastos bajo la opción A, no tiene que responder a esta pregunta).*

- ☐ No lo recuerdo.
- ☐ No, en 2010 no tuve gastos ni recibí regalos de este tipo, se produjeron otros años.
- ☐ Sí, recuerdo que concretamente en 2010:

Tuve un gasto de .... € (o recibí un regalo por valor de .... €) que consistió en ....

....

Tuve un gasto de .... € (o recibí un regalo por valor de .... €) que consistió en ....

....