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Multidimensional Indicators to Assess the Sustainability of Demersal Small-Scale Fishery in the Azores

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Abstract: The Azorean demersal fishery sector is one of the most important in the archipelago. As a small-scale fishery, it plays an important role in the livelihood of the community, being a source of employment and income, and contributing to poverty alleviation. Because fisheries are a complex system, a multidisciplinary approach that includes socioeconomic indicators is required for a broader assessment of fishery sustainability. This study analyzes the Azorean bottom longline fishery using the Fishery Performance Indicators tool, regarding its ecology, economy, and community indicators. The findings indicated that the fishery is mostly sustainable, although there is still opportunity for improvement. Its ecological indicators had a good performance, mainly due to the effort and work of the scientific community that makes continuous studies to examine the state of its stocks. The economic indicators are in good condition as well, but some obstacles stopped the indicator from obtaining a better performance; mainly the landing volatility and the fishery's main source of capital (subsidies), which can make the fishery less competitive. Finally, its community indicator had a very good performance, which reflects the fishery's socioeconomic and cultural relevance for the Azores.

Keywords: FPI; triple bottom line; sustainability indicators; bottom longline fishery; demersal species; NE Atlantic

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1. Introduction

Demersal fisheries have been present for thousands of years as a major source of nutrition and commerce for the different fishing communities around the world [1]. This fishery is established in coastal and deep-sea environments and uses a wide variety of fishing gear [1,2] such as pots, traps, hook-and-lines, and net techniques (entangling, gillnets, and purse and seines) [2,3]. Due to its evolution throughout the years, fishing efforts have increased, threatening stock conservation, and leading to overfishing of some demersal marine resources [4].

Overfishing is the main cause of the decline in the abundance of many marine resources [5]. Stocks fished at biologically unsustainable levels increased from 10% in 1974 to 34.2% in 2017 [6,7]. Declines in fish stocks are mainly due to poor management conditions and can trigger several effects on marine communities such as cascading effects; affecting predator-prey dynamics; and changing marine communities' structure, composition, and dynamics [8–12]. Consequently, the socio-economic conditions of fishers will also be affected, especially in developing countries that rely heavily on fisheries [12,13]. Thus, it is important to continuously evaluate fisheries to promote good management policies and prevent such consequences.

1.1. Sustainability Indicators for Fisheries Assessment

The ecosystem-based fisheries management (EBFM) is a comprehensive approach to managing fisheries that consider many ecosystem components. This systematic, interdisciplinary approach aims to include the ecological, socioeconomic, and political aspects of a fishery to enhance management outcomes and keep fisheries resilient, productive, and healthy [14,15]. The concept of EBMF and the need to incorporate a fishery's ecological, socioeconomic, and political dimensions into a single evaluation have recently given rise to several approaches (e.g., Rapfish, Delphi method, ISIS-fish [16–24]). One of these approaches is the Fishery Performance Indicators tool (FPI), a comprehensive and multidimensional approach designed to assess the management performance of individual fisheries in a single or multi-species fishery context [24,25]. The FPI tool is a holistic tool that assesses the sustainability of the fisheries through different indicators grouped into different dimensions of fisheries [26,27]. The design of this tool was created to facilitate assessment that is accurate, cost-effective, and applicable both in data-poor and data-rich scenarios helping to compare different fishery systems, understand how the fisheries are supporting the community, and how harvesters and processors are performing economically [26,27].

The FPI tool is comprised of an array of metrics that evaluate stock status, Harvest and Post-Harvest sectors, and three sustainability indicators: ecology, economics, and community—the Triple Bottom Line (TBL) [24]. Additionally, exogenous factors that may enable fishery impacts are also assessed [24]. It is important to notice that the TBL is a key to sustainability and does not measure it directly [28]. These two concepts are interrelated, given that the TBL is driven by sustainability [28,29]. Sustainability is defined as the ability to improve social and environmental performance to meet present needs, without compromising the ability of future generations to meet their own needs [30]. It is also the capacity of taking into consideration environmental protection while considering the economic sphere and the individual, and community, well-being [28]. The TBL is a method that measures these sectors' performance impact, giving equal importance to all sectors [28,29]. The TBL has its share of faults, related to the way of measurement of social and ecological features, and understanding how certain measures might contribute towards sustainability [31]. Despite its challenges, the framework allows for a long-term perspective and leads to a better evaluation of future decisions [28]. The better the performance, the higher the well-being of the sector, which will be more prone to contribute to a sustainable fishery. When referring to sustainability, we mean the well-being of the TBL sectors (ecology, economy, and community), which provide us with an insight into fishery sustainability.

The FPI tool has already been applied to 149 fisheries worldwide, allowing for comparison between the world's fisheries management systems, enabling the identification of strengths and weaknesses, and promoting problem-solving measures [27,32]. The absence of an assessment of the political, community, and economic diagnosis of the fishery makes it hard to determine the effectiveness of the fishery's management and the inputs necessary for the sustainable success of the activity [27].

1.2. Demersal Fisheries in the Azores

The Azores archipelago (from 36° to 40° N and from 24° to 32° W) is composed of nine islands spread over 600 km and has an Exclusive Economic Zone (EEZ) with nearly 1 million km^2 in the total area [33]. Its marine ecosystem is characterized by an abundant abyssal area (mean depth of 3000 m), a very narrow or lack of a coastal platform, steep slopes, numerous seamounts, and reduced island shelves [34]. Demersal fishery occurs around the island slopes and in the seamounts [34].

Landings of demersal fishery in the Azores represent 60% of the total value production, being the region's most important fishery in value and the second one in weight [35]. This fishery is considered a small-scale fishery because 90% of the fleet is less than 12 m in length and uses different hook-and-line gears to target many different species [33,34]. The bottom longline fishery dynamics are mainly driven by the blackspot seabream *Pagellus bogaraveo*, which is the main target species [34]. Fishing effort is also directed to other commercially important demersal species such as the blackbelly rosefish *Helicolenus dactylopterus*, European conger *Conger conger*, forkbeard *Phycis phycis*, and alfonsinos *Beryx decadactylus* and *B. splendens* [36]. These species represent 6 of the 22 priority stocks for assessment and monitoring under the European Union Marine Strategy Framework Directive (MSFD) Descriptor 3 and the United Nations Sustainable Development Goal 14 (SDG; Indicator 14.4.1) [36].

Previous studies on the demersal fisheries in the Azorean region have mostly focused on the ecological part of the fishery, and how the marine ecosystem and fish stocks are affected by fishing [34,37–39]. However, the fishery is a complex and transdisciplinary system, its impacts can affect not only the environment and stocks but also the economy and community of a region by losses of jobs and income that can have a significantly negative impact [5,40,41]. Fisheries worldwide contribute to employment and increase the Gross Domestic Product (GDP), nutrition, and foreign exchange [42]. Understanding the consequences of the fishing sector, including the Harvest and Post-Harvest sectors, on the community and economy of the region is essential given the socioeconomic importance of the fishing sector for the Azores [34].

The present study aims to evaluate the small-scale bottom longline demersal fisheries in the Azores archipelago using FPI tools. The socio-economical relevance of this fishery on a local and regional level, as well as its importance as a major source of income for the Azores, led to its selection. This is the first attempt to evaluate this fishery in a comprehensive and holistic manner that incorporates the environmental, economic, and social aspects of the fishery. The outputs will make it possible to compare fishery systems around the globe and provide a broad view of the state of the current situation of the fishery in the Azores, which can be used to plan and suggest management actions. The outcomes assess the current status of fisheries and use this as a baseline for comparisons in the future, evaluating the potential effects of management measures on the performance of that fishery.

2. Materials and Methods

2.1. Methodological Approach

The FPI tool is composed of two main categories: the outputs and inputs. The outputs measure two sets of indicators: the triple bottom line (ecological, economic, and community), constituted by 14 dimensions; and the sector performance of a fishery, constituted by 11 dimensions. Both indicators share 68 metrics scored in different dimensions of those indicators. Outputs identify and measure if the fishery is delivering socio-ecological sustainable and economically viable results [24] (Figure 1). The inputs are constituted of 5 components divided into 15 dimensions and 54 metrics [43]. Inputs capture the exogenous factors and management descriptors, which might affect the outputs of the fishery [26]. Together, outputs and inputs make a total of 122 individual metrics distributed in different dimensions.

Each metric was scored from a 1 to 5 score system, where 1 was the lowest and 5 was the highest score, all scores received a confidence grade: A (the reviewer was highly confident that the score was correct), B (the reviewer was highly confident that the metric would be within one of the given scores) or C (the reviewer made an educated guess, based on the available information) [24]. To score the metrics, the authors relied on primary and secondary data sources such as evidence from scientific articles; group discussions; and interviews with local experts, businesses, fishermen, and local authorities, among others. The list of metrics, experts, and stakeholders consulted is available in Table S1. After all the metrics were scored, they were all reviewed by the scientists of the present work. The average of the scores was made per dimension, being comparable to other fisheries.

The dimension values were compared with the average scores of 97 fisheries in developing countries (DC), and with the scores of the top 10 fisheries performers (T10) according to the FPI method (Iceland Nephrops lobster, Icelandic cod, Australia Western zone abalone, US-Alaska pollock, Japan wagu lobster, Australia Southern zone rock lobster, Japan Ofunato set-net salmon, Australia Spencer Gulf prawn, Norway's purse seine, and Japan

Toyama Bay set-net). These reference scores were obtained from the collaboration with the research group that developed the method at the Institute for Sustainable Food Systems at the University of Florida and the available literature [26,44].

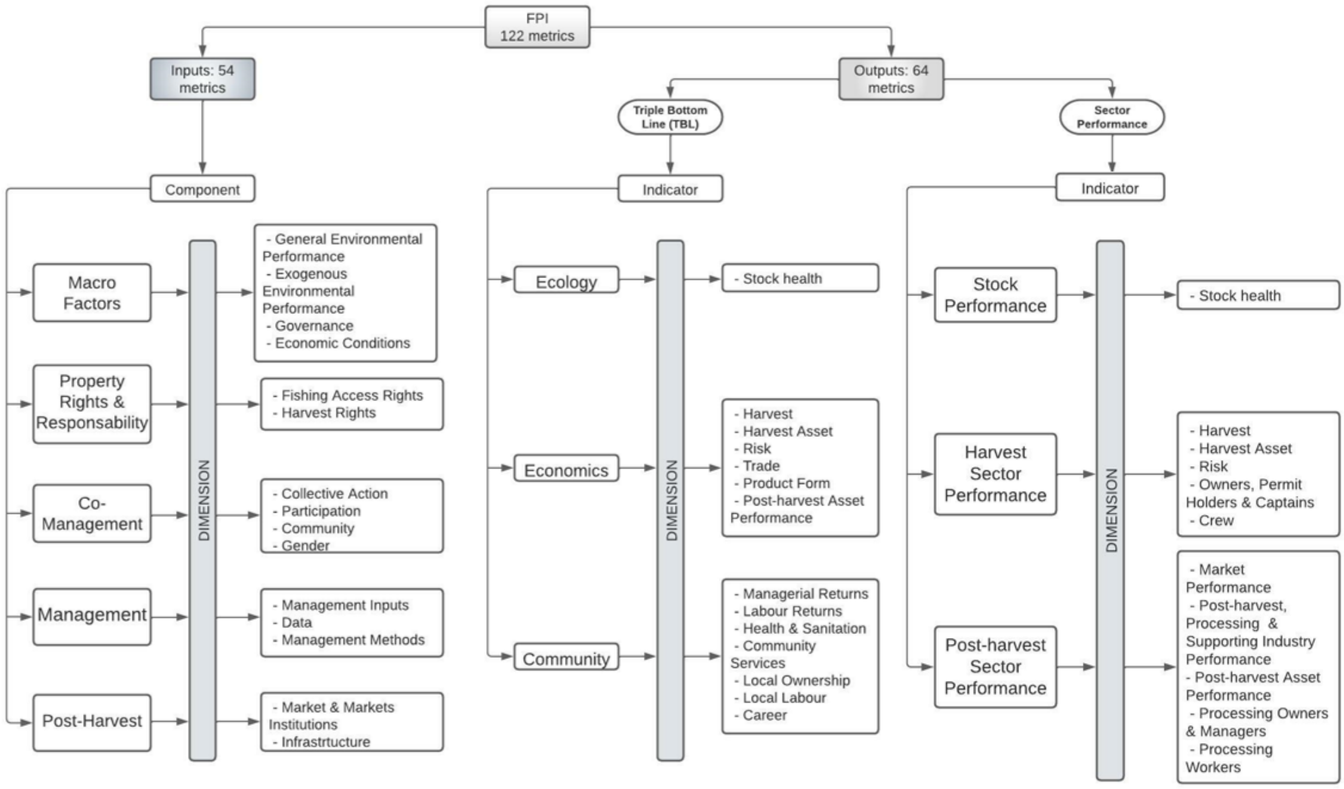

Figure 1. Schematic illustration of the hierarchical organization of the metrics evaluated in the Fishery Performance Indicators approach. Data source: Anderson et al. [24].

2.2. Species Selection Procedure

For multispecies fisheries, the FPI tool advises using a maximum number of five species [24]. Considering the multispecies characteristic of the Azorean bottom longline fishery, a procedure for the selection of the most important species was performed based on the official commercial landings in value. To do this, commercial landings by *métier* were obtained under the European Commission's Data Collection Framework (DCF) for the years 2013 to 2016 (Table S2). This corresponded to the most recent period for which this information was available separately for set longlines for demersal fish (i.e., LLS_DEF *métier*). The blackspot seabream *P. bogaraveo*, European conger *C. conger*, blackbelly rosefish *H. dactylopterus*, forkbeard *P. phycis*, and alfonsino *B. decadactylus* ranked as the top five species in terms of landed value, together accounting for 63% of the total landings in value (Figure 2 and Table S2).

There was only one case where the number of species analyzed surpassed the selected ones. For stock evaluation, the FPI tool requires an evaluation of the fishery itself, and not only the selected species (for more information consult Anderson et al. [24]). Thus, 10 species were considered from the 22 priority stocks (Table S3). For these species, the LLS_DEF is considered more effective in catching (i.e., more than 50% of the landed weight of these species are caught by this *métier* [28,31]), and information about the stock status was available.

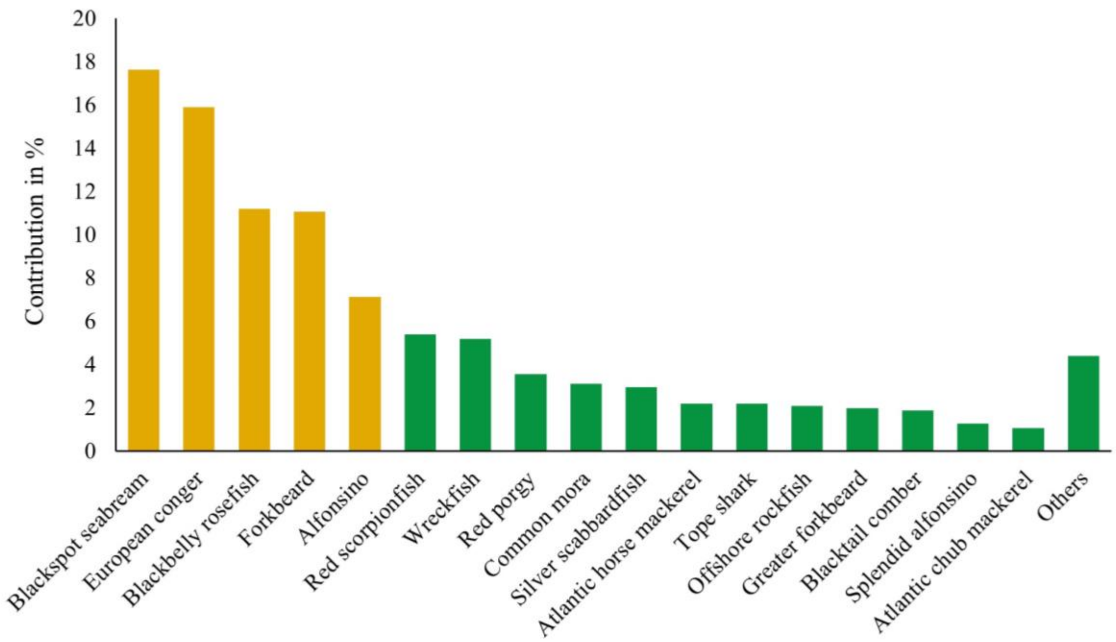

Figure 2. Species contribution (%) to the total landing value for the bottom longline demersal fishery in the years 2013 to 2016 in the Azores. The five most valuable species landed are in yellow. Data source: European Commission's Data Collection Framework (DCF).

3. Results

The accuracy of the 122 metrics analyzed, according to the quality of the information, was approximately 76% type A, 21% type B, and 3% type C.

3.1. Outputs Indicator

3.1.1. Triple Bottom Line (TBL) Performance

The lowest score was attributed to the Ecology sector (3.5), followed by the Economics (3.86), and the Community (4.36) sectors (Table S7). Azores' bottom longline fishery performed better than DC in all indicators but had lower scores than the T10 fisheries (Figure 3).

Regarding each dimension of the TBL performance, this study performed once again better than the DC performance, and lower in general than the T10, but with close values, even surpassing its scores in the Local Ownership, Local Labor, Career, Trade, and Product Form dimension (Figure 4).

Ecological Performance

The Ecology indicator, which assess stock health, had a good performance (score: 3.50; Table S4), and in general, its metrics performed well. This indicator had the biggest difference between its score and the T10 score (4.50), mainly due to the metric Proportion of Harvest with a Third Party Certification (score: 1), which did not allow the indicator to score higher.

Economics Performance

The Economic indicator evaluates the fishery's efficient capacity of generating the maximum number of benefits. On average, this indicator scored 3.86 and its dimensions ranged from 3 to 4.25 (Table S4). All its dimensions' scores were very close to those of T10 scores, even surpassing them. The only exceptions were the Harvest Assets and Risk dimensions, which scored 3 and 3.33, respectively, and were notably lower and closer to the DC values (Table S4).

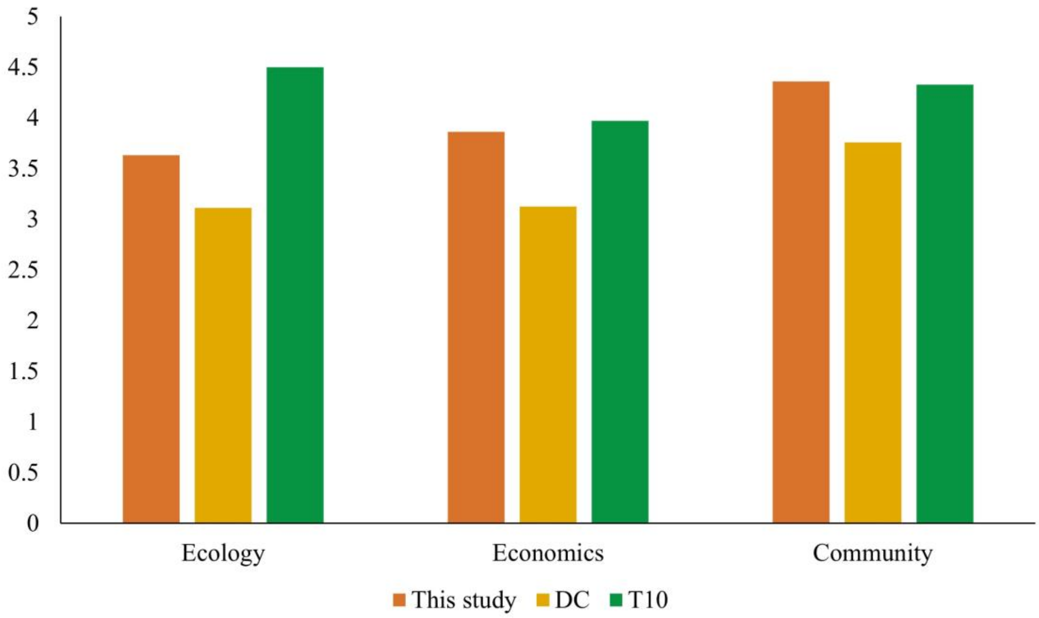

Figure 3. Comparison of TBL output indicators scores for the Azorean bottom longline fishery and the average FPI scores of developing countries (DC) and the average FPI scores of the top 10 best performing world fisheries (T10).

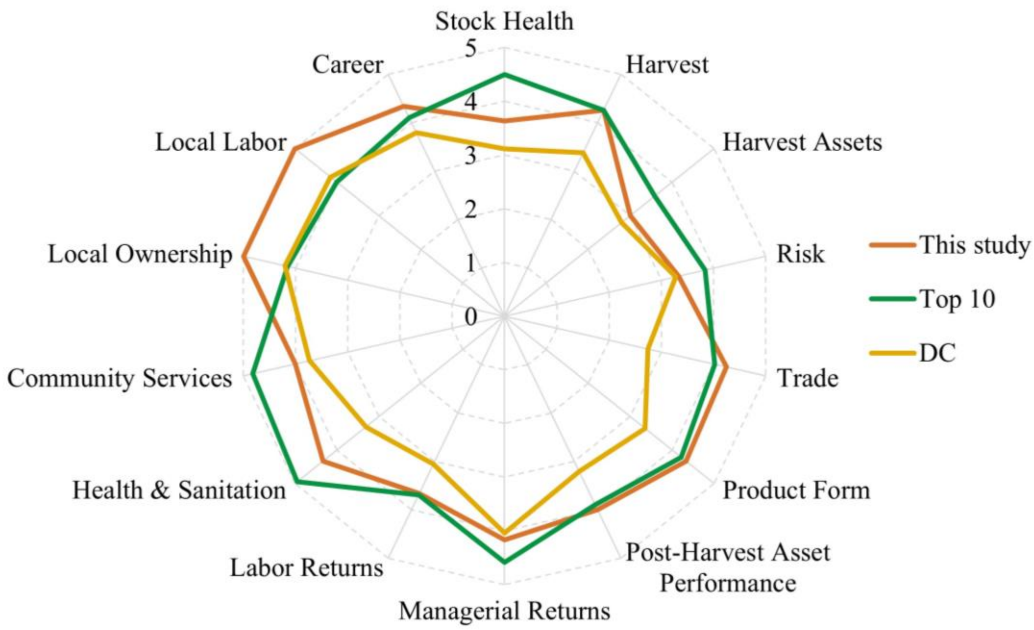

Figure 4. Comparison of TBL output dimensions scores for the Azorean bottom longline fishery and the average FPI scores of developing countries (DC) and the average FPI scores of the top 10 best performing world fisheries (T10).

Community Performance

This indicator measures the social benefits generated by the fishery. It is made of 7 dimensions, and it had a very well performance (score: 4.36, surpassing the T10 score (4.33) (Figure 3). Its dimensions' scores ranged from 3.50 to 5 (Table S4), close, and higher values than those of the T10 (Figure 4).

3.1.2. Sector Performance

The Stock Performance indicator scored the lowest (3.5), followed by the Harvest Sector (3.85), and the Post-Harvest Sector (4.14) (Table S8). All dimensions scored higher than the DC scores (Figure 5). Besides the Stock Performance, the other dimensions' scores were similar to the T10 scores, even surpassing them in some cases (Figure 5).

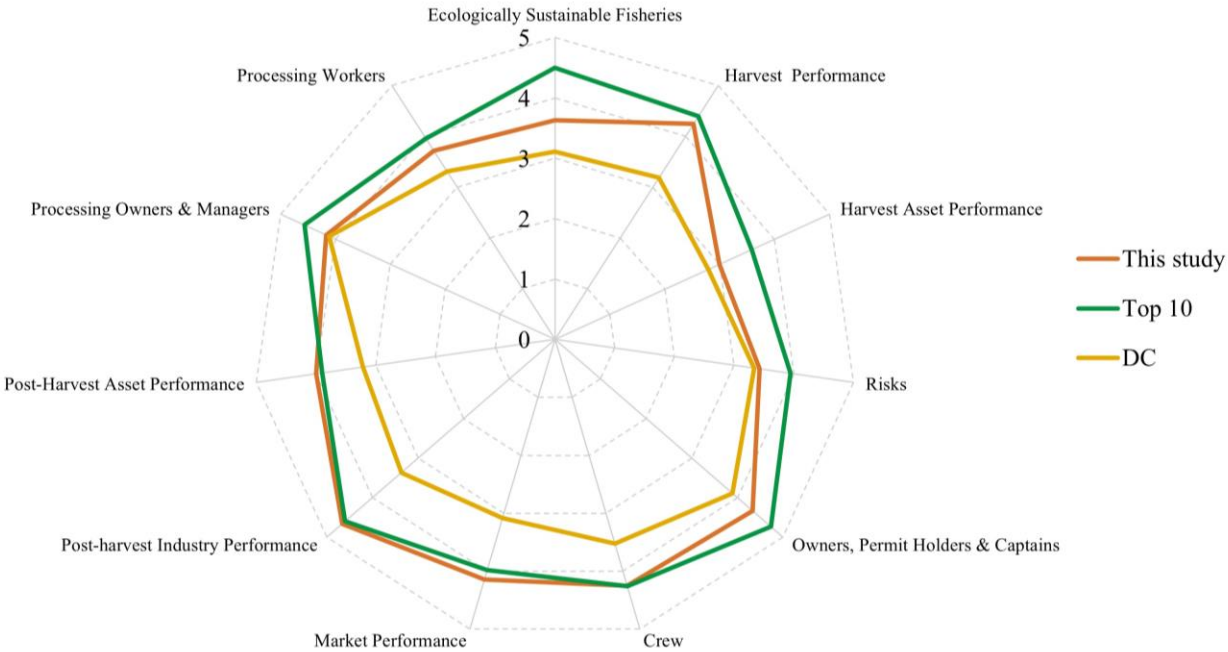

Figure 5. Comparison of Wealth Creation output dimensions scores for the Azorean bottom longline fishery, the average FPI scores of developing countries (DC), and the average FPI scores of the top 10 best-performing world fisheries (T10).

Stock Performance

Although Stock Performance had the lowest score among the indicators, the score means that this indicator performed relatively well, slightly higher than DC, but still lower than the T10.

Harvest Sector Performance Indicator

This indicator measures harvesters' social and economic benefits. On average this indicator scored 3.85, and all its dimensions scored above 4, except for the Harvest Asset Performance and the Risk dimension, which scored 3 and 3.43, respectively (Table S8).

Post-Harvest Sector Performance Indicator

The Post-Harvest Sector evaluates fish product processing and trade, and whether these generate sustainable socio-economic benefits. On average, this indicator had a very good performance (score: 4.14), and all its dimensions scored equal to or above 4, except for the Processing Workers dimension (score: 3.71) (Table S8).

3.2. Input Indicators

Comparing Input performance (Table S9), the highest score was attributed to the Macro Factors component (4.0), followed by the Post-Harvest (3.9), Property Rights and Responsibility (3.5), Management (3.2), and Co-Management (3.1). Comparing the performance of the Input dimensions with DC and the T10 average results, there was a tendency for the Azorean bottom longline fishery to score better than the DC, and lower than the T10 (Figure 6), following the same pattern of output results. Most of the component scores had similar values to the T10 scores, except for the General Environmental Performance and Management Inputs components, which scored relatively low in comparison to the T10 scores.

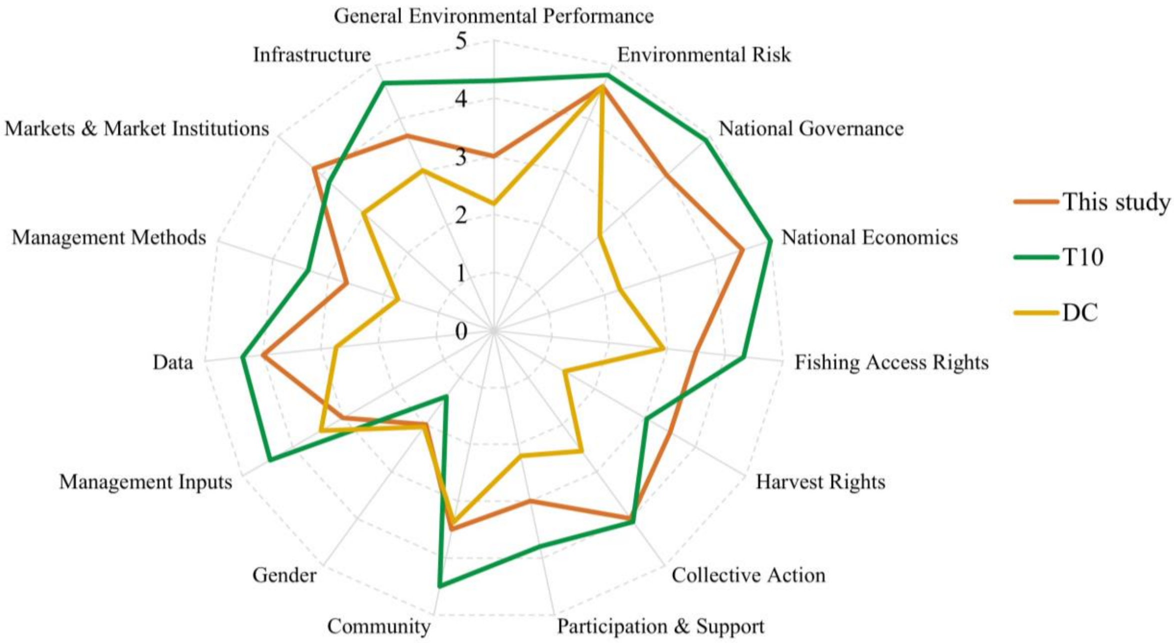

Figure 6. Comparison of scores of Input dimensions for the Azorean bottom longline fishery, the average FPI scores of developing countries (DC), and the average FPI scores of the top 10 best-performing world fisheries (T10).

3.2.1. Macro Factors Performance

The Macro Factors component evaluates the institutional state of the region. On average, this component had a very good score (4), and all its dimensions scored equal to or above 4, except for General Environmental Performance, which scored 3 (Figure 6).

3.2.2. Property Rights and Responsibility Performance

This component evaluates the type and amount of control that individuals exercise in the fishery. Its score was good (3.5), and its values were close to the T10 and always higher than the DC scores (Figure 6).

3.2.3. Co-Management Performance

The Co-Management component assesses the stakeholders' role in fishery management. It had an intermediate score (3.13) on average and the scores of its dimensions ranged from 2 to 4 (Figure 6). The Gender dimension scored the lowest (2), mainly due to the poor influence of women in the fishery, a tendency observed both in the T10 and the DC.

3.2.4. Management Performance

The Management Performance component evaluates the efficiency of the management system, and of the governmental financial incentives (scientifical monitoring) and subsidies. Its score was intermediate (3.22) on average and the scores of its dimensions ranged from 2.67 to 4 (Table S9). The dimensions of Management Methods (score: 2.67), and Management Inputs (score: 3) contributed to the component's low performance (Figure 6). The Management Inputs dimension had the highest difference from the T10 values, and it was the only score lower than the DC score.

3.2.5. Post-Harvest Performance

Post-Harvest indicator evaluates the quality of the economic and physical infrastructure of the region. It is made of two dimensions: Markets and Market Institutions; and Infrastructure, which scored 4.17 and 3.67, respectively (Table S9). In general, this dimension obtained a good score (3.92). The Market and Market Institutions dimension score outperformed the T10 score, as opposed to the infrastructure dimension, which was lower than the T10 score (Figure 6).

4. Discussion

4.1. Triple Bottom Line and Sector Performance

4.1.1. Ecology Indicator Performance

Overall, the Ecology indicator performed well (3.63). This may be related to the nature of the fishing activity in the Azores region. The small-scale bottom longline fishery is more selective and has less impact on the seabed, especially when compared to other fishing techniques such as bottom trawling and nets, or industrial fisheries [27,45,46]. Some metrics such as Percentage of Stocks Overfished, Regulatory Mortality, Illegal, Unreported, and Unregulated Landings (IUU), and Proportion of Harvest with a Third Party Certification presented intermediate and low scores, and to achieve a more sustainable performance of that indicator, an improvement of these metrics is required.

Regarding the percentage of stocks overfished, the results showed that around 50% of the stocks evaluated in this study displayed signals of overfishing (red porgy, silver scabbardfish, offshore rockfish, thornback ray, and splendid alfonsino—Figure S2). Stock status information is still preliminary in the Azores, and the results obtained from this study are the outcomes of exploratory analyses using length-based data-poor models. Even so, they provide good proxies of the stock condition for stakeholders [47]. Stock overexploitation might happen due to the general lack of biological knowledge of the exploited species. Additionally, demersal deep-sea species are more vulnerable to exploitation due to their life history traits, such as long life, slow growth, and later sexual maturation [35], which might have contributed to the intermediate score of the Percentage of Stocks Overfished metric.

The regulatory mortality and Illegal, Unreported, and Unregulated catches (IUU) percentages of fisheries were relatively low for the selected species [46,48,49]. Nevertheless, bycatch rates of vulnerable species associated with hook-and-line fisheries have been reported worldwide [43] (e.g., [50–52]). Having accurate and precise information on fishery discards is challenging [53], and the numbers presented for the study might be an underestimation of the real values, which may lead to inadequate fishery management measures. One way to gather more precise estimations is with monitorization onboard. However, it is a difficult task for a small-scale fishery with a high number of small boats with limited capacity and independent fishers. Another alternative would be to use electronic monitoring (sensors and video), but it is expensive and may require a certain level of computer experience [53].

The Azorean bottom longline fishery has some regulations to avoid overexploitation of the resources [47]; however, the studied species, and all demersal species in general, possess no Third Party Certification, of which its goal is to ensure sustainable practices of the fishery [24]. Applying for certification is an expensive process, and detailed research data is necessary (e.g., maximum sustainable yields—MSY and associated reference points) [54], which is only recently being collected in the Azores archipelago for demersal species. It would be beneficial to first join the Fishery Improvement Projects (FIPs) program to seek MSC certification in the future, once fishery markets are increasingly demanding eco-labeled seafood products [55]. Such programs are also beneficial for the economy and community of the region, due to the fishery contribution to these sectors [56].

4.1.2. Economy Indicator Performance

Small-scale fisheries can have a great impact on the economy of a region, or nation, contributing to poverty alleviation [57]. Small island firms rely on exports to be their predominant internationalization mode [58]. In the Azores, marine resources contribute to over 20% of the total exports [59]. The bottom longline fishery products export (considering the studied species) represents a substantial share of the trade market, with more than 90% of blackspot seabream and alfonsino being exported (data provided by the Azorean Fish Traders Association—ACPA). This trade is critical for income generation, growth and development, and job creation, as it happens with many small exporters (e.g., Seychelles, Maldives, Cape Verde, Mozambique) [60].

The Economy indicator did not have a higher score due to the Harvest Asset Performance and Risk dimensions, which evaluated the historical economic conditions. Fish prices are determined by the demand and supply of producing centers and consumer markets, and usually they may vary due to changes in supplies and other fish prices in the market [61]. Ex-vessel prices and landings in the Azores, have been suffering fluctuations throughout the years [47], probably due to the fishery's multi-specific characteristic, where target species change, according to abundance and market value. Price volatility happens all over the world [61,62] and influences costs, trade, income, and food security, and may create financial obstacles and be a risk for those who decide to invest in the fishery [24,63].

Moreover, Azorean fisheries are heavily subsided, being the main source of capital for the fishery, which may reveal, once again, a higher risk for investment [24]. Investing in fisheries always carries a risk, but if the investor is careful, he should have a capital return [64]. With increased risk, fewer investors will emerge, which could have a negative effect on the fishery economy. The use of subsidies is something that usually stirs up the economy and has a higher impact than what is seen in the FPI evaluation. With such a high level of subsidies, the Economy score should have been lower since this impactful measure does not contribute to sustainability itself. The higher performance presented by the tool highlights its limitations, which are discussed further in Section 4.2.5.

4.1.3. Community Indicator Performance

The Community sector had a very good performance (score: 4.33), higher than the DC and the T10 average scores. The results reflected the great impact of the fishery on the Azorean community, and the good quality of the services that are provided for the fishery communities, such as free education access for children, which creates job opportunities for the new generation, and health care assistance, among others. Such conditions promote comfort and security for fishers and their families, increasing life quality [65].

The fishery sector is one of the most important sectors in the archipelago as it happens in many small-scale fisheries worldwide (e.g., [66,67]), and it employs millions of people around the world [65]. In the Azores, fisheries employ, on average, 2500 fishers per year (average from the years 2008–2020 for all Azorean fisheries [68]), around 5% of the islands' workforce [69], and more in the Post-Harvest sector.

Fishers' remunerations are conducted through a fishing sharing system: after deducting fishing and other costs (insurance, operational costs, etc.) the crew receives a proportion of the revenue from the sale (usually shared equally between the crew and the vessel owner) [69,70]. This method increases wages and incentivizes workers, preventing the shrinking of the crew [70,71]. Additionally, the government of the Azores supports the fishing community by providing support facilities in the existing ports, and in the auction houses, preventing fish loss, increasing the fish price, and improving food security and socio-economic well-being [72–74].

All the reasons mentioned above contributed to the very good performance of the fishery in the Community dimension. In addition, the sector's high score might have been enhanced by the high number of subsidies provided for the fishery, especially capacity-enhancing subsidies. This type of subsidy incentivizes participation in the fishery [75], and due to the monetary help, especially on fuel, this might enhance fishermen's income since they would have fewer expenses.

Even though the Community sector had a good performance, there was a noticeable discrepancy between the Labour Returns performance, which was relatively low compared to the Managerial Returns performance. Additionally, the Harvest and Post-Harvest sectors had the same difference, where the Post-Harvest outperformed the Harvest sector. This same difference is observed in the T10 and DC scores, meaning that it is a tendency worldwide.

Usually, commercial crews' earnings are relatively high when compared to the average earnings of a person with a similar level of education [76], as happens in the Azores. However, most fishers have only grade school, which would not allow getting a different occupation with a similar earning potential [76], in contrast to a Post-Harvest worker who usually has a high school level of education. However, there is a lack of socio-economic information regarding Azorean fishers, which may lead to some uncertainties regarding these dimensions. Therefore, it is essential to regularly collect socio-economic information regarding both crew and captains and promote transitional education and training among the fishery community, promoting occupational mobility for individuals [76].

4.2. Inputs Performance

4.2.1. Macro Factors Performance

There is no clear evidence that the Azorean bottom longline fishery is affected by pollution; however, several studies have confirmed the high level of plastic pollution in the Azores archipelago [77–82]. Islands easily accumulate marine debris on beaches, which are directly affected by ocean currents, winds, waves, tides, etc., and for that reason are considered vulnerable to plastic pollution [81]. The Azores archipelago is influenced by a variety of ocean processes (e.g., Gulf Stream, North Atlantic Current, Azores current), which may bring plastic to the islands originating from long-distance sources, as found by Pieper et al. [81].

Very little is known about the effects of plastic pollution in the deep sea and its species, in the Azores archipelago. However, it is known that this problem is affecting the deep sea [83–85] and it has already been found in the north-east Atlantic at 2200 m depth [84]. Recent studies discovered plastic in the stomachs of blackbelly rosefish and blackspot seabream with a relatively high frequency for a remote area [86,87]. Despite these findings, more research is needed, especially on the deep-sea environment. Likewise, there are no studies about diseases and pathogens that affect the studied species, which could affect harvest and consumption. This lack of information on such subjects, allied with the low interference of natural disasters, contributed to the higher score of the Macro Factors dimension.

Despite the component's good performance, the Environmental Performance Index (EPI) metric had an intermediate score (3). The EPI tool evaluates how the country addresses its environmental challenges based on criteria such as environmental health, ecosystem vitality, and climate [88]. Regarding the country's score, decision-makers can create better and more comprehensive sustainability policies to face its environmental problems [89]. In 2020, Portugal occupied 27th place in the EPI global ranking of 180 evaluated countries [89]. Currently, Portugal occupies 48th place, meaning that its performance has decreased and that improvement might be needed in national policies to face current environmental problems.

4.2.2. Property Rights and Responsibility Performance

The bottom longline fishery in the Azores has well-defined property rights, which are crucial to determine fishers' attitudes and behavior, and are crucial for economic efficiency [90,91]. According to Dimech et al. [90], a fishery with strong property rights incentivizes resource protection and its conservation.

The Azorean bottom longline fishery has restricted access through licensing schemes (licenses are required in the Regional Directorate for Fisheries—DRP), with a maximum number of boats allowed to be registered in the regional fleet. Likewise, harvest access rights are restricted through the implementation of quotas. Additionally, most of the interviewed fishers felt secure and comfortable regarding their harvest and access rights and durability.

By contrast, neither fishing access nor harvest rights are transferable; one of the most important property rights, according to Arnason et al. [91]. Transferability incentives the conservation of marine resources and gives fishers the power to negotiate [92]. The lack of transferability right in the Azores' bottom longline fishery reflects a lack of flexibility in the fishery, which is enhanced by several fishing restrictions that exist [47]. Although this reduced the Property Rights and Responsibility component score, the fishing restrictions that reduce flexibility are necessary to avoid overexploitation of the resources.

4.2.3. Co-Management Performance

The Co-Management component score was low mainly due to the Gender dimension, which scored the lowest. Women have always had a role in the Azorean fishery, but their work has been undervalued for years, especially because working in a fishery is considered a man's job [93]. This is a global concept, and both DC and the T10 scored very low for this dimension. However, around 50% of primary and Post-Harvest workers in the world in 2020 were women (including aquaculture) [94]. Despite women's importance to the sector, most of the time they have the lowest payments, less stability, and less skilled segments of the work [95].

Because it is difficult to disaggregate data between fisheries concerning this matter, the Gender dimension was evaluated regarding all fisheries in the Azores. Most workers in the Harvest sector are men and have been for years, due to several reasons: fishery is a high-risk, very physically demanding occupation with unstable incomes and is often associated with alcohol consumption, violence, and being a sexual risk for women, with vessels also having low-hygiene sanitary conditions. [27,96]. Most of the women that work in the fishing industry of the Azores are employed in the Post-Harvest sector [93], and very few have management influence. In 2008, two associations were established to support women fishers and their communities [93], taking a step forward for the inclusion and recognition of women in fisheries.

The other three dimensions had relatively good scores. Harvesters' organizations are well established in the archipelago, and they intervene and give a voice to fishers, having a certain influence on management and business decisions and participating in several meetings throughout the year (information provided by the Azorean Fisheries Federation—FPA). However, co-management is a work in progress in the Azores.

Co-management is a typical and important approach to the management of small-scale fisheries [97]. Stakeholders' inclusion in the management of fisheries improves collective action and conflict resolution, leading to innovation and higher problem resolution through improved data collection, analysis, and monitoring [97,98]. Although it is going in the right direction, the management of Azorean fisheries would benefit from a more active participation of stakeholders. Additionally, social cohesion between fishermen is not as strong, especially when it comes to shared social norms, which is also a key determinant of effective co-management [99].

4.2.4. Management Performance

The Management component had a weak performance. The Management Methods dimension contributed to the low performance of the component, mainly because of the lack of spatial management in the Azores archipelago (this does not include Marine Protected Areas—MPAs). Spatial management, such as Territorial Use Rights for Fisheries (TURFs), can be beneficial, especially for a multispecies fishery, increasing its productivity and profitability [100]. They are seen as a good measure to fight the overexploitation problem and economic problems by preventing rent dissipation [101,102]. Although considered suitable for the management of small-scale fisheries and having been applied in some [103,104], there is no certainty that such a measure would be beneficial for the Azores, especially with fishers' low social cohesion. It could lead to more social conflicts and possible manifestations. Further studies should be applied to evaluate the benefits of implanting TURFs in the archipelago since these can be advantageous for the management of fisheries.

The metric Level of Subsidies, which analyses public resources, contributed to the low score of the Management Inputs dimension, and consequently of the Management component. The fishery is the most heavily subsidized production sector [105], and according to Clark et al. [106], a greater amount of subsidies may be harmful to the economy and to resource health. Some of the subsidies in the Azores are capacity-enhancing, used for boat construction, tax exemptions, and fuel, among others [105]. This type of subsidy may lead to excessive fishing capacity and [75] some authors believe that eliminating these subsidies will inherently improve the overfishing global problem [107,108]. In fact, in 2001 the World Trade Organization (WTO) negotiations were initiated to eliminate harmful fisheries subsidies, but with no deadline [109].

This hypothesis was tested for the Azores archipelago by Carvalho et al. [105]. The reduction and elimination of fisheries subsidies would have a substantial negative impact on fisheries, and the fishery processing sector, as in contrast with a positive effect on the economy as a whole [105]. Therefore, its complete elimination would not be possible for now. However, a reduction of capacity-enhancing subsidies might be feasible, as shown in the Norwegian case [110]. The fishing community would probably be negatively affected as a consequence of the negative effects on the fishery economy. Nonetheless, that would be a short-term response, since capacity-enhancing subsidies are not substantial for small-scale fisheries, and according to Cisneros-Montemayor et al. [111], the elimination or reduction of such subsidies would improve the fishery.

The best solution would be to redirect the subsidies toward alternative forms of support, as this has been proven to be the most successful strategy [112]. These could be fisher assistance, stock enhancement, improved knowledge in fish harvesting, and scientific and technological investments such as monitoring and co-management [109,112]. There would be an improvement in economic viability and thus in the fishing community as well.

4.2.5. Post-Harvest Performance

The Post-Harvest component had a good performance. The infrastructure quality for product trade helped with the good score. Processing companies have easy access to electricity and refrigeration, and each auction house in the archipelago is supplied with ice for fishers and small retailers, keeping the product fresh. Azorean ports have several support facilities for stakeholders which include water, electricity, repairing gears, fuel supply, and sanitary installations, among others [72]. Additionally, the scientific community tries to engage with the fishing community, promoting workshops, and educational activities. This interaction is crucial to facilitate communication and cooperation as this relationship is not always based on trust, understanding, and efficient communication [113].

Regarding infrastructure, roads in the Azores are not always in the best condition, which can prejudice the distribution flow inside the island and increase transportation costs [24]. However, the score attributed (2) does not reflect the road quality. A score of 3 would be more appropriate, but due to the global scale that is used by the FPIs, a score of 2 was attributed. This same issue occurs in Chu et al. [25].

The Markets and Market Institutions dimension had a very good performance, contributing to the component's good performance. This was mainly due to the free trade between European Union countries, which benefits international transactions in Europe [114]. Additionally, the Azorean fishery market is very competitive, comprising a high number of buyers, improving efficiency, and generating positive outcomes [115].

The dimension did not score higher due to the lack of vertical integration in the fishery (linkage between fishers and the processing industries). It is believed that the flow of information is facilitated by vertical integration and the competition between the Harvest and Post-Harvest sectors decreases [24]. However, most Azorean fishers are independent workers and are not linked to any company. In fact, independent harvesters tend to fear vertical integration [116], since it may lead to a few corporations controlling most of the industry, from harvesting to market [117].

Finally, the FPI tool has some limitations in that it simply provides a single frame of the fisheries while demonstrating how the organization is now doing. It should instead highlight which indicator or dimension is most crucial to laying the foundation for sustainability over the long-term. Because it is not known if the indicators are equally important, averaging scores as if they were can bring anomalies into the results and show a scenario that is not real. This could impose negative consequences on management plans, affecting all three sectors of the fishery. As a practical example, the Economy sector should have scored lower due to the negative effects of the heavy subsidization that is employed in the fishery. The fact that it scored higher shows that the tool gives equal value to all metrics and dimensions, instead of prioritizing those that have higher impacts on sustainability. As with all tools, the FPI tool is not perfect, but it still provides a reasonable insight into the sustainability of the fishery evaluated and it is a starting point for a deeper, and possibly more complex, evaluation. Multicriterial frameworks are a useful alternative when trying to evaluate fisheries holistically or in fisheries with limited data, when only fragments of information in different dimensions are accessible. We suggest that future studies using different multicriteria frameworks (e.g., Rapfish [16]) must be performed and their results compared to determine the strengths and drawbacks of the different tools when applied in small-scale fisheries.

5. Conclusions

For the first time, the Fisheries Performance Indicators were utilized to analyze the bottom longline fishery in the Azores archipelago. The results suggested that the fishery is mostly sustainable, in the sense that the TBL scores showed great well-being, which in return reflects a higher state of sustainability in the long term. Nevertheless, there is still room for improvement. Ecological indicators may benefit from continued research on the status of exploited stocks. Collecting data on the socioeconomic elements of this fishery is also crucial for gaining a deeper and more complete understanding of its social condition and economical vulnerabilities. A notable weakness of Azorean bottom longline fishing is the high amount of subsidies in the sector. Therefore, a decrease in capacity-enhancing subsidies, whose long-term effects would become apparent, should be further investigated. Additionally, it would be essential to implement a co-management strategy in fisheries management. By including fishers in fisheries management, we may be able to improve data collection, analysis, and monitoring, which could lead to more collaboration, conflict resolution, and problem-solving skills. The fishing communities would feel a sense of belonging and value if they were given a voice. This would likely also aid in enhancing the interaction between fishers and the scientific community and their desire to interact.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su142416585/s1, Figure S1: Top five demersal fish species caught by bottom longliners in the Azores based on their commercial landed value. (A) blackspot seabream Pagellus bogaraveo, (B) forkbeard Phycis phycis, (C) European conger Conger conger, (D) blackbelly rosefish Helicolenus dactylopterus, (E) alfonsino Beryx decadactylus; Table S1: List of indicators, metrics and expert consulted and the form of consultation; Table S2: Mean landing values (€) between the years 2013–2016 of species targeted by the bottom longline fishery in the Azores; Table S3: Top 10 species for which the LLS_DEF métier (i.e., set longlines for demersal fishes) is considered more effective in catching (i.e., more than 50% of the landed weight of these species are caught by this métier); Table S4: Fishery Performance Indicators: Outputs (Measuring TBL); Table S5: Fishery Performance Indicators: Outputs (Measuring Wealth); Table S6: Fishery Performance Indicators: Inputs (Enabling Wealth Creation); Table S7: Fishery Performance Indicators: Outputs of the bottom longline fishery of the Azores archipelago—TBL Performance dimensions; Table S8: Fishery Performance Indicators: Outputs of the bottom longline fishery of the Azores archipelago—Sector Performance dimensions; Table S9: Fishery Performance Indicators: Inputs dimensions of the bottom longline fishery of the Azores archipelago.

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