Article

Value Chain for Non-Indigenous Bivalves in Greece: A Preliminary Survey for the Pearl Oyster *Pinctada imbricata radiata*

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Abstract: The present study investigates through an integrated survey, for the first time in Greek shellfish market, the marketing distribution towards a new edible shellfish product that of the non-indigenous pearl oyster *Pinctada imbricata radiata*. The survey conducted through personal interviews on sector entrepreneurs/staff of the supply (i.e., shellfish producers, wholesalers, fishmongers, owners of restaurants). Internet-based quantitative research was also conducted to explore the market supply of the pearl oyster covering all nine regional units of Greece. The market for pearl oyster seems to be there as a substitute of the major commercial species in seasons of shortages. There is a specimen mislabeling throughout Greece, thus, extraction of significant information about the market supply of pearl oyster is deficient. Further knowledge on the bivalve shellfish value chain is needed, to define how the wild and the farmed species (mussels) interact in the market and in the distribution channels, toward a product-easy to use in the supply chain and friendly to the consumer. Findings also raises additional concerns as a priority for conservation, and the current practices do not satisfy the Common Fisheries Policy in terms of traceability.

Keywords: non-indigenous species; seafood market; mislabeling; Mediterranean

1. Introduction

Bivalves are more than a healthy food source, as they also perform ecosystem functions such as water filtering [1]. Few studies have focused on bivalves in terms of food processing and labelling [2,3] in the Mediterranean, whereas in Greece in particular, studies on consumer demand for bivalve products were conducted two decades ago [4] and only recently [5]. Despite the presence of a diverse range of bivalve species in Greek seas, public consumption is limited to specialty seafood restaurants and local "*tapas*"-style bars so called "*ouzeri*" [6], as bivalves are not considered a "safe" seafood due to past shellfish poisoning occurrences [7].

The Greek shellfish market is at a halt, and products that are not exported, primarily Italy [8] and France, are distributed locally to a small number of restaurants and fishmongers. Approximately 5% of the firsthand sales is directed to hotels, restaurants, and catering [9]. Greece's demand for shellfish products has not increased across years and the country's seafood per capita consumption remains low (almost 5%: [10]), significantly below the European average [11]. The traditional wholesale sector remains dominant in the value chain for the (Mediterranean) mussel *Mytilus galloprovincialis* (Lamark, 1819) [12]. Though, the distribution of farmed mussels has changed during the past few years, as production companies have become wholesalers. The estimated profit margin at wholesale level exceeds 50% and the same magnitude of profit margin level is also estimated for the

retail sales except in the case of fishmongers. Fishmongers dominate the retail market of mussels as they distribute more than 90% of total quantities sold in 2014. The presence of fresh, domestically produced mussels in retail stores is rather limited in Athens, the capital of Greece and in touristic regions. Despite the availability of farmed mussels, only basic processing occurs [13,14]. The most common possessing activity is the de-shelling of mussel bodies producing unvalved mussel meat distributed in in bags weighing 350 and 500 g (drained weight) and characterized by a short life cycle (5–6 days). Approximately 5% of the production is sold in this form and are present in most menus of seafood restaurants or traditional taverns in Greece [9,13].

Pearl oyster *Pinctada imbricate radiate* (Leach, 1814) is an exotic species with significant presence in the Greek seas and good potential for commercial exploitation [15]. Up to now limited unregulated and unreported quantities are directed to the market with different names of the bivalve, due to lack of the relevant legal framework of the species. In the local markets pearl oyster is referred with different names as "*stridoxteno*"," tiganaki", "*margaritoforo stridi*", "*stridi*", "*xteni*", "*kaloxteno*", etc. Their catches are often deliberately or unintentionally misreported or misidentified and recorded within other group of bivalves [16], compromising accurate reporting about this taxon. The promotion of the pearl oyster as a substitute shellfish product due to its high nutritional content and benefits for human health [17] may be necessary due to the scarcity of other bivalves because of overfishing [18], environmental shocks [19,20] that directs to mass mortality events [7,21–23], and HABs episodes losses because of harvesting prohibitions and price collapse [7,24–26]. Selling illegal, unreported, and unregulated (IUU) seafood [27], which has become a significant problem in the Greek bivalve market [15], is an illustration of a breakdown in product information and traceability. All marketed seafood products are required by EU law to clearly label their nominal scientific name, the common name in the official language of the Member State they are being sold in, the FishBase Information System or the ASFIS database of the Food and Agriculture Organization [27], the fishing gear used, and the condition of the product (frozen, fresh, etc.). By linking far-off producers with consumers, advanced bivalve supply chains can increase the quantity and accessibility of food.

The present study has integrated different types of information aiming to investigate the marketing distribution towards a new edible shellfish product that of the non-indigenous pearl oyster *Pinctada imbricata radiata* in the Greek shellfish market. The survey based on personal interviews with sector entrepreneurs/staff (i.e., shellfish producers, wholesalers, fishmongers, owners of restaurants), and internet-based research, to explore the market supply of the Greek shellfish and of the pearl oyster. This study aims to outline the importance for oyster consumption by Greek consumers via the inside of the shellfish market owners, vendors, and restaurant owners. There is no detailed record of the shellfish value chain in Greece apart for few reports on mussels [10,13]. Considering the scarcity of data regarding bivalve marketing [5] and the poor situation of the Mediterranean bivalve shellfish stocks [14], this work contributes to reveal opportunities relevant to the development of the Greek bivalve market strategies.

2. Materials and Methods

2.1. Survey Design

The survey was conducted on sector entrepreneurs/staff of the supply chain (i.e., shellfish producers, wholesalers, fishmongers, owners of restaurants) through personal interviews. Participants were randomly recruited depending on their role in shellfish market within the supply chain to minimize any potential bias in participant selection. Participants discussed their experiences over the time period under consideration, as well as what they learned from client feedback. The spatial coverage of the sector entrepreneurs of supply chain is focused on areas (Figure 1) where bivalves are mostly consumed [6,28] and pearl oyster is mostly exploited [6]. In the northern Greece, nearby the main production areas, flea markets and retail stores (i.e., supermarkets) are also important outlets. In southern Greece, and especially in the Athens metropolitan area, only few big retail stores

offer fresh mussels. Despite that the presence of fresh, domestically produced farmed mussels in retail stores is rather limited in Athens [9,15], the region that pearl oysters are harvested, and our research is focused. However, to understand the value chain of a new and non-indigenous species, the value chain of the other traditional harvested wild bivalves [29,30] and their commercial links and interactions with the farmed mussels [6], for which a lack of knowledge is still present, needs to be also shown [31]. The interviews were conducted during September 2019–September 2022 via face-to-face interviews. Participants were interviewed individually and were not identifiable by other participants.
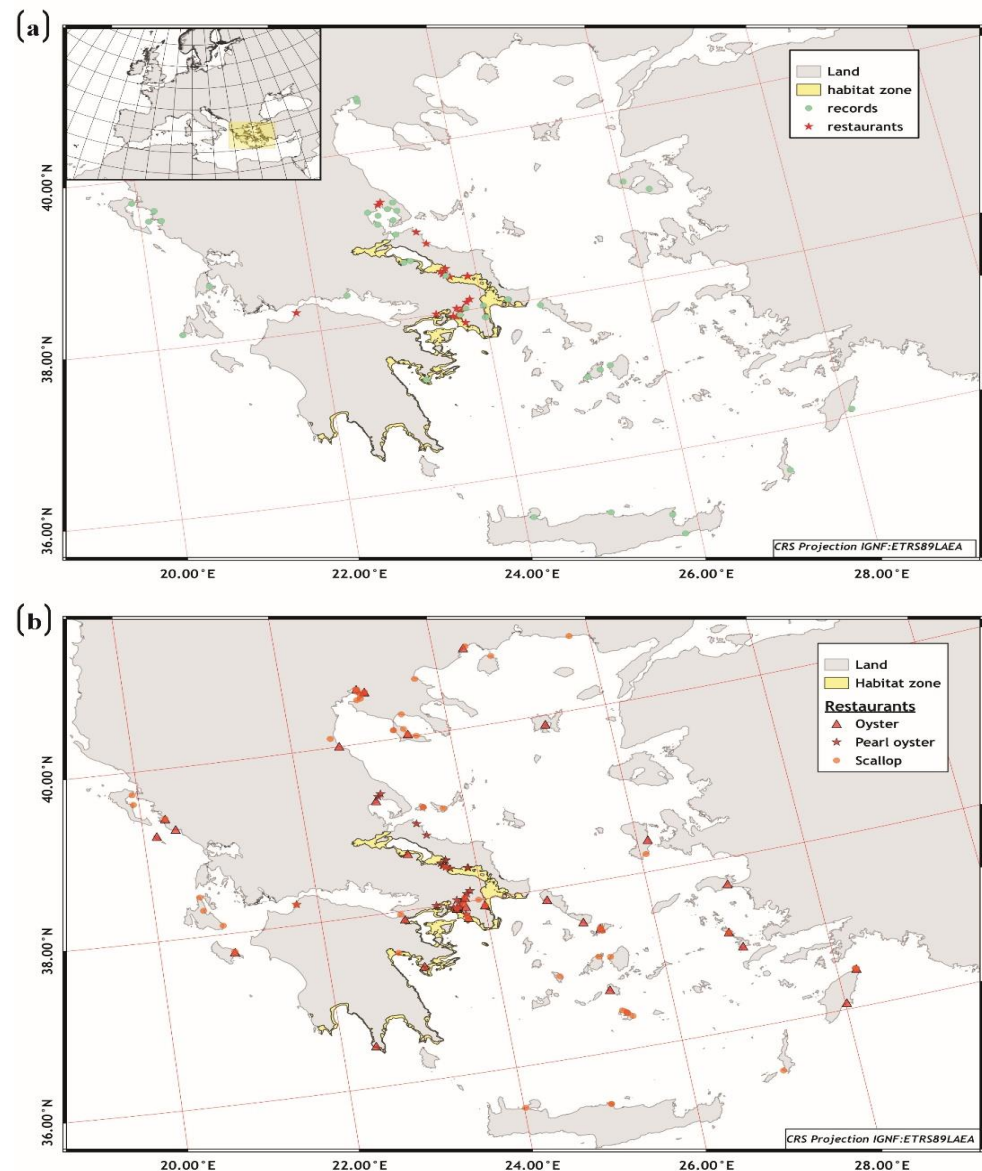

Figure 1. (**a**) *Pinctada imbricate radiata* habitat zones (yellow line), records of presence (blue circle) and shellfish market points (red star). (**b**) market points of *Ostrea edulis* (red triangle), *P. i. radiata* (red star) and *Aequipecten opercularis* (orange circle) in relation to *P. i. radiata* habitat (yellow line).

The questionnaire consisted of two sections (Table A1 in Appendix A). The first section included 32 questions, covering the experience of the sector entrepreneurs regarding commercial demand for shellfish, seasonality of demand, types of preferences, problems, and perspectives of the workplace. In the present study special attention was given to questions focusing on the prospect of promoting new shellfish products, in particular oysters, such as the non-indigenous pearl oyster. The second section included the demographic charac-

teristics of the interviewed employers and gathered information on seven demographic and socio-economic characteristics of the employers, namely the owner's gender, age, professional experience, education level, place of residence, number of employees, type, and legal status of the business.

An internet-based survey also conducted between January 2021 and March 2021 intending to evaluate the presence of the pearl oyster in the markets of Greece in relation to the native European flat oyster *Ostrea edulis* Linnaeus 1758 and the scallop (pectenid) *Aequipecten opercularis* (Linnaeus, 1758). Both species are phenotypically very close to the pearl oyster that is called in Greek as "*stridocteno*" that means chimera/hybrid of native oyster "stridi" and scallop "cteni". These commonly used words in Modern Greek have been used as keywords in three popular search engines: "Google.com", "Yahoo.com", and "Bing.com". Also, a popular restaurant promotion platform was used, "tripadvisor.com", to obtain indicative listings related to the market of *O. edulis* and *A. opercularis*. These queries have been chosen to match with those currently searched by potential bivalve consumers and the use of multiple search engines optimizes our findings [32]. Double entries, which were counted and sorted manually, were carefully excluded from the records. The information emerging from the analyses of the downloaded posts were disaggregated per area and species involved. The geographical distribution includes all nine regional units of Greece: Thrace, Macedonia, Epirus, Central Greece, Thessaly, Peloponnese, Ionian Islands, Aegean islands, Crete (Figure 1).

2.2. Data Analysis

The frequency of preferences in the whole sample was estimated and at the level of the independent variables mentioned above and for their presentation the method of the correlation tables was chosen, but also that of the diagrammatic presentation. At the same time, an independence test was performed with the χ^2 distribution (Likelihood-ratio χ^2), for each of the preference questions and in relation to the independent ranking variables of the respondents [33]. In cases of statistical significance, an analysis of the "Adjusted Standardized Residuals", the theoretical in terms of observed frequencies related to consumer preferences. All the analyses were carried out using the statistical package IBM SPSS Statistics 27.0.1.0 [34].

3. Results

3.1. Demographic Characteristics

A total of 45 sector entrepreneurs participated in the survey, from which 77% were men aged from 32 to 61 years (mean age of 45.9 years and standard deviation of 6.8 years), and the remaining were women (23%) aged from 40 to 66 years (mean age of 50.8 years and standard deviation of 9.2 years). More than half attained high school graduates and the rest were graduates of higher (26%) or private (10%) schools. The type of business in 25 of the 31 companies concerned catering (restaurants, taverns, bars-cafes and ouzo), while the rest were fish shops and shellfish wholesale (processing and distribution). The professional experience of the participants in the research ranged from 6 to 40 years (mean 18.7 years with standard deviation of 9.6 years). More than 4/5 of the participants ordinated from Volos (26.9%), Evvoia and Attiki (both at 23.1%) and to a lesser extent from (Igoumenitsa and Fthiotida with 7.7%) and the remaining areas contributed the rest with percentages less than 5%.

3.2. Aspects of Bivalves Trading

The species that are traded to a greater extent were the (Mediterranean) mussel *Mytilus galloprovincialis* (Lamark, 1819) (71.0%) (Figure 1) followed by warty venus clam *Venus verucossa* (56.7%), and to a lesser extent by scallops such as the smooth scallop *Flexopecten glaber* (Linnaeus, 1758) and the variegated scallop *Mimachlamys varia* (Linnaeus, 1758) (66.7%), the flat oyster (32.3%), and the brown venus *Callista chione* (Linnaeus, 1758) (28.0%). In contrast, there were no trade for olive green cockle *Cerastoderma glaucum* (Bruguière,

1789) (96.8%), *Donax trunculus* (Linnaeus, 1758) (87.1%), Noah's ark *Arca noea* (Linnaeus, 1758) (77.4%) and the razor shell *Solen* spp. (77.4%) (Figure 1). Almost two third of the sector entrepreneurs did not trade pearl oyster, whereas a third given limited importance (Figure 2).
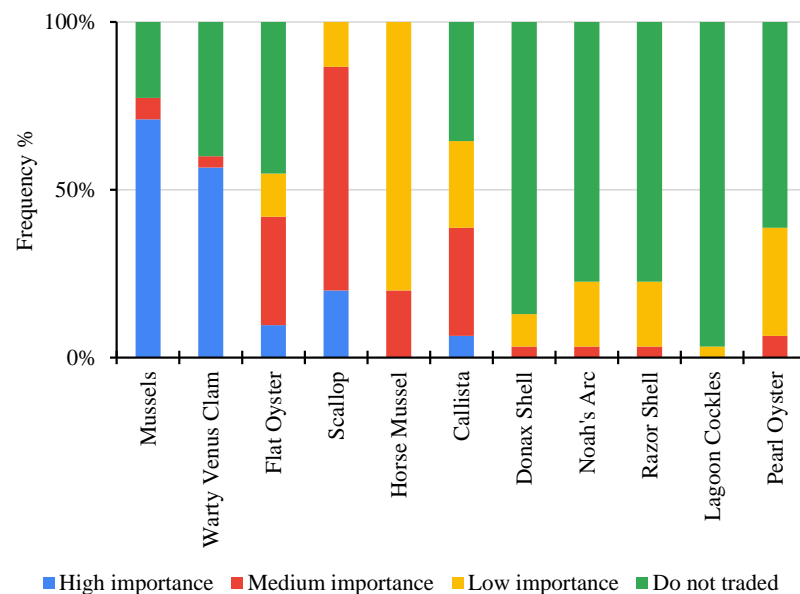

Figure 2. Frequency of the order of importance of shellfish species supplied by the sector entrepreneurs. Species definition: Mussels (*Mytilus galloprovincialis* (Lamark, 1819)), Warty Venus Clam (*Venus verrucosa*), Flat Oyster (*Ostrea edulis*, L. 1758), Scallop (smooth scallop *Flexopecten glaber* (Linnaeus, 1758) and Variegated Scallop *Mimachlamys varia* (Linnaeus, 1758)), Horse Mussel (*Modiolus modiolus*), Callista (*Callista chione*) the smooth clam Donax Shell (*Donax trunculus*), Noah's Arc (*Arca noea*, Linnaeus 1758), Razor Shell (*Solen* spp.), Lagoon Cockles (*Cerastoderma glaucum*, Poiret, 1789), Pearl Oyster (*Pinctada i. radiata*, Leach, 1814).

Pearl oyster consumption takes place in the lent season before Easter (40.6%), followed by summer (31.3%) and to a lesser extent in another season (28.1%). The seasonal pattern did not differ significantly in terms of business location (urban, coastal), and professional experience (χ^2, $p > 0.05$). Almost 2/3 of the employers claimed that customers were aware of bivalve species (75.8%), a patter which is not affected significantly (χ^2, $p > 0.05$) with business location.

According to sector entrepreneurs interviewed, the preferable bivalves for customers are mussels (92.9%), followed by callista (57.1%), and to a minor extend by pearl oyster (7.1%). Employers stated that customers chose bivalves on their vacations or on special holidays (35.3% and 33.3%, respectively), and to a lesser extent on their family outings or «Romantic moments»/Anniversaries (17.6% and 13.7%, respectively). These reports did not differ significantly with professional experience or business location (χ^2, $p > 0.05$). Almost two out of three of the employers would not supply/trade ready-to-eat shellfish (pre-cooked). In contrast, the remaining percentage stated that they were positive to serve pre-cooked shellfish for sure or rarely (16.6% and 20.0%, respectively). The most popular pre-cooked shellfish product is the marinade shellfish (34.5%), followed by smoked or boiled shellfish (20.7% and 10.3%, respectively). Almost 1/3 of the employers stated another unspecified pre-cooked form.

The vast majority (81.5%) of the employers stated that the government has not taken any measure related to the consumption promotion of pearl oyster. This statement did not differ significantly with employers' educational level or professional experience (χ^2, $p > 0.05$). The most frequent measure to fill the gap between consumer and pearl oyster consumption are "Advertising, Nutritional value studies, Production support" or "Informative

promotions" (each with 23.5%). When employers were asked about problems and barriers in their activities, almost half of them (45.0%) responded negatively. On the other hand, the primary problems are COVID and products freshness (10.0% both). Most employers (96.6%) trust veterinary services related to shellfish hygiene, regardless of their age, educational level, or professional experience (χ^2, $p > 0.05$).

3.3. Pearl Oyster Products

More than half of the respondents (54.0%) ranked as the first, among 8 suggested products (Figure 3a), the fresh live oysters, whereas at the second and third preference participants stated the fresh live in a net and the fresh live in a vacuum (38.0% and 47.0%, respectively). Less desirable products were the uncovered frozen or smoked in jar, while last in the ranking of the proposed products were the uncovered in jar with brine or their placement in a jar with olive oil and oregano or breaded nuggets. Regarding the suggested quantities that the above packages would contain, they mainly ranged (80.0%) between 1.0 to 2.5 kg (Figure 3b), while in the packages in pieces the range of the pieces ranged from 6 to 16 pieces of oysters (not shown in figure). The vast majority (84.0%) of the respondents agreed that the packaging material would be useful to be transparent and glassy (71.0%).
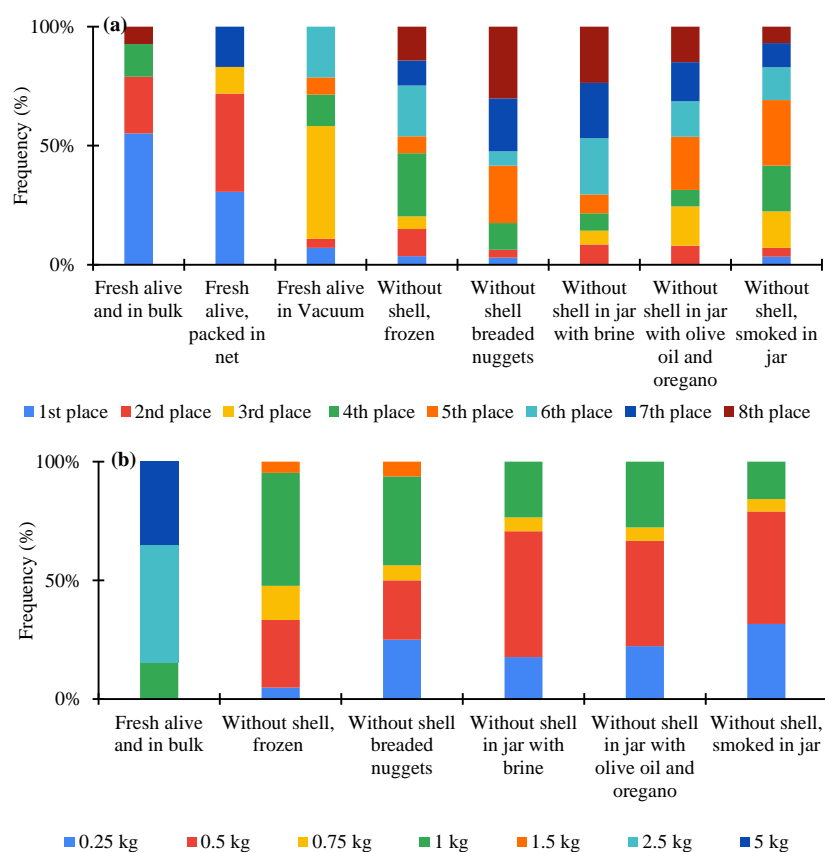

Figure 3. Frequency of: (**a**) of packaging preference and (**b**) recommended quantity of Pearl Oyster fresh product.

3.4. Internet-Based Survey

Overall, a total of 457 records about pearl oyster were found, with 25 of them related to the market of pearl oyster (Figure 1) distributed in the market in three geographical areas in Greece: Peloponnese, Central Greece, and Thessaly (Figure 1). Google had the most reports (292), followed by Yahoo (102) and Bing (63). Repeated results were 61. Unique results from Google were 170, from Yahoo 42, and from Bing 2. In total, only 5% of the reports were concerned restaurants and commercial points. A total of 88 results were found

regarding *O. edulis*, with all of them related to restaurants. The geographical distribution of these includes all nine studied regions of Greece (Figure 1).

4. Discussion

The present study aims to investigate the marketing distribution towards a non-indigenous edible shellfish product that of the pearl oyster in the Greek shellfish market. The approach based on an internet survey to identify the geographical expansion of the marketing distribution of this species in relation to the flat oyster and the scallop pectinids and on interview survey conducted on the sector entrepreneurs (i.e., shellfish producers, wholesalers, fishmongers, owners of restaurants). This study aims to outline the importance for shellfish consumption by Greek consumers via the inside of the shellfish market owners, vendors, and restaurant owners. Exploring new distribution patterns will favor market stability to better balance supply and demand for fishery products. Direct supply chains, such as the bivalve marketing in Greece, have fewer steps between producers and consumers, and often represent pathways for products to be sold locally or regionally.

Despite the limited marketing importance of the pearl oyster in the Greek shellfish marketing, sector entrepreneurs suggested specific type of packaging for the promotion of this species to consumers, such as primarily the packaging of the fresh live oysters, and to a lesser extent the fresh live in a net and the fresh live in a vacuum. This is in accordance with other studies, in which the most preferred product is the fresh oysters on a half shell [4]. Most of the participants to this study agreed that the packaging material would be useful to be transparent and glassy. Pre-shucked and half-shell oysters are new preparation formats already available in international seafood markets like USA [3] yet almost absent in the European market. Both pre-shucked and half-shell oysters are ready-to-eat products as they are pre-opened. Pre-shucked oysters keep the two original shells together, thus appearing very similar to closed oysters, while half-shell oysters are sold with one shell only and the edible part made clearly visible.

The vast majority (81.5%) of the sector entrepreneurs stated that the government has not taken any measure related to the consumption promotion of pearl-oyster. A way to encourage consumers towards the consumption of the pearl oyster over the other important bivalves, could be the use of the former as substitute of other species that already have supply shortages such as warty venus clams, oysters, callista, even mussels especially out of their harvesting seasons. Special attention needs to be carried out on the marketing to increase the shellfish consumption (in general) for all the bivalve species. Also, cooking shows seems to encourage the seafood consumption experience as it has been shown in other Mediterranean countries [35].

Internet-based survey revealed that although peal oyster was first observed in Greek waters in the 60s [10], however, in the areas where this species was still absent, no reports of its availability to consumers were found (Figure 1). On the contrary, in areas that peal oyster were well-established dozens of references were found to the market purchased native oysters and scallops. It seems that there is a specimen mislabeling throughout Greece, thus, extraction of significant information about the market supply of pearl oyster is deficient. The species lists reported by the Ministry of Commerce and fisheries authorities should be revised and synchronized. As a result, the data's resolution will be improved, and the oyster products sold in Greek markets will be more easily traceable.

The present outcomes cannot be considered generic for the entire Greek shellfish marketing, but presents a good picture of the overall situation, especially for more abundant species. In addition, the use of the online survey format to evaluate the presence of the pearl oyster in the markets of Greece in relation to the native flat oyster *O. edulis* and the scallop *A. opercularis* biased the structure of the samples with surveys performed using face-to-face surveys [36]. Nevertheless, [37] found that face-to-face surveys still deliver the most representative results followed by telephone interviews, and finally by online quota survey. Despite the limited number or sector entrepreneurs participated to this survey, the

results indicated that there is the need of an in-depth study of the bivalve value chain in Greece, which characterized by lack of knowledge.

Despite the limitations of the present study, this work provides a general picture of bivalve marketing in Greece that could be backed up in future with conventional, on-site, surveys, in a future perspective, and with a more spatial expanded sample, this research would assist policymakers in expanding and supporting the development of bivalve market programs across the country, hence promoting bivalve consumption. This would bridge the gap among producers and consumers by promoting the vertical integration of the supply chain [8,38]. Regulatory agencies can track products and reduce food safety risks, businesses can hold one another accountable and lower economic risks, and consumers can differentiate between products in the marketplace and follow changes in industry sustainability by improving the way supply chains function regarding product flows and information flows [31].

Emphasis must be placed on the regulations provided for the exploitation of bivalve species within designated allowed zones, as described in [21], in accordance with the current safety norms and standards in order to address concerns about public health related to the consumption of this non-indigenous bivalve species. Illegal harvests conducted either beyond the classified zones or during the harvesting bans enhance the mistrust of consumers on the shellfish marketing [7,9,21]. To tackle such issues, a monitoring plan regarding the commercial exploitation of this non-indigenous bivalve species, based on [21], is already submitted to the relevant authorities. Last but not least, as the present study is a value chain investigation rather an ecotoxicological one, comparative corresponding studies on the specific species bioaccumulation are more than welcome, due to a gap of knowledge existed on the environmental quality of the harvesting zones that directly effects the bioaccumulation of the species.

5. Conclusions

In conclusion, initiatives such as the present study aiming to facilitate the transition toward a more sustainable supply chain and highlight the advantages of promoting invasive species as a food [28,39]. The market for pearl oyster seems to be there as a substitute of the major commercial species in seasons of shortages. This becomes more frequent the last years due to mass losses due to heatwaves [28,40] and species overexploitation. In addition, promotion actions of the targeted species could enhance the demand. Further knowledge on the bivalve shellfish value chain is needed [29,41], to define how the wild and the farmed species (mussels) interact in the market and in the distribution channels [30,42]. Seafood supply chains are complex [20,31] and relatively unstudied in Greek market creating a food system that connects producers with consumers and creates economic opportunities for businesses [43–46].

By considering the financial gains made as a fishery resource, the willingness to include the non-native pearl oyster *P. i. radiata* in the market for bivalve products would reveal alternative methods to control this species and lessen its impact on the ecosystem [5]. Finding ways to convey the environmental advantages of eating bivalves and determining whether consumers would be willing to pay more for that reason are two additional directions for future research. The planning of regional festivals to encourage the consumption of novel shellfish species prepared in various ways may be a fruitful strategy for achieving this objective. The positive attitude of the Greeks sampled group towards the consumption of NIFS emphasizing the high sense of responsibility towards the protection of marine habitats. Labelling the non-indigenous products could facilitate their consumption. Market promotion campaigns are vital for increasing the familiarity of citizens with alien species products, and further increase demand and consumption. The outcomes of the present study are useful for policymakers and fish product vendors in their efforts to expand and support the introduction of new fish species, based on consumers' willingness to pay for these species as food items.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data supporting reported results of the study can be provided upon request to the last author.

Appendix A

Table A1. Questionnaire for Pearl-Oyster Consumption.

Department of Animal production, Fisheries and Aquaculture
Questionnaire for the marketing opportunity of Pearl-Oyster.
The present research is carried out to record the circulation and purchasing intensity of the oyster in the Greek catch market. The questionnaire is ANONYMOUS and does not contain any information that leads to the identification of the respondent. Your answers will be evaluated to serve the purpose mentioned above.

- Date of interview

- Questionnaire number

1. How many years have you been involved in the fishery trade?
2. Mention the species of fishery products that you trade and their fishing area.

Species	Area	Species	Area

3. Which of the following species of shellfish do you supply/distribute (Multiple answers, rank species in order of priority)?

Mussels	1
Warty Venus Clam	2
Flat Oyster	3
Scallop	4
Horse Mussel	5

Table A1. *Cont.*

Callista	6
Donax Shell	7
Noah's Ark	8
Razor Shell	9
Rayed pearl-oyster	10
Lagoon Cockles	11

4.   Which season, oysters are most consumed?

Lent [1] ☐	Summer [2] ☐	Christmas [3] ☐	Other season [4] ☐

5.   Does the consumer know the shellfish species?

YES [1]	NO [2] ☐

6.   Does the consumer prefer the shellfish species?

YES [1] ☐	NO [2] ☐

7.   If YES, which are they?

8.   From your experience, when do your customers choose shellfish?

In vacations	1
Special holidays	2
Family outings	3
«Romantic moments»/Anniversaries	4

9.   Is there a change in the trend of consumers in the last 5-10 years in the consumption of oysters?

YES [1] ☐	NO [2] ☐

10.   If YES, since when and what is this new trend?

11.   What are the main problems you face?

12.   Has the government taken measures to promote the consumption of pearl-oysters?

YES [1] ☐	NO [2] ☐

13.   If NO, what do you suggest?

14.   Does the current legislation cover pearl-oyster fishing, based on the nomenclature of species belonging to this group?

YES [1] ☐	NO [2] ☐

15.   If NO, what do you suggest?

16.   Does the current legislation make your activities easier?

YES [1] ☐	NO [2] ☐

Table A1. *Cont.*

17. If NO, what do you suggest?

18. What other measures do you think would help boost the purchasing power of pearl-oyster?

19. Would you supply / trade ready-to-eat shellfish (pre-cooked)?

YES	1
NO	2
RARELY	3

20. If YES, how would you prefer them to be (multiple answers)?

BOILED	1
FRIED	2
MARINARED	3
SMOKED	4
IN ANOTHER FORM	5

21. Would you like the shellfish you buy in addition to the Shipping Center accompanying label, to have a quality control certificate or a quality badge?

YES	1
NO	2
I DO NOT CARE	3

22. Do you trust or not the announcements of the veterinary services regarding the hygiene of shellfish?

YES	1
NO	2

23. Have you ever encountered a customer health problem from eating shellfish?

YES	1
NO	2

24. Rank in order of preference (from 1 as most desired to 8 as less desired), which of the following Pearl Oyster products on the market would you prefer?

Fresh alive and in bulk	
Fresh alive, packed in net	

Table A1. *Cont.*

Fresh alive in Vacuum	
Without shell, frozen	
Without shell breaded nuggets	
Without shell in jar with brine	
Without shell in jar with olive oil and oregano	
Without shell smoked in jar	

25.　In case of choosing fresh alive in nets, what size of package would you like? (Kg)

0.5 kg ☐	1 kg ☐	2 kg ☐	3 kg ☐	5 kg ☐

26.　In case of choosing fresh alive in Vacuum, what quantity of packaging would you like? (Pcs)

4 pieces ☐	6 pieces ☐	8 pieces ☐	12 pieces ☐	16 pieces ☐

27.　In case of choosing without shell, frozen, what size of package would you like? (Kg)

250 gr. ☐	500 gr. ☐	750 gr. ☐	1000 gr ☐	1500 gr ☐

28.　In case of choosing without shell breaded nuggets, what size of package would you like? (Kg)

250 gr. ☐	500 gr. ☐	750 gr. ☐	1000 gr ☐	1500 gr ☐

29.　In case of choosing without shell in jar with brine, what size of package would you like? (Kg)

250 gr. ☐	500 gr. ☐	750 gr. ☐	1000 gr ☐	1500 gr ☐

30.　In case of choosing without shell in jar with olive oil and oregano, what size of package would you like? (Kg)

250 gr. ☐	500 gr. ☐	750 gr. ☐	1000 gr ☐	1500 gr ☐

Table A1. *Cont.*

31.	In case of choosing without shell smoked in jar, what size of package would you like? (Kg)			
250 gr. ☐	500 gr. ☐	750 gr. ☐	1000 gr ☐	1500 gr ☐

32.	What packaging material would you like?		
Transparent ☐	Opaque ☐		Dark-Colored☐
Glass ☐	Plastic ☐		Metal (canned)☐

<div align="center">BUSINESS CHARACTERISTICS & PROFILE</div>

1. Professional Experience (years):
2. Sex: Man [1] ☐ Woman [2] ☐
3. Age:
4. Education:

I have not finished elementary school	[1] ☐	High school diploma	[4] ☐
Elementary school diploma	[2] ☐	Private Schools	[5] ☐
Junior high school diploma	[3] ☐	University	[6] ☐

5. Type of business:

Shellfish producer Shellfish fisher ☐ Shellfish culture ☐	Shipping center—Shellfish trade ☐	Wholesale ☐	Food Retail Fish shop ☐ Itinerant ☐ Food Store ☐ Supermarket ☐	☐ Restaurant ☐ Greek tavern ☐ Bars ☐ other (identify)

6. Legal status of the company:

Private ☐	OE-EU ☐	Ltd. ☐		SA ☐

7. Number of employees: Full time Part time
Thank you very much for your participation in the survey

References

1. Chatzivasileiou, D.; Dimitriou, P.D.; Theodorou, J.; Kalantzi, I.; Magiopoulos, I.; Papageorgiou, N.; Pitta, P.; Tsapakis, M.; Karakassis, I. An IMTA in Greece: Co-Culture of Fish, Bivalves, and Holothurians. *J. Mar. Sci. Eng.* **2022**, *10*, 776. [CrossRef]
2. Kecinski, M.; Messer, K.D.; Knapp, L.; Shirazi, Y. Consumer Preferences for Oyster Attributes: Field Experiments on Brand, Locality, and Growing Method. *Agric. Econ. Res. Rev.* **2017**, *46*, 315–337. [CrossRef]
3. Bruner, D.M.; Huth, W.L.; McEvoy, D.M.; Morgan, O.A. Consumer Valuation of Food Safety: The Case of Postharvest Processed Oysters. *Agric. Econ. Res. Rev.* **2014**, *43*, 300–318. [CrossRef]
4. Li, T.; Kecinski, M.; Messer, K.D. Heterogeneous Preferences for Oysters: Evidence from Field Experiments. *Agric. Econ. Res. Rev.* **2017**, *46*, 296–314. [CrossRef]
5. Moutopoulos, D.K.; Minasidis, V.; Ziou, A.; Douligeri, A.S.; Katselis, G.; Theodorou, J.A. Investigating the Acceptance of a New Bivalve Product in the Greek Shellfish Market: The Non-Indigenous Pearl Oyster *Pinctada imbricata radiata*. *J. Mar. Sci. Eng.* **2022**, *10*, 251. [CrossRef]
6. Batzios, C.; Angelidis, P.; Moutopoulos, D.K.; Anastasiadou, C.; Chrisopolitou, V. Consumer attitude towards shellfish in the Greek market: A pilot study. *Medit. Mar. Sci.* **2003**, *4*, 155–174. [CrossRef]
7. Theodorou, J.A.; Moutopoulos, D.K.; Tzovenis, I. Semi-quantitative risk assessment of Mediterranean mussel (*Mytilus galloprovincialis* L.) harvesting bans due to harmful algal bloom (HAB) incidents in Greece. *Aquac. Econ. Manag.* **2020**, *24*, 273–293. [CrossRef]
8. Bush, S.R.; Oosterveer, P. The missing link: Intersecting governance and trade in the space of place and the space of flows. *Sociol. Rural.* **2007**, *47*, 384–399. [CrossRef]
9. Theodorou, J.A.; Viaene, J.; Sorgeloos, P.; Tzovenis, I. Production and marketing trends of the cultured mediterranean mussel *Mytilus galloprovincialis* Lamarck 1819, in Greece. *J. Shell. Res.* **2011**, *30*, 859–874. [CrossRef]
10. Theodorou, J.A.; Perdikaris, C.; Spinos, E. On the occurrence of rayed pearl oyster Pinctada imbricata radiata (Leach, 1814) in Western Greece (Ionian Sea) and its biofouling potential. *Biharean Biologist* **2019**, *13*, e181204.

11. Moutopoulos, D.K.; Ramfos, A.; Theodorou, A.J.; Katselis, G. Biological aspects and population dynamic of Pearl Oyster in the Eastern Mediterranean. *Reg. Stud. Mar. Sci.* **2020**, *45*, 101821.

12. European Market Observatory for Fisheries and Aquaculture Products. *Fresh Mussel in the EU*; Publications Office of the European Union: Luxembourg, 2019; ISBN 978-92-79-79953-2. [CrossRef]

13. Avdelas, L.; Papaharisis, L.; Galinou-Mitsoudi, S. Cost Structure and Profitability of Mussel Aquaculture in Greece. In Proceedings of the No 005, EAFE (European Association of Fisheries Economists) Conference Papers, Nisea, Via Irno, 11 - 84135 Salerno, 2015. Available online: https://EconPapers.repec.org/RePEc:irf:wpaper:005 (accessed on 15 June 2022).

14. Avdelas, L.; Avdic-Mravlje, E.; Borges Marques, A.C.; Cano, S.; Capelle, J.J.; Carvalho, N.; Cozzolino, M.; Dennis, J.; Ellis, T.; Fernández Polanco, J.M.; et al. The decline of mussel aquaculture in the European Union: Causes, economic impacts and opportunities. *Rev. Aquac.* **2020**, *13*, 91–118. [CrossRef]

15. Katsanevakis, S.; Poursanidis, D.; Issaris, Y.; Panou, A.; Petza, D.; Vassilopoulou, V.; Chaldaiou, I.; Sini, M. Protected marine shelled molluscs: Thriving in Greek seafood restaurants. *Medit. Mar. Sci.* **2011**, *12*, 429–438. [CrossRef]

16. Theodorou, J.A.; Akrivos, V.; Katselis, G.; Moutopoulos, D.K. Use of Local Ecological Knowledge on the natural recruitment of bivalve species of commercial exploitation in a Natura area. *J. Mar. Sci. Eng.* **2022**, *10*, 125. [CrossRef]

17. Galil, B. Poisonous and venomous: Marine alien species in the Mediterranean Sea and human health. In *Invasive Species and Human Health*; Mazza, G., Tricarico, E., Eds.; CAB International: Wallingford, UK, 2018; pp. 1–15.

18. Theodorou, J.A.; Leech, B.-S.; Perdikaris, C.; Hellio, C.; Katselis, G. Performance of the Cultured Mediterranean Mussel *Mytilus galloprovincialis* (Lamark 1819) after Summer Post-Harvest Reimmersion. *Turk. J. Fish. Aquat. Sci.* **2017**, *19*, 221–229.

19. Gephart, J.A.; Deutsch, L.; Pace, M.L.; Troell, M.; Seekell, D.A. Shocks to fish production: Identification, trends, and consequences. *Glob. Environ. Change* **2017**, *42*, 24–32. [CrossRef]

20. Davis, K.F.; Downs, S.; Gephart, J.A. Towards food supply chain resilience to environmental shocks. *Nature Foods.* **2021**, *2*, 54–65. [CrossRef]

21. Zgouridou, A.; Tripidaki, E.; Giantsis, I.A.; Theodorou, J.A.; Kalaitzidou, M.; Raitsos, D.E.; Lattos, A.; Mavropoulou, A.-M.; Sofianos, S.; Karagiannis, D.; et al. The current situation and potential effects of climate change on the microbial load of marine bivalves of the Greek coastlines: An integrative review. *Environ. Microbiol.* **2022**, *24*, 1012–1034. [CrossRef]

22. Fox, M.; Mitchell, M.; Dean, M.; Elliott, C.; Campbell, K. The seafood supply chain from a fraudulent perspective. *Food Secur.* **2018**, *10*, 939–963. [CrossRef]

23. Guillotreau, P.; Allison, E.H.; Bundy, A.; Cooley, S.R.; Defeo, O.; Le Bihan, V.; Seki, T. A comparative appraisal of the resilience of marine social-ecological systems to mass mortalities of bivalves. *Ecol. Soc.* **2017**, *22*, 46. [CrossRef]

24. Theodorou, J.A.; Ioannis Tzovenis, I. A framework for risk analysis of the shellfish aquaculture: The case of the Mediterranean mussel farming in Greece. *Aquac. Fish.* **2021**, *in press*. [CrossRef]

25. Theodorou, J.A.; Tzovenis, I.; Katselis, G. Empirical approach to risk management strategies of Mediterranean mussel farmers in Greece. *Oceanol. Hydrobiol. Stud.* **2021**, *50*, 455–472. [CrossRef]

26. Guillotreau, P.; Le Bihan, V.; Morineau, B.; Pardo, S. The vulnerability of shellfish farmers to HAB events: An optimal matching analysis of closure decrees. *Harmful Algae* **2021**, *101*, 101968. [CrossRef]

27. FAO. *The State of Mediterranean and Black Sea Fisheries*; General Fisheries Commission for the Mediterranean: Rome, Italy, 2018; p. 172.

28. Varble, S.; Secch, S. Human consumption as an invasive species management strategy. A preliminary assessment of the marketing potential of invasive Asian carp in the US. *Appetite* **2013**, *65*, 58–67. [CrossRef]

29. Le Bihan, V.; Catalo, M.; Le Bihan, J. Reorganization of the value chain activities of oyster companies on the Atlantic coast following health crises in France (2006–2013). *Mar. Pol.* **2020**, *117*, 103154. [CrossRef]

30. Thrane, M.; Ziegler, F.; Sonesson, U. Eco-labelling of wild-caught seafood products. *J. Clean Prod.* **2009**, *17*, 416–423. [CrossRef]

31. Bosona, T.; Gebresenbet, G. Food traceability as an integral part of logistics management in food and agricultural supply chain. *Food Contr.* **2013**, *33*, 32–48. [CrossRef]

32. Ledford, J.L. *SEO Search Engine Optimization Bible*, 2nd ed.; Wiley Publishing: New York, NY, USA, 2009.

33. Zar, J.H. *Biostatistical Analysis*, 5th ed.; Prentice-Hall/Pearson: Upper Saddle River, NJ, USA, 2010; p. 944.

34. SPSS. *SPSS BASE 27.0.1.0.*; Applications Guide; SPSS Inc.: Chicago, IL, USA, 2020.

35. Galic, B.L.; Nourry, M.; Pirrone, C. Can TV programs improve the competitiveness of european seafood products? Exploratory results from the success project. In Proceedings of the No 012, 2015 EAFE (European Association of Fisheries Economists) Conference Papers, Nisea, Via Irno, 11 - 84135 Salerno, 2015. Available online: https://EconPapers.repec.org/RePEc:irf:wpaper:012 (accessed on 15 June 2022).

36. Giovos, I.; Barash, A.; Barone, M.; Barría, C.; Borme, D.; Brigaudeau, C.; Charitou, A.; Brito, C.; Currie, J.; Dornhege, M.; et al. Understanding the public attitude towards sharks for improving their conservation. *Mar. Pol.* **2021**, *134*, 104811. [CrossRef]

37. Szolnoki, G.; Hoffman, D. Online, face-to-face and telephone surveys -Comparing different sampling methods in wine consumer research. *Wine Econ. Policy* **2013**, *2*, 57–66. [CrossRef]

38. Bush, S.R.; Oosterveer, P.; Bailey, M.; Mol, A.P. Sustainability governance of chains and networks: A review and future outlook. *J. Clean. Prod.* **2015**, *107*, 8–19. [CrossRef]

39. Nuñez, M.A.; Kuebbing, S.; Dimarco, R.D.; Simberloff, D. Invasive Species: To eat or not to eat, that is the question. *Cons. Let.* **2012**, *5*, 334–341. [CrossRef]

40. Theodorou, J.A.; Makri, M.; Douvi, X.; Ramfos, A.; Spinos, E. Seasonal variation in the biochemical composition, condition index, and meat yield of the non-indigenous pearl oyster *Pinctada imbricata radiata* (Leach, 1814) from the West of the Aegean Sea, Greece. *Aquac. Fish.* **2021**, *in press*. [CrossRef]
41. Le Bihan, V.; Pardo, S.; Guillotreau, P. Risk perception and risk management strategies of oyster farmers. *Mar. Resour. Econ.* **2013**, *28*, 285–304. [CrossRef]
42. Bush, S.R. Understanding the potential of eco-certification in salmon and shrimp aquaculture value chains. *Aquaculture* **2018**, *493*, 376–383. [CrossRef]
43. Theodorou, J.A.; Tzovenis, I. Managing the risks of the Greek Crisis in Aquaculture: A SWOT Analysis of the Mediterranean Mussel Farming in Greece. *Agric. Econ. Rev.* **2017**, *18*, 18–26.
44. Krishnan, R.; Agarwal, R.; Bajada, C.; Arshinder, K. Redesigning a food supply chain for environmental sustainability. An analysis of resource use and recovery. *J. Clean. Prod.* **2020**, *242*, 118374. [CrossRef]
45. Marucheck, A.; Greis, N.; Mena, C.; Cai, L. Product safety and security in the global supply chain: Issues, challenges, and research opportunities. *J. Oper. Manag.* **2011**, *29*, 707–720. [CrossRef]
46. Govindan, K. Sustainable consumption and production in the food supply chain: A conceptual framework. *Int. J. Prod. Econ.* **2018**, *195*, 418–431. [CrossRef]