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(Un)wanted Fish: Potential Consumers' Acceptability of Landings in the Portuguese Case

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Abstract: The Landing Obligation (LO), introduced in 2015 by the Common Fisheries Policy of the European Union (EU-CFP), has been subject to a transitional period until recently. The rationale behind the measure is that all fish species subject to a total allowable catch (TAC) must be landed to increase the sustainability of fishing activities. Through the analysis of official statistical data, it is possible to find out which species of fish were landed and their relative importance, including their monetary value, and verify the potential for consumer acceptance. Some insights are drawn from the interconnection between these three factors (i.e., social acceptability, landings of main fish species, and their market value) with empirical results and the scientific literature using data from Portugal.

Keywords: circular economy; discards; marine fish species; non-edible; waste

Key Contribution: The purpose of this study is to analyze the literature in search of potential processing options for fish (or their parts) lacking a clear market, providing them a justifiable use while reducing waste of resources that are already under some pressure to run out. The approach's primary objective is to make a relationship with the species caught and relate to the potential outlet according to the landings market.

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1. Introduction

Although progress has been made, there is a huge difficulty in managing fishing resources in a sustainable way. There are many species that have suffered immense pressure from overfishing and, as a result, became overexploited [1,2]. It is somehow consensual among the scientific community that, in general, the world's fisheries have already reached their exploitable limit regarding commercial species and are currently in a phase of stagnation [3–5]. Many such fishable resources—i.e., several commercial species—are subject to various pressures [6,7]. Likewise, with the sustainability issues of renewable resources, it has been important to consider and incorporate not only mitigating measures of certain less correct fishing practices, but also to introduce the concept of circularity within a blue economy scope. To this end, sustainability approaches are posing particular emphasis on the aspect of avoiding discards, as well as taking advantage of species and parts of the fish/specimens that are underused or even unused [8–10].

In the European Union, landings are mandatory for species subject to quotas [11–13]. This legislation—i.e., Regulation (EU) No 1380/2013, where all species subject to catch limits must be landed—has been gradually put into practice since 1 January 2019 [14,15].

Nevertheless, this type of public policy positioning is not only difficult to implement, but has also generated some controversy [16–18]. Upstream of the problem, there are issues of various order, such as landing through unofficial channels of less desirable or undersized species. Downstream, there is the issue of post-landing storage, especially when there are no immediate buyers or other outlets for the landed species [19].

The blue economy is an expression that relates to the exploration, preservation, and regeneration of the marine environment. In the particular case of marine fish landed in Portugal, it is important to know the quantities caught in order to be able to assess the status of fish stocks and their potential sustainability or vulnerability over time [20].

Illegal, unreported, and unregulated (IUU) fishing has been identified all over the world. IUU is thought to occur in many fisheries and may amount to as much as 30% of total catches in certain fisheries [21]. In Portugal, there are some estimates of unreported fishing—i.e., fishing that has not been declared or that has been incorrectly reported—to national authorities. It is a recurrent practice and difficult to enforce the applicable law and regulations [22].

In the reported landings of the Portuguese fleet that occur along the coast, there are about 40 main species that have commercial value and consequently good marketability, while over 100 species are captured as by-catch [23–26]. Some of the by-catch species—i.e., with no apparent market—do not have any destination, because it is not known how to value them [27]. This finding is easily corroborated by studies that are conducted in the field of fisheries research [28,29]. Recent time series [30] show that the marine fish species that have the best commercial value in the wholesale market are about a dozen (sold for more than 10 EUR/kg), while, in the tail, there are some species whose average value of market is normally low (less than 1 EUR/kg).

The general aim of this work is to point out solutions to greater sustainability in responsible production and consumption of marine fish. In order to address the above, this work is divided into three additional parts. First, we frame what is perceived as social acceptability of seafood (with a focus on marine fish). Second, based on what is effectively and officially reported in terms of landings, we draw up a list of marine fish species that are landed by the commercial fleet in Portugal and categorize if they are subjected to quota. Third, we estimate the wholesale market value per unit of weight for each of those species.

2. Materials and Methods

2.1. General Background and Hypothesis

In a very general way, markets are the result of the balance that exists between demand—for certain goods and services—and their supply [31]. In a free market, but regulated and well established in time, the transactions of goods and services have a certain value depending on the needs of consumers and the possibility of satisfying them, being subject to rules of competition and scarcity [32]. Herein, it is assumed that the wholesale fishery market behaves in this way.

In the present case study, it is hypothesized that the potential acceptability that consumers of marine fish have are dependent on what is landed in Portuguese wholesalers and the average value at auction that each of the landed species has. For this, we developed a conceptual framework to be able to integrate the main factors and their interaction.

2.2. Conceptual Framework

The literature search suggests that, in general, the concept of social acceptability is usually more focused towards paradigmatic changes. In that scope, social acceptability has been related to forest conditions [33], renewable energy [34–36], marine protected areas [37–39], and others. In terms of marine-related themes, there are studies on social acceptability of aquaculture developments and their food products [40,41].

The present conceptual framework was developed in an original way, given the data available and what was hypothesized to be analyzed. Herein, one approach was adopted

that focuses on the importance of establishing a conceptual framework to integrate three factors (Figure 1).

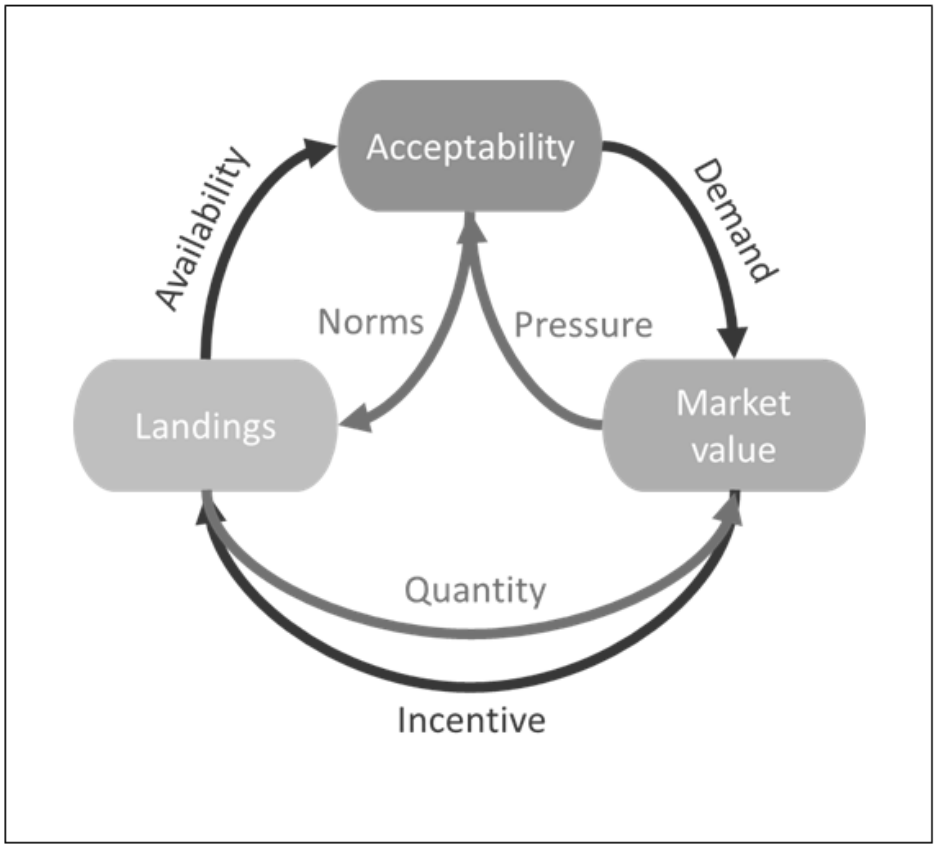

Figure 1. Conceptual framework for the analysis approach carried out in this work.

The framework involves three factors. The starting factor in the present study consists of the social acceptability linked to the consumers of fish/seafood. In turn, this factor should be integrated into a system linked to another factor consisting of the abundance of marine fish species (estimated) from official landings. The final factor consists of the average market value of landed species, according to the quantity supplied and the acceptability, that is, admitting that the value of the distinct species is a function of several factors (e.g., scarcity, freshness, and perceived taste). We assumed that there is an interconnection between the three main factors mentioned: social acceptability, landings of marine fish species, and the value of the species in the wholesale market.

From the social acceptability factor as a starting point, it can be assumed that consumers are aware of their own consumption habits [42]. The latter may depend on well-established norms, whether cultural, religious, health, and/or nutritional value of fish species [43]. The productive sector—which, in this case, is the fishing industry—supplies the catches according to what the social acceptability of all potential consumers suggests, depending on the marine resources available, and the legal, technical, or other constraints [44].

These attitudes and preferences of consumers regarding fish are determined by tastes, nutritional aspects, and the quality and freshness of the product [45–47]. The demand for fish products is also very dependent on regulations, as households will avoid consuming endangered species or those which have limitations in terms of size or weight or which come from protected areas or polluted sites or that may eventually cause any health hazard in any way [48,49].

To some extent, consumers' demand determines the landing prices (i.e., at 1st auction, in the fish wholesale market) that are adjusted over time. Market prices reciprocally exert some effect on consumers' choices [50]. Demanding consumers or those with greater

purchasing power can pay more for species that reach a higher market value. Species with lower market value are purchased by less demanding consumers or those less willing to pay for fish [51,52].

In general, the value that species reach in the wholesale market depends on the historical record of that species and the quantity available [53]. If a species usually sold on the market occasionally appears in great abundance and has little demand, the market value will inevitably drop considerably. In contrast, if a species has a substantial market demand but there is a shortage to supply it, there will be an incentive for the fishing fleet to catch that species to satisfy the demand, but with the inevitable increase in costs that will be reflected in the final product [54].

2.3. Acceptability of Marine Fish

When people make choices about fish species in general, several acceptability determinants can be considered (Table 1). Olsen [55] established three main determinants: attitudes and preferences, norms, and control or barriers. In the present work, we will use Olsen's terminology but with some adaptations to the Portuguese case study.

Table 1. Conditions affecting marine fish acceptability in the Portuguese case. Source: adapted from Olsen [55].

Acceptability		
Attitudes and Preferences	**Norms**	**Control/Barriers**
- Taste - Negative effect - Nutrition - Quality/freshness	- Social expectations - Moral obligations - Health involvement	- Price/cost - Convenience/availability - Knowledge
Motivation to consume and/or buy		
Propensity to consume (behavior)		

The first determinant highlights the possibility that people's decisions to eat fish can be made solely on how the species tastes. In contrast, people also react negatively to attributes of a certain species that are not appealing for consumption. There is also the nutritional aspect, where factors such as the quantity and quality of the fats (namely fatty acids) and proteins consumed should be considered, for instance, for health reasons. The quality of the fish that is available for consumption, including its freshness and general appearance, is another factor.

The second determinant refers to the norms that can be found in societies. As well as social expectations about what people expect from the appearance of the fish, the texture, the edible parts, the source of production (wild caught fish or farmed fish from aquaculture), there are also moral obligations regarding aspects of fishing or production, such as ethically responsible sourcing of fish, sustainable capture, avoiding suffering of organisms. Consumers also want to know whether the waters and surrounding environment where the fish was caught are places that have a Good Environmental Status of conservation (GES) or simply free of pollution.

Finally, the third determinant is related to the control or barrier conditions. When there is a high demand for a certain species (of marine fish) and a finite supply, the market price is solely determined by the industry's capacity to produce and supply that species. Demand can be a motivator to produce or catch more of that species even when there are technological or legal restrictions or when production costs are high. As a result, the availability of species is influenced by their abundance in natural environments and by how easily the business can meet consumer demand. Imports are used when local production is unable to meet demand. Scientific or empirical knowledge can also be important in influencing the acceptability of consumption of some species at a given time.

To codify acceptability, we used a simple traffic light code, where green is usually positive, orange is neutral, and red is commonly negative.

2.4. Reported Official Landings of Marine Fish

Based on official data from the Portuguese National Institute of Statistics (INE) [30], a list of the species landed at fish auctions in Portugal (including mainland and archipelagos of Azores and Madeira) for the year 2021 was compiled. The classification of the species listed was made in descending order of the quantity landed.

It is also important to point out which species are subject to quotas. These are distributed from agreements made in Brussels with other countries within the EU [56,57].

2.5. Market Value

As not all species landed have the same commercial interest, it was necessary to classify them according to their average value at the 1st auction market [58–60]. To this end, a simple method was used, which consisted of dividing the total value in EUR of each species by its total quantity landed, thus obtaining an average value of EUR per kilogram. This listing was subsequently classified into five wholesale market value categories (i.e., up to EUR 0.99, EUR 1 to EUR 1.99, EUR 2 to EUR 4.99, EUR 5 to EUR 9.99, and over EUR 10) empirically from the most valuable to the lowest set of fish species.

3. Results

3.1. Marine Fish Acceptability

Table 2 presents the results of applying a method derived from Olsen [55], which adopted a simple traffic light categorization, to the 42 landed species in terms of reasons affecting acceptability.

Table 2. Empirical classification of fish species by level of commercial acceptability. For acceptability, we used a traffic light code, where green is usually positive, orange is neutral, and red is commonly negative. Sources: nutrition (% protein: >15 g/100), social acceptability (% edible part: >60%), and moral obligations (gear used: line/hook) are based on [61], whereas health involvement (mercury: <0.5 mg/kg) is based on [62]; all other scores are based on authors' own scoring and adapted from acceptability defined by Olsen [55].

Marine Fish Species	Acceptability									
	Attitudes/Preferences				Norms			Control/Barriers		
	Taste	Negative Effect	Nutrition	Freshness	Social Expectations	Moral Obligations	Health Involvement	Price/Cost	Availability	Knowledge
Wreckfish (*Polyprion americanus*)			[61]		[61]	[61]				
Alfonsino (*Beryx decadactylus*)			[61]		[61]	[61]				
Red mullets (*Mullus spp.*)										
Turbot (*Psetta maxima*)										
Red seabream (*Pagrus major*)			[61]		[61]	[61]				
John Dory (*Zeus faber*)										
Brill (*Scophthalmus rhombus*)										
Snappers (*Pagrus pagrus*)			[61]		[61]	[61]				
Gilt-head seabream (*Sparus aurata*)			[61]		[61]	[61]	[62]			
Sea bass (*Dicentrarchus labrax*)			[61]		[61]	[61]				
Flounders (*Microchirus spp.*)			[61]		[61]	[61]				
Meagres (*Argyrosomus spp.*)			[61]		[61]	[61]				
Grouper (*Epinephelus marginatus*)										
Monkfish (*Lophius piscatorius*)			[61]		[61]	[61]	[62]			

Table 2. *Cont.*

Marine Fish Species	Acceptability									
	Attitudes/Preferences				Norms			Control/Barriers		
	Taste	Negative Effect	Nutrition	Freshness	Social Expectations	Moral Obligations	Health Involvement	Price/Cost	Availability	Knowledge
Common pandora (*Pagellus erythrinus*)										
Redfish (*Sebastes spp.*)										
Axillary seabream (*Pagellus acarne*)			[61]		[61]	[61]				
Whiting (*Merlangius merlangus*)										
Flounders (*Hippoglossus spp.*)			[61]		[61]	[61]				
Whiteseabream (*Diplodus spp.*)										
Forkbeard (*Phycis phycis*)			[61]		[61]	[61]				
Scabbardfish (*Lepidopus caudatus*)			[61]		[61]	[61]	[62]			
Dogfish (Squaliformes)			[61]		[61]	[61]	[62]			
Hake (*Merluccius merluccius*)			[61]		[61]	[61]	[62]			
Blacksword fish (*Aphanopus carbo*)			[61]		[61]	[61]	[62]			
Scaldfishes (*Arnoglossus imperialis*)										
Conger (*Conger spp.*)			[61]		[61]	[61]				
Atlantic pomfret (*Brama brama*)										
Skates (*Raja spp.*)			[61]		[61]	[61]	[62]			
Tuna and similar (*Thunnus spp.* and other)										
Gurnards (Triglidae)										
Anchovy (*Engraulis encrasicolus*)										
Pout (*Trisopterus luscus*)										
Horse mackerel (*Trachurus trachurus*)			[61]		[61]	[61]	[62]			
Atlantic mackerel (*Scomber scombrus*)			[61]		[61]	[61]	[62]			
Mullets (*Liza spp.* and *Mugil spp.*)										
Sardine (*Sardina pilchardus*)			[61]		[61]	[61]				
Blue whiting (*Micromesistius poutassou*)										
Black horse mackerel (*Trachurus picturatus*)										
Toadfish (*Sarpa salpa*)										
Mackerel (*Scomber japonicus*)			[61]		[61]	[61]	[62]			
Bogue (*Boops boops*)										
Other										

3.2. Marine Fish Landings

More than 100 commercial species are landed in Portugal [24,26]. However, just over 40 are reported in the official statistics. Figure 2 shows the official statistics of marine fish landed at auction for the year 2021 [30]. The species landed in greater quantity are essentially (small) pelagic fishes. In Figure 2, the species that are subject to quotas are also identified in a distinct color. Most of the larger and some of the smaller pelagic species landed are subject to a quota, namely sardine, horse mackerel, anchovy, or tuna and similar.

3.3. Marine Fish Landings Value in the Wholesale Market

From the data available in landing statistics for the year 2021 [30], it was possible to know the value (in EUR) by each species according to the quantity landed. Thus, we defined the average value (EUR/kg) per species and five categories were empirically defined depending on the average price obtained in the wholesale market (Figure 3).

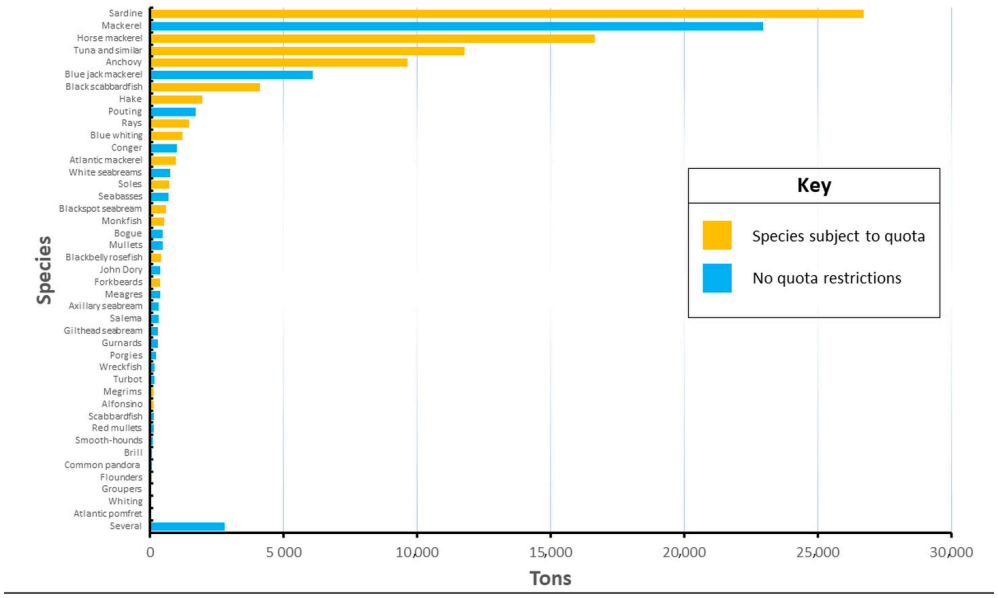

Figure 2. Listing of fish species landed in mainland Portugal. Note: major tuna species have quotas but "Tunas and similar" includes species without quota.

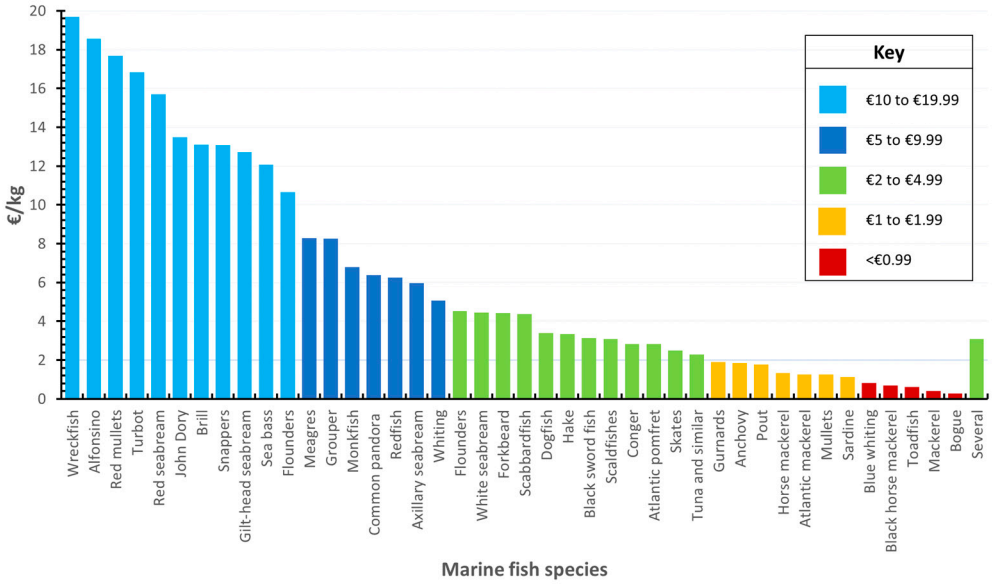

Figure 3. Marine fish wholesale market value (EUR/kg).

4. Discussion

Regarding the acceptability of fish landed in Portugal, there may be much variability. Portugal, despite being a relatively small country, has a large level of consumption of fish, being over 50 kg/per capita average for 2017–2019 [63], one of the countries that consume the most fish in the world, only being surpassed by Japan, Iceland, and some island states in the Pacific Ocean [64]. Nevertheless, there is a wide variation in fish consumption per region; understandably, in coastal areas, there are generally numerous supply sources both for residents and for tourists [65].

Moreover, in Portugal, the high consumption of fish is related to sociocultural reasons [66]. Inland, fish consumption is much scarcer, only having some notoriety at festive occasions, such as Christmas (cod and octopus) and summer (sardines) and popular or saints' festivities (*Santos Populares*) (particularly sardines). However, this study does not

include the statistics for cod or octopus. Cod is almost entirely imported from Northern European countries. Likewise, all marine species other than fish (the octopus is a cephalopod mollusk) were also excluded. Sardines are an extremely popular fish only when they are fat, that is, in the late spring/summer, which also defines the beginning of the fishing season. Coincidentally, sardines are also the fish with the largest volume landed in Portugal. Sardines, as well as some other small-sized pelagic species, are also consumed in canned form [67]. Hence, perhaps the fact that they have lower market prices, as they are purchased in massive quantities by the processing industry. Anchovy stands out in this field and, for about two decades, mackerel has also been on the list of these species, with a significant effort on the part of various entities to promote the species because it is very nutritionally rich and because it has proven benefits to health [68].

There are also species, such as tuna, which are also highly demanded by consumers but for different, sometimes opposing reasons. On one hand, due to the nutritional and exquisite characteristics of tuna but generous size of these fish, they are consumed in terms of fresh or frozen tuna steaks. On the other hand, tuna is processed in canning factories [66].

The fish that command the greatest prices on the market are typically intended for the hospitality and tourism industry, where freshness is a crucial factor, particularly for the tourism sector [69]. According to the data analysis, 11 species that were landed in Portugal in 2021 have an average wholesale value of more than EUR 10 per kilogram (in a descending order: wreckfish, alfonsino, red mullets, turbot, blackspot seabream, John dory, brill, porgies, gilthead seabream, seabasses, and soles). Except for sea bass and sea bream, which may be produced in aquaculture, these species are scarcer on the market, which contributes to their high market value. They are also in high demand in the tourism and hospitality sectors [70].

The species from landings that have a lower value, on the other hand, include species that are substantially less acceptable to consumers [71] because they are sometimes associated as living in polluted waters, e.g., mullets [72]; they are herbivores and consume plants that accumulate substances that can be harmful and eventually transmit problems to human health, e.g., salema or bogue, [73]; and some herbivorous fish also have the problem of not having a pleasant taste if they are not eviscerated immediately after being caught [74]. Fish with lower market value are not always associated with their great abundance. There are other conditions that influence this value, such as low demand from households, either due to lack of knowledge or for other reasons of acceptability in relation to one aspect or another that is associated as being negative (e.g., less pleasant taste and being captured in places whose waters are of poor quality) [58].

Associated with all these catches there is also the question of the parts of the organisms that are not consumed as human food. Usually these parts include scales, bones, spines, eyes, viscera, and gonads. All the above-mentioned species are consumed fresh and whole, but some of them are also processed to create other products, such as canned (e.g., all small pelagic species, such as sardine, mackerel, and anchovy, and some large ones, such as tuna). Some parts are also sometimes used in canned products (e.g., gonads of sardine, mackerel, and hake). The current societal pressure in terms of sustainability, rejects products and practices that generate damages to the environment, the stocks, the animals and produce excessive waste, and supports the enhancement of inedible parts [75,76]. Therefore, it is particularly important to consider in the future for better management of living marine resources not only fish of lower value that is not consumed as food, but also to find ways to value fish as much as possible in the sense of circularity of the economy [9,77].

5. Conclusions

The fish that is landed and traded at first auction or the wholesale market derives from several factors related to the efficiency of the fishing fleet and its different gears for catching fish (supply). Fishing activities are subject to a series of technical, legal, and environmental constraints, which are reciprocally determined by demand on the part of consumer acceptability. The value of fish is realized in the prices practiced in the wholesale

market derived from a historical record that is continuously adjusted, considering the balance between demand and supply of fresh fish.

It can be pointed out that there are some species in which there is interest in continuing to study possibilities to value them (e.g., pouting, blue whiting, and mullets). This valuation should be based on their relative abundance, that is, that they are not subject to excessive pressure and that, biologically, they recover easily. In the same way, for the consumer/household, awareness must be made in the sense of social acceptability for consumption, showing, for example, the benefits for health and the Good Environmental Status (GES) of the species. Examples in this sense are mackerel and Atlantic mackerel, whose appreciation is recent in Portugal.

In order to circularize the blue economy, in the future, it is important to focus attention on the following specific objectives:

- Of the least valued species, scrutinize those with the most potential for household consumption.
- Find ways of preservation where less energy is spent.
- Enhance the parts of the fish that are not edible.

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