*fishes*

MDPI

*Article*

# Métiers and Socioeconomics of the Hellenic Small-Scale Sea Cucumber Fishery (Eastern Mediterranean Sea)

**Kyriakoula Roditi [1], Chryssanthi Antoniadou [2,*], Chrysoula Apostologamvrou [1] and Dimitris Vafidis [1]**

[1] Department of Ichthyology and Aquatic Environment, School of Agricultural Sciences, University of Thessaly, GR 38446 Volos, Greece; roditi@uth.gr (K.R.); chapostol@uth.gr (C.A.); dvafidis@uth.gr (D.V.)
[2] Department of Zoology, School of Biology, Aristotle University, GR 54124 Thessaloniki, Greece
* Correspondence: antonch@bio.auth.gr

**Abstract:** Holothurian fisheries have become a prominent métier in the Mediterranean due to increasing worldwide demand for sea cucumbers. In these newly explored grounds, their fisheries are poorly understood, especially considering the applied tactics and socioeconomics of the harvesting fleet. This study examines the small-scale holothurian (*Holothuria*) fishery métiers and associated socioeconomics in the Hellenic Seas—a main Mediterranean fishery ground. *Holothuria* fishing licenses increased in 2020 and stabilized (130) in the next years. *Holothuria poli* and *H. tubulosa* are the target species, caught by hand, using the surface air supply method or free diving. Most fishermen harvest holothurians close to the port of origin, and only the fleet from Kalymnos exploits remote grounds over the Greek territory. According to harvesting tactics, three economically viable métiers are practiced; however, shifting to alternative fishery resources is necessary to grant annual income. Sea cucumbers are sold fresh from fishermen to merchandisers who process the catch into final products (trepang) and export them. For most fishermen (64.7%), fishing for holothurians is the main occupation, gaining a highly variable monthly income (EUR 700 to 4000). The presented results refine the métiers and associated economics of an active holothurian fishery fleet, providing essential information for the viability of coastal fishery societies.

**Keywords:** *Holothuria*; invertebrate exploitation; harvest tactics; sea cucumbers processing

**Key Contribution:** Sea cucumber fishing fleets constitute a significant sector of small-scale Mediterranean fisheries. Three economic viable métiers are practiced, though shifting to alternative small-scale fishery resources, holding licenses for bath sponges, sea urchins, shellfish, shrimps, or other trammel net catch is necessary to supplement their annual income, mostly due to the limited harvesting season of holothurians.

check for updates

Academic Editor: Junbo Zhang

Received: 14 April 2025
Revised: 22 May 2025
Accepted: 26 May 2025
Published: 1 June 2025

**Citation:** Roditi, K.; Antoniadou, C.; Apostologamvrou, C.; Vafidis, D. Métiers and Socioeconomics of the Hellenic Small-Scale Sea Cucumber Fishery (Eastern Mediterranean Sea). *Fishes* **2025**, *10*, 258. https://doi.org/10.3390/fishes10060258

**Copyright:** © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

## 1. Introduction

Fisheries is an ever-evolving sector, affected by environmental, economic, legislative, and social factors [1]. Small-scale fisheries represent the larger part of the fishery fleet but remain understudied, especially considering their socioeconomic viability [2]. The economic viability of small-scale fisheries refers to the capacity to provide a sufficient income within a fishing season and is assessed through financial indicators describing current and/or future performance [2]. Under the global threat of overfishing impacting the vast majority of marine resources, small-scale fishermen need to be flexible by adapting their fishing tactics to maximize catch and profit [3–11]. These strategies may include innovative technologies to detect fishing grounds and improve the efficiency of fishing

methods and gears, the diversification of the target species, and the opening of new markets for the commercialization of the catch [12].

Sea cucumber fishing has emerged as an alternative resource for small-scale fisheries [13–15]. The increasing demand for sea cucumbers as a delicacy and nutraceutical, especially in Asian countries, has enlarged the fishing fleet and added new harvest areas and species [16–18]. Nowadays, sea cucumbers constitute a key resource, contributing to poverty alleviation for probably more than three million fishers globally [17,19,20].

For a long time, the availability of sea cucumber stocks has been taken for granted, and this has resulted in irresponsible or no management at all. In more recently explored areas, such as the Mediterranean Sea, the systematic fishing of holothurians is carried out by Turkey, Greece, Spain, France, and Italy [18,21–23]. The harvest of sea cucumbers for human consumption in the two leading Mediterranean countries, Turkey and Greece, has been allowed since 1996 and 2018, respectively [18,24], but in Greece, they have been harvested for decades as baits [22].

International market prices for sea cucumber have risen greatly in recent years, increasing both the number of holothurian fishermen [19,25,26] and the fishing pressure on natural stocks [17,20]. The adoption and implementation of sustainable management measures is, therefore, urgently needed for the protection of holothurian populations. The minimum legal size is a regulatory measure that generally has broad support in sea cucumber fishery [17]. Moreover, data on size at sexual maturity and size-dependent fecundity have been recognized as the rational basis for setting minimum size limits to ensure offspring production and reduce the chances of recruitment failure due to overfishing [17,27]. Minimum size limits should also seek to maximize the economic performance of the fishery [14,17,28]. A number of studies has examined the efficiency of stock abundance and biometrical data on the Mediterranean small-scale holothurian fishery [16,18,23,24,29–33]; however, relevant data on applied métiers, i.e., a group of fishing operations targeting specific species, using a specific gear, during a precise period of the year and/or within the specific area [3,4,8–10], and socioeconomics of the harvesting fleet are missing.

Considering all the above, the present study aims to analyze the main characteristics of a typical Mediterranean sea cucumber fishery. More specifically, it examines the different fishery tactics applied by the small-scale sea cucumber (*Holothuria* spp.) fishery in the Hellenic Seas, explores the socioeconomic profile of the fishermen, scrutinizes the economic and technical characteristics of the small-scale sea cucumber fishing fleet, and evaluates their contribution to the local community by focusing mostly on the main holothurian fishing centers of Greece.

## 2. Materials and Methods

Holothurian fishery data were retrieved from each of the Administrative Regions of Greece via personal interviews. The records of vessels licensed to harvest sea cucumbers, together with their technical characteristics, were organized per region under the port of origin. Special emphasis was given in the main regions (Central Macedonia, North Aegean, Southern Aegean, Epirus, and Central Greece) that are active or emerging holothurian fishing centers, together with a moderate one (Thessaly), which was considered representative of the remaining regions. In those regions, the applied fishery tactics and associated socioeconomics were further investigated. Southern Aegean—Kalymnos island, in particular—was the first region that harvested holothurians as fishing baits [22] and, after 2018, for human consumption [18]. It harbors the largest small-scale fishing fleet in Greece [9,11,34] and has a long tradition of fishermen diving for sponges and other invertebrates [35]. Central Macedonia and Central Greece consist of the second largest fishing centers of holothurians, as the shellfish divers started to exploit sea cucumbers in

the highly productive Thermaikos and Maliakos Gulfs, respectively. In North Aegean and Epirus, interest in fishery has increased in recent years, especially in the coastal waters of Lemnos island and Amvrakikos Gulf, where significant natural stocks of *Holothuria* spp. have been found and explored [18]. In Thessaly, the interest in sea cucumbers is moderate, as in the remaining regions of Greece.

Three separate actions were carried out to assess the main features of sea cucumber fisheries by gathering data on (i) the fishing fleet, (ii) the métiers and socioeconomic profiles of fishermen, and (iii) the processing, marketing, and exportation of the catch, as described below.

The size (i.e., number of licensed vessels) and the technical characteristics, i.e., overall length (LOA), gross tonnage (GT), engine power (kW), and fishing gear, of the sea cucumber fishery fleet were assessed from March to June 2022 based on the official records of the Fisheries Departments of the Administrative Regions of Greece. The relevant data were retrieved from the official beginning of the sea cucumber fisheries in 2018 [18] and up to 2022. In 2018, no license was authorized; thus, the available data cover four years, 2019–2022.

The fishing activity was surveyed for a 6-month period, from April to September 2022, in the fishing ports of the main (Central Macedonia -Thessaloniki, Southern Aegean-Kalymnos island), emerging (North Aegean-Lemnos island, Epirus-Preveza), and reference (Thessaly-Volos) holothurian fishery regions. Unfortunately, the fishermen from the main sea cucumber fisheries center of the Central Greece region refused to participate. Thus, five regions were surveyed in total.

In each region, all licensed sea cucumber fishermen for 2022 were personally interviewed to collect data on the characteristics of the fishing activity (year of employment, months of fishing, duration and frequency of fishery trips, distance from the port of origin, duration of dives, number of dives per day, depth of fishing, fishing gear), the fishing area (substrate type), and the target species (Supplementary Material S1). All owners of the sea cucumber fishery fleet were interviewed to collect data on the number of crew members, the complete characteristics of the fishing vessels (length: LOA; gross tonnage: GRT; and engine power: HP), and the age (years) and current value (EUR) of the main engine and the hull of the vessel (without any equipment). Data on the fixed and variable costs of the vessel, such as the annual maintenance costs and the fee of each crew member (per fishing trip or per day of fee), were also recorded [9–11].

Data on the type and quantity (maximum and minimum) of catch were also collected during the fishermen's interviews, since the Integrated Electronic System of Fisheries Records, as provided by the national fisheries regulation to record daily quotas per area and species from each vessel, is not yet operational [18]. Catch data referred both to the fishing grounds where they were caught and their disposal area; the prices of holothurian catch in recent years were also recorded [8].

The socioeconomic data of the fishermen provided information about the age, education level, marital status, number of children, years of fishing, main and secondary, if any, employment, and monthly income from fishing [4,19,36]. The relationship of the fishermen's predecessors with fisheries (if they were fishermen, sponge fishermen, or shellfish fishermen) and the appearance of any health problems related to their occupation were also noted [10].

Descriptive statistics were used to analyze the gathered information. Multivariate techniques (cluster analysis and MDS) were applied to the fishing activity and catch data matrix to identify different fishing tactics, i.e., métiers [10]. Holothurian catch per target species (maximum and minimum quota), the number, the depth and the duration of daily dives, the explored fishery grounds and the substrata type, the duration of fishing trips

and their distance from the port of origin, and the fishing activity per month were used as main variables to assess different métiers using the Bray–Curtis index under 60% cut-off value [9,10].

The processing of holothurian catch, from fishermen to final product, trepang, was described through interviewing licensed fishermen in 2022 and the personnel of the "Nautilus Seafood" processing company. Within each of the five surveyed regions, fishermen from Central Greece refused to participate, as mentioned before, and all licensed fishermen were interviewed. "Nautilus Seafood" is among the biggest sea cucumber processing and trepang exportation companies in Greece, covering about 20% of the internal trade of harvested holothurians, originating mostly from the South Aegean region. Monthly quotas of processed sea cucumbers per species were analyzed from 2016 to 2021, based on the company's official records.

## 3. Results

### *3.1. The Fishing Fleet*

The official opening of holothurian harvesting issued 94 licenses; this number increased by 60.63% in 2020, dropped by 17.1% in 2021, and increased again in 2022 by 10.32% (Figure 1). According to the annual issuance of licenses for sea cucumber fishing from 2019 to 2022, four main regions are evident, with mean annual licenses ranging from 21 (North Aegean) to 31 (Central Greece). In the rest of the regions, few licenses have been issued, ranging from four to eight; in Attica, only one license has been issued until 2021, whereas another one has been added in 2022. In most regions, the number of licenses followed an increasing trend, with the exception of the Eastern Macedonia and Thrace region, where the licenses issued in 2019 were never renewed, and the fishery for holothurians has been practically stopped in the area.

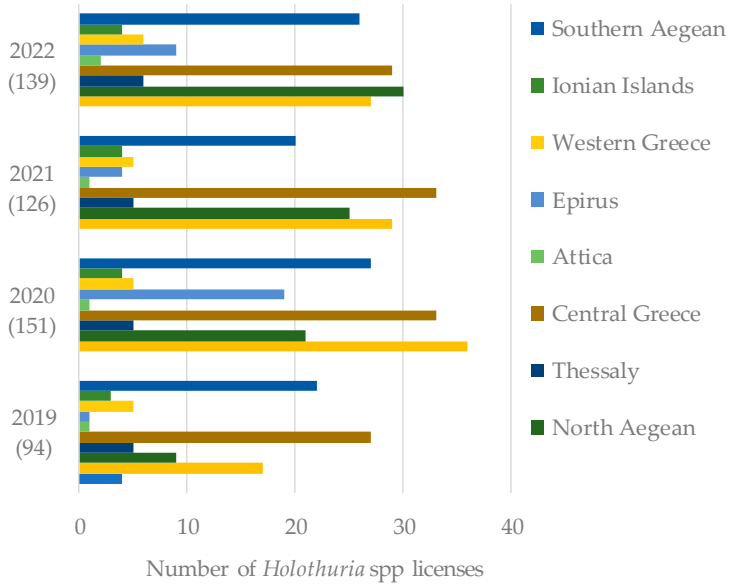



**Figure 1.** Annual sea cucumber fishing licenses per Administrative Region of Greece (regions without issued licenses have been omitted, i.e., Crete, Peloponnese, and Western Macedonia) for the years 2019–2022. The total number of licenses per year is given in parentheses.

Overall, 139 vessels were fishing for holothurians in the Hellenic Seas in 2022, all belonging to the small-scale fishery fleet. The number of licensed vessels and their technical characteristics per region are presented in Table 1. The holothurian fleet was generally small in size; the overall length ranged from 3.9 to 19.00 m, with a mean of 7.57 m, tonnage from 0.25 to 19.06 GT with a mean of 2.83, and engine power from 0.44 to 175 HP with a mean of

33.71. The vast majority of vessels (96.4%) were less than 12 m in LOA, with only five boats (3.6%) being larger than 12 m. These larger boats operate in the Central Macedonia (three vessels), North Aegean (Lemnos island, one vessel), and Southern Aegean (Kalymnos island, 1 vessel) and generally follow the same practices as the smaller boats of their region. Southern Aegean hosted the largest vessels in terms of the LOA and GT, and Central Macedonia in terms of the HP. In general, large differences in the technical characteristics of the fleet were evident within geographic regions, particularly Southern and North Aegean, and across geographic regions (Table 1).

**Table 1.** Number of vessels and technical characteristics of the Hellenic fleet fishing for *Holothuria* spp. in 2022 over the Hellenic Seas and per region (N = number of licensed vessels, LOA = overall length, GT = gross tonnage, HP = engine power, for LOA, GT and HP mean ± standard deviation are given calculated per total N of the fleet, in total and per region).

| Hellenic Fleet | N<br>139 | LOA<br>7.57 ± 2.35 | GT<br>2.84 ± 2.59 | HP<br>33.71 ± 33.06 |
|---|---|---|---|---|
| Southern Aegean | 26 | 9.18 ± 1.13 | 4.82 ± 3.23 | 40.56 ± 38.59 |
| Ionian Islands | 4 | 7.97 ± 2.11 | 3.39 ± 1.92 | 38.62 ± 25.60 |
| Western Greece | 6 | 5.52 ± 1.43 | 0.95 ± 0.84 | 16.67 ± 8.14 |
| Epirus | 9 | 7.49 ± 1.71 | 2.19 ± 1.20 | 10.31 ± 1.70 |
| Attica | 2 | 8.15 ± 0.78 | 3.37 ± 1.03 | 37.00 ± 0.00 |
| Central Greece | 29 | 6.35 ± 1.54 | 1.69 ± 1.26 | 26.69 ± 23.43 |
| Thessaly | 6 | 7.45 ± 2.19 | 2.99 ± 1.98 | 35.08 ± 23.21 |
| North Aegean | 30 | 7.35 ± 2.04 | 2.79 ± 3.44 | 30.33 ± 30.00 |
| Central Macedonia | 27 | 7.98 ± 3.54 | 2.68 ± 1.55 | 48.70 ± 44.42 |

### *3.2. Métiers, Fishing Practices, and Vessel Expenses*

Multivariate analysis of the holothurian fishery data matrix of the five selected regions identified three main métiers (Figure 2). The first, and most distinctive métier from the others, is operated by the fishermen from Kalymnos island. This métier is characterized by the performance of long-distance and long-duration fishing trips, exploitation of deeper stocks (up to 30 m depth), amplification of active vessels in spring (March and April), where the fleet is almost eightfold increased, and a much larger quota of *H. poli*. The second métier is operated in the Epirus-Preveza region by local fishermen that exploit very shallow sea cucumber stocks (less than 3 m) using free diving and performing multiple dives (60 to 100 dives per day) of short duration (1 to 1.5 min); overall, the sea cucumber quota is low and the fleet operates mainly in winter (November to January) and then shifts to the exploitation of other species using different gears. The third, and most common métier, is operated by the rest of the fishermen in Central Macedonia, North Aegean, and Thessaly regions. This métier shares most of its characteristics with the second one but uses the air supply diving method and explores relatively deeper stocks, typically up to a depth of eight meters.

Based on the collected dataset, the target species are *Holothuria tubulosa* and *H. poli*. Overall, 64.7% of the fishers are full-time engaged in sea cucumber harvesting. The remaining 35.3% are part-time involved, as they mainly target bath sponges (Kalymnos) and shellfish (Kalymnos, Thessaloniki), and generally engage in small-scale fishery using trammel nets (Volos, Thessaloniki, and Preveza). The exploited sea cucumber grounds consist of sedimentary (mostly sandy) or mixed sedimentary bottoms with rocky enclaves, and extend to depths ranging from 0.5 to 30 m. Most fishers are using the surface air supply diving method, with the exception of Preveza. Most fishermen are diving up to 8 m depth, whereas those from Kalymnos go much deeper (30 m). The fishing fleet typically makes one to seven dives daily, with a mean duration of 1.5 h, largely depending on the diving depth.

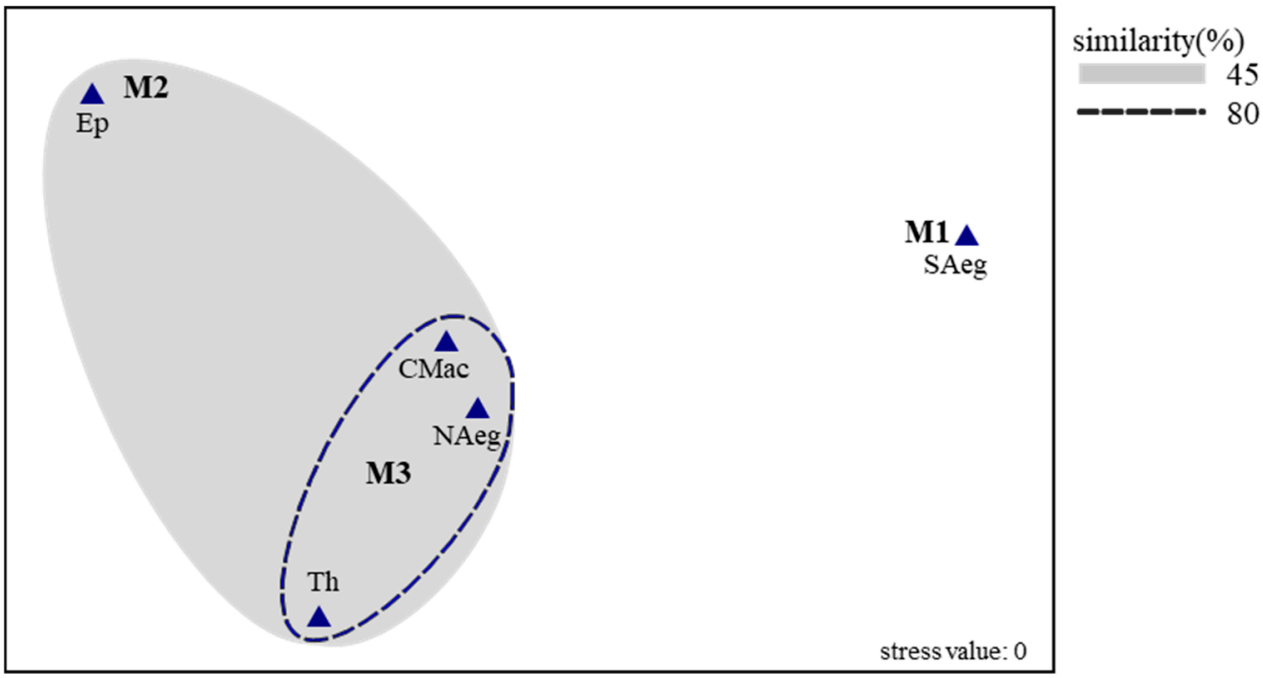



**Figure 2.** Multidimensional scaling ordination of holothurian fisheries data matrix of the five selected regions of the Hellenic Seas (Ep = Epirus, CMac = Central Macedonia, NAeg = North Aegean, SAeg = South Aegean, Th = Thessaly) showing the clustering of fishing tactics under three main métiers (M1–M3); the symbol refers to the centroid of data derived from each region.

In general, fishermen harvest holothurians in grounds close to the port of origin, avoiding long fishing trips (Figure 3). The fleet from Volos (Thessaly Region) explores holothurian grounds within Pagasitikos and northern Evoikos Gulfs. The relevant fleet from Thessaloniki (Central Macedonia Region) explores holothurian grounds within Thermaikos and Toroneos Gulfs, and the fleet from Preveza (Epirus Region) explores holothurian grounds within Amvrakikos Gulf and occasionally around Lefkada island (Ionian Sea), whereas those from Lemnos (North Aegean Region) explore holothurian grounds around the island. In contrast to the above tactic, the fleet from Kalymnos (South Aegean Region) performs long trips to harvest holothurians in remote areas. They spread and explored the grounds over the Dodecanese, the Cyclades (mainly Paros and Naxos), and the North Aegean islands (mainly Lesvos); the Evoikos, Pagasitikos, and Korinthiakos Gulfs; and the Ionian Sea (mainly Astakos). The vast majority of the South Aegean fleet (92.3%) changes landing port every 4.8 ± 1.6 days, on average. Overall, the Hellenic fleet covers 16.18 miles per fishing trip.

In total, 67% of the sea cucumber fishermen owned the vessel, while another 26.9% had a first-degree family relationship with the owner. The value and age of the main engine ranged from EUR 1000 to 20,000 and from 4 to 42 years, respectively. The relevant values for the hull of the vessel (without any equipment) ranged from EUR 1000 to 60,000 and from 4 to 57 years, respectively. The mean vessel maintenance cost was EUR 2370 ± 1206 (500–6000), and the salary of each crew member ranged from EUR 40 to 150 (65 ± 22) per trip.

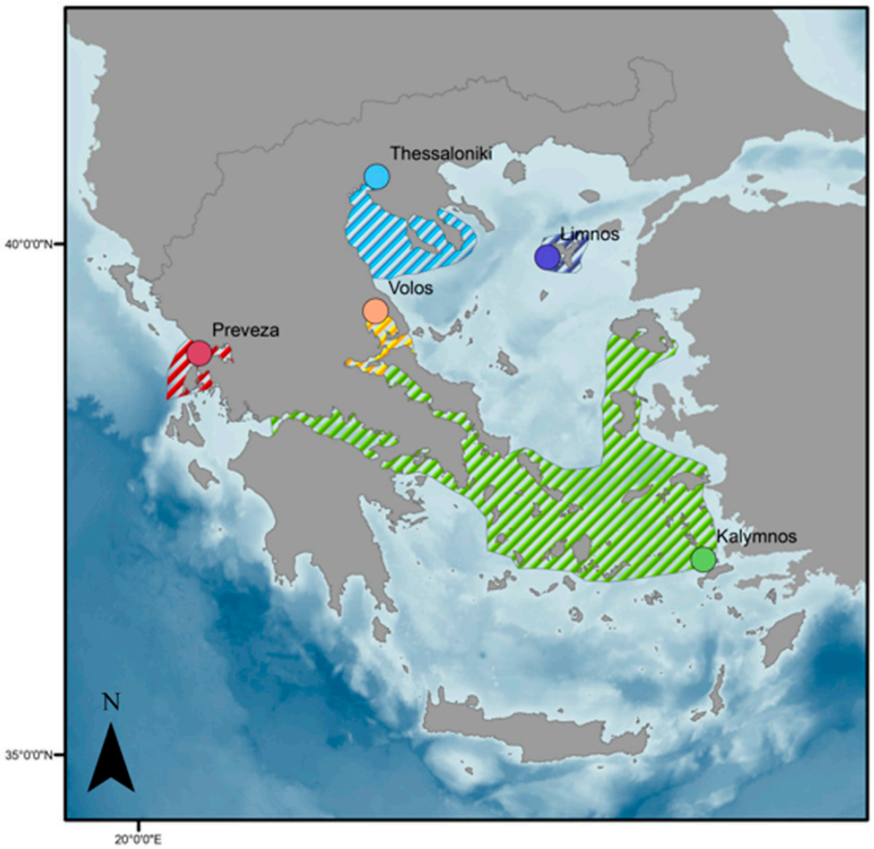



**Figure 3.** Holothurian fishing grounds explored by the relevant fleet originated from the main five regions of Greece: Epirus-Preveza (Amvrakikos Gulf and Lefkada island), Central Macedonia-Thessaloniki (Thermaikos and Toroneos Gulfs), North Aegean-Lemnos (Lemnos island), Thessaly-Volos (Pagasitikos and Evoikos Gulfs), South Aegean-Kalymnos (Dodecanese, Cyclades, and North Aegean islands; Evoikos, Pagasitikos, and Korinthiakos Gulfs).

### *3.3. Socioeconomic Data*

Overall, 51 sea cucumber fishermen from the five main studied regions (Central Macedonia, North Aegean, Thessaly, South Aegean, and Epirus) fully responded to the questionnaires on socioeconomic data. Their mean age was 50 ± 11 (range 28–75) years. The age class of 51–60 years predominates (31.4%), followed by 28–40 years (27.5%) and 41–50 years (21.6%). It is worth mentioning that 19.6% of the fishers are aged over 61 years. Both the youngest and the oldest holothurian fishermen were from Kalymnos (Table 2). The vast majority of sea cucumber fishers derived from a fisherman family (76%), targeting sponges (35%), shellfish (12%), or generally belonged to the small-scale fishery (29%). Overall, 24% did not come from a fishing family, whereas the relevant percentage for the Central Macedonia region is over double (60%). In total, 84.3% of the fishermen were married—7.8% were divorced—and had one to five (2 ± 0.8) children. Most fishermen completed only compulsory education, with 37% being primary and 20% secondary school graduates; 21% graduated from high school and 12% from technical school, whereas very few attended higher education.

Fishing was the main employment for 64.7% of the interviewed fishermen, providing a monthly income of EUR 700 to 4000. These numbers reveal large variability in economic performance between fishermen from different geographic regions, and even within the same geographic region. Fishermen from North Aegean gain the lowest income from holothurians; however, few of them have sea cucumber fishing as their main occupation. In contrast, the largest proportion targeting on holothurians as main occupation is reported from South Aegean region, Kalymnos (96%), but they gain much lower income (1375 ± 342

range EUR 750 to 2250) than fishers from all other regions that explore holothurians as secondary occupation, with the exception of the North Aegean fishermen, as previously explained. Interestingly, none fishermen from Preveza (0%) harvest sea cucumbers as their main occupation. In this latter area, fishermen mainly target the prawn *Penaeus kerathurus*, and the fishing for holothurians is a secondary occupation. In most regions, fishermen are officially harvesting holothurians for at least 3 years (Table 2); fishermen from Thessaloniki (7 to 10 years), Volos (7 to 9 years), and Kalymnos (3 to 8 years) have the longest occupation, whereas fishermen from Lemnos (3 to 5 years) and Preveza (3 years) have the shortest. New people are entering the sector, especially in the areas of Kalymnos, Lemnos, and Preveza, where many fishermen have been only recently involved, i.e., the last 3 years, in holothurian harvesting. Fishermen from all studied regions did not experience any health problems related to their profession, with the exception of Kalymnos, where the majority of divers reported suffering from decompression illness (diver's disease), ear and sinus injuries, joint inflammation, hypothermia, and dehydration.

**Table 2.** Socio-demographic and economic data of sea cucumber fishers in the five studied regions (CMac = Central Macedonia, Th = Thessaly, NAeg = North Aegean, SAeg = South Aegean, Ep = Epirus) of the Hellenic Seas.

| Socioeconomic Data | CMac | Th | NAeg | SAeg | Ep |
|---|---|---|---|---|---|
| Mean age | 50 | 46 | 51 | 50 | 52 |
| Marital status (%) | | | | | |
| Married | 90 | 100 | 100 | 81.3 | 75 |
| Single person | 10 | 0 | 0 | 6.3 | 25 |
| Divorced | 0 | 0 | 0 | 12.5 | |
| Number of children (mean) | 1 | 3 | 2 | 2 | 2 |
| Education (%) | | | | | |
| Primary school | 40 | 0 | 33.3 | 40.6 | 25 |
| Junior high school | 0 | 100 | 0 | 21.9 | 25 |
| High school | 30 | 0 | 33.3 | 21.9 | 0 |
| Technical school | 20 | 0 | 33.3 | 9.4 | 0 |
| Higher education graduates | 10 | 0 | 0 | 6.2 | 0 |
| Mean income (EUR) from holothurians | 2000 | 2750 | 1233 | 1375 | 1500 |
| Holothurians as main occupation (%) | 10 | 100 | 33.3 | 96.9 | 0 |
| Holothurians as secondary occupation | 90 | 0 | 66.7 | 3.1 | 100 |
| Years of work in the sea cucumber fishery (mean) | 10 | 8 | 3 | 5 | 3 |

### *3.4. Processing and Marketing*

Monthly catch data from 24 vessels operating in the Cyclades fishery grounds were retrieved from the official records of the "Nautilus Seafood" processing company during 2016–2021 (Figure 4). In that period, the company processed 139.86 t of fresh gutted *H. tubulosa* and 95.89 t of *H. poli*. Holothurian quota increased in 2017–2018 and then vastly dropped due to a temporary ban on fishing around the island of Paros, which was the main fishing area in the South Aegean region, resulting from local conflicts and the COVID-19 lockdown. The largest quantities were obtained at the opening of the fishing season (November) or at the end of winter to early spring (February, March). This latter pattern may be due to a weather ban effect, as the fishing grounds are offshore coastal gulfs and thus, diving is not possible under harsh weather conditions (strong winds) that prevail in the region.

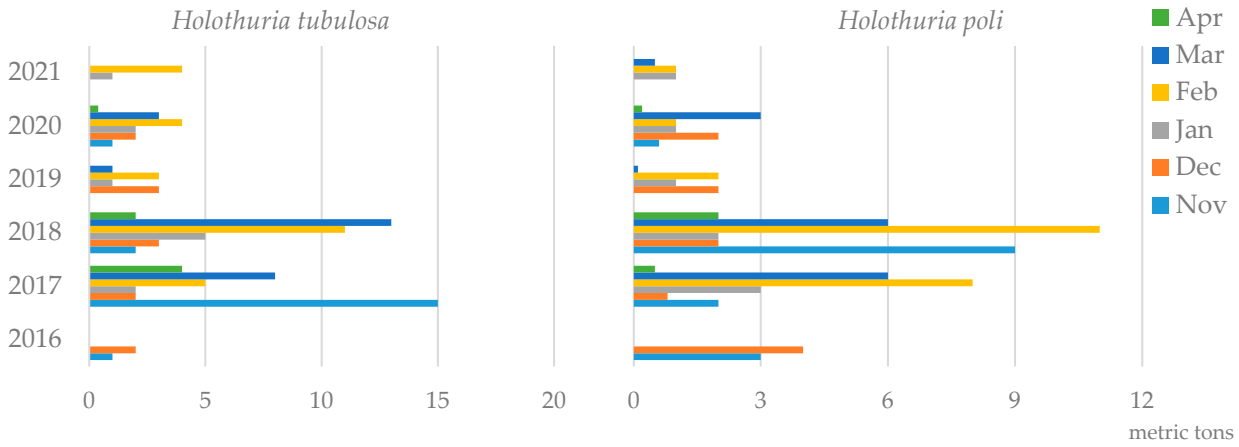



**Figure 4.** Monthly total fresh gutted weight of the sea cucumbers *H. poli* and *H. tubulosa* fished in the Cyclades fishery grounds (mainly around Paros) and sold to the Nautilus Seafood processing company for the period 2016–2021.

The processing of sea cucumbers starts with evisceration, which is typically completed by fishermen on board, and then the holothurians are transported to specific licensed sea cucumber processing companies. The entire process has been recorded in situ in the "Nautilus Seafood" company and schematically presented (Figure 5).

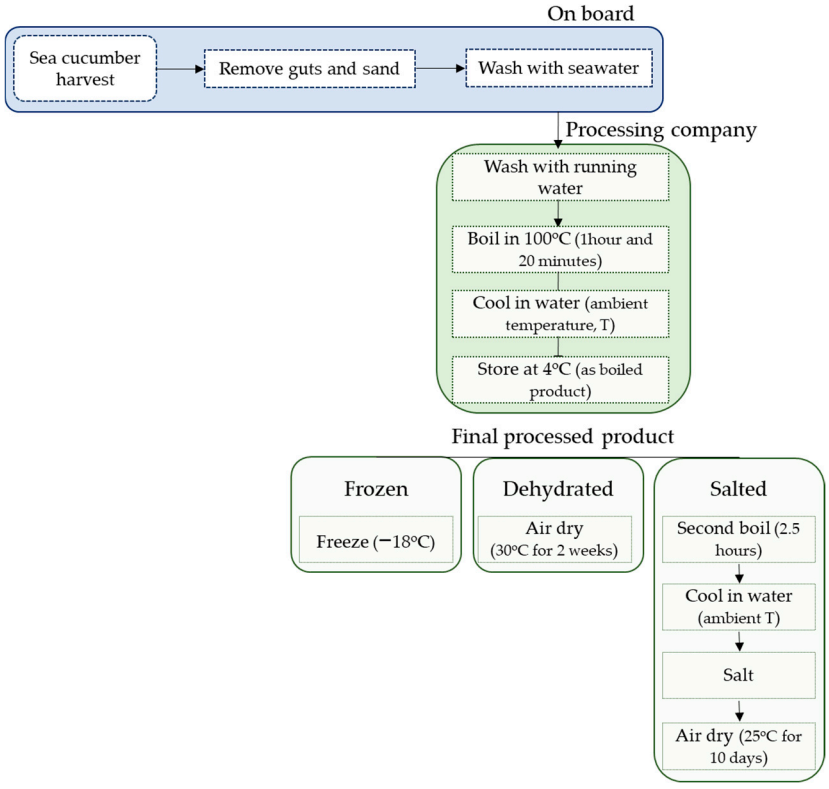



**Figure 5.** Flow chart showing sea cucumber processing methods.

Fresh sea cucumbers are processed as described in Figure 5 to produce a boiled or dried final product. Boiled sea cucumbers lose 66–67% or 60–62%, for *H. tubulosa* and *H. poli*, respectively, of their gutted weight. Dried sea cucumbers, which are typically the final exported product (trepang), lose 90–91% (*H. tubulosa*) or 91–92% (*H. poli*) of their gutted weight. Accordingly, the final product for the period 2016–2021 of the sea cucumbers caught

from the Cyclades fishery grounds is estimated to be 13.29 metric tons for *H. tubulosa* and 8.15 metric tons for *H. poli*.

All sea cucumber fishermen (100%) sold their catches at wholesale (*H. poli* and *H. tubulosa*), with a mean price of 3 EUR/kg for *H. poli* and 6 EUR/kg for *H. tubulosa*. They have created a trust with a specific processing company for each fishing season, and the company undertakes the transportation of quotas from landing ports to its facility. After processing, the final product is exported, typically by the processing company, to foreign markets, i.e., China (Figure 6).

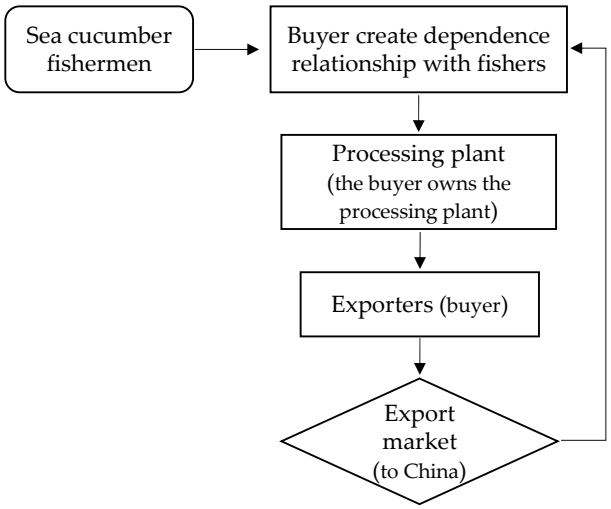



**Figure 6.** Linkage between the different actors involved in the sea cucumber trade, i.e., fishers, buyers, processing companies, and exporters.

The sea cucumber fishermen reported an increasing trend in the selling price of holothurians in recent years at all studied regions except South Aegean. In the latter region, most fishermen (92%) reported a decreasing trend, whereas few of them considered the prices as stable (4%) or increasing (4%).

## 4. Discussion

Sea cucumber fishing has become an important sector of small-scale fisheries in several Mediterranean countries, leading to the establishment of regulatory measures [16,18,33]. However, to efficiently manage small-scale fisheries, it is necessary to gather multidisciplinary information on biological (e.g., stock assessment), social, and economic components of the fishery [37,38]. To face these constraints, much scientific effort has been recently devoted to gathering information on the biology of commercial (*Holothuria* spp.) sea cucumbers in the Mediterranean [16,23,24,29–33]. However, only one study has included some data on socioeconomic aspects of their fishery in the Mediterranean [24]. Relevant studies carried out in the tropics have revealed the importance of balancing socioeconomic and biological indicators for the long-term harvesting of holothurians and the sustainability of local traditional fishery communities [39,40].

Based on official data, the fishing fleet of holothurian fishers in the Hellenic Seas numbers about 130 vessels; the vast majority are less than 8 m in length, with a 2.8 GT and 34 HP, and they all belong to small-scale fishery. The fleet is active from November to April according to the national legislation, so most fishermen have multiple licenses for other target species, such as sponges, shellfish, sea urchins, sea squirts, and prawns, depending on the region. The fleet shares some common features with the adjacent one from Turkey, which is, however, larger in the number of licensed vessels, length, and engine power [24]. These differences may reflect the fact that sea cucumber harvesting is mainly restricted in

shallow and sheltered coastal areas very close to the port of origin in all regions of Greece, except for South Aegean, where fishers explore remote grounds using relatively larger vessels in length, tonnage, and engine power.

Most fishery studies adopt the EC definition of métiers as units of fishing practices targeting a specific assemblage of species using a specific gear, during a precise period, and within a specific area (2008/949/EC). Based on subdivisions of the above parameters, such as the technical characteristics of the gear, various métiers are identified in Mediterranean small-scale fishery [3,10,36], often under the umbrella of using a main fishing gear, e.g., nets [9] or longlines [11]. However, excluding cephalopods, shrimps, and lobsters, the fishery of invertebrates is rarely considered as a métier; however, Roditi et al. [11] report the traditional harvest of bath sponges by diving as an a priori distinct métier in small-scale Mediterranean fisheries. The harvesting of *Holothuria* spp. in the Mediterranean is practiced with diving. Free diving and diving with the surface air supply method (narghile) are the officially accepted practices, whereas a severe problem exists with illegal and uncontrolled harvesting using SCUBA diving [24]. Based on the collected data, three well-defined métiers are practiced by the professional sea cucumber fleet in the Hellenic Seas. These métiers were mainly identified according to the type (free or narghile), the duration (few minutes up to 2 h), and the daily replication (1 up to 90) of dives, the targeted species (*H. poli* or *H. tubulosa*), the explored grounds (depth, mainland or insular, coastal, or offshore), the number and distance of fishing trips, and the seasonality of fishing. The first métier, M1, operates in offshore, insular areas, exploits deep stocks and larger quantities of *H. poli*, is particularly active in late winter to early spring, and is practiced by the South Aegean regional fleet that performs multiday fishing trips; M1 presented high catch and sufficient profit, despite the comparatively higher expenses (e.g., fuel). The remaining sea cucumber fleet all over the Greek territory practices the other two métiers (M2 and M3). They operate in sheltered coastal bays close to the mainland being active from the opening of the fishing season in November to January; they exploit very shallow stocks, catching lower quotas equally partitioned between the two target species, using either the free (M2) or surface air supply diving method (M3), but always operating in less than 8 m depth. Due to the limited duration of sea cucumber licensing (6 months), a seasonal substitution of the holothurians' métiers is practiced by all fishermen.

Even if the profit gained by the sea cucumber métiers is lower than other small-scale fishery métiers, young fishers are entering this sector, especially in the regions of Central Macedonia, Epirus, and South Aegean, probably responding to the increased demand for holothurians in the international markets [15,16,41]. Holothurians appear to be an attractive biological resource for small-scale fishers with diving skills, as many of them moved from the decline in sponge and shellfish fishing to this fishery resource [18]. From the findings of the survey, it is interesting to note that a large part of sea cucumber harvests are not coming from fishermen's families, so they have consciously chosen this profession. In general, the fishermen face no health problems, except those from the South Aegean region. This is probably related to the M1 métier, operated deeply, in addition to their long involvement in diving, as a large part came from sponge fishery, which has exposed divers to high risk and long-term disorders.

Sea cucumber fishery is the main source of income for the majority of fishermen, so they are actively engaged in maximizing production to safeguard a sufficient income for their family, as most of them are married and have one to five children. The owners of the Hellenic holothurian fishery fleet are fishers as well, and usually, they have one crew member paid by the day. This contrasts the structure of some tropical sea cucumber fleets, such as those in Kenya, where the vessel owners are not involved in harvesting, which is exclusively carried out by crew members [19,42].

The social profile of sea cucumber fishermen was similar between the studied regions; however, the mean income from the Aegean insular fishermen and the Ionian mainland fishers was comparatively lower. This result is likely due to the much higher fixed costs incurred by the M1 métier practiced by the South Aegean fleet, whereas in the case of the North Aegean and Epirus fleets, this may reflect the short occupation with the relevant métiers.

According to the presented results, sea cucumber fishing appears to be a significant source of income in the Hellenic Seas. However, the spatial limitations of this study due to the refusal of the fishermen from Central Greece to participate in interviews and provide socioeconomic data, should be taken into consideration, although the sea cucumber fishery in Central Greece is expected to share common features with the Central Macedonia region, as fishermen harvest in shallow shelter bays according to the relevant fishery department. The temporal replicability of the study is also rather narrow, with emphasis on 2022 data, but it covers the period right after the official opening of holothurian harvesting for human consumption in Greece. So, a large period of uncontrolled harvesting of sea cucumbers as bait is ignored as relevant data are completely lacking [21]. These limitations may have an impact on the accuracy of generalizations derived from the socioeconomic findings of this study, highlighting the need for recursive long-term monitoring. Unfortunately, relevant studies have not been published from other Mediterranean regions to allow comparisons. Relevant socioeconomic studies from tropical regions revealed that sea cucumber fishing is dominated by men, as is the case in the present study, and provides significant income, although there is a severe need to improve supply chains [19,43,44].

There are no intermediaries in the trade chain of holothurians; the fishermen/owners of the fishing vessels have direct contracts with the owners of the processing companies and sell the entire catch after evisceration. The companies receive and process the eviscerated sea cucumbers and export the final dried product to China; the relevant processing companies from Turkey mainly export frozen sea cucumbers [24]. During the procession, a severe shrinkage of holothurians is taking place, depending on the species and generally surpassing 85% for Mediterranean *Holothuria* [45]. The same merchandise pattern is followed in Indonesia (Sulawesi), where processing plants directly buy and export sea cucumbers [46]. Processing companies control prices through their contracts with fishermen, who are obligated to provide specific quotas for a fixed price. So, although this tactic is beneficial for the fishermen in the short term, it may become unprofitable due to the lack of competition, severely impacting their income in the long term. This monopolization tactic is in contrast to the relevant industry in Kenya, where middlemen purchase the sea cucumbers from fishers and sell them to exporters [19]. The presence of middlemen severely affects the sea cucumber market, augmenting market prices but lowering relevant gains of fishers, who, however, remain free to negotiate prices. This is challenging for a market facing declining supply but increasing demand [46].

Recent studies identify the importance of incorporating socioeconomic data in designing management plans for small-scale fisheries [36,37]. The regional analysis of the socioeconomic status and the applied métiers of the Hellenic sea cucumber fishery revealed some important issues that should be taken into consideration for sustainable management. Accordingly, at least two types of fishery grounds should be set and distinctively managed to conform to the different métiers practiced by fishermen: in exposed, deep offshore areas along the national territory (M1) and in sheltered coastal shallow water gulfs (M2 and M3), respectively. Besides stock assessment data, relevant measures on quotas should take into account the limited fishing trials per month due to harsh weather conditions, the 6-month fishing period covers wintertime (from November to April), and the increased expenses faced by M1 fishermen. These fishermen are also exposed to

higher human risk, e.g., decompression sickness; therefore, training is essential to improve safety at sea. Considering the long tradition of harvesting by diving in the South Aegean region [34], particularly Kalymnos island, it is important to promote and support the viability of this artisanal occupation. The education and the active involvement of fishermen and other stakeholders in the designation and implementation of adaptive management plans are imperative to safeguard the sustainability of both local fishery societies and marine ecosystems.

## 5. Conclusions

The present study analyzes the first comprehensive data on the socioeconomic characteristics of Mediterranean sea cucumber (*Holothuria* spp.) small-scale fisheries, filling relevant knowledge gaps. The vast majority of fishermen apply a conservative métier harvesting holothurians in shallow coastal grounds by performing short-distance daily trips. This tactic seems to prevent health risks associated with diving in deeper, as is the case in the most distinct métier practiced by the South Aegean fishermen (Kalymnos island, in particular). Two out of the three identified métiers represented the main occupation of most fishermen, and they were all assessed as economically viable; the absence of intermediaries and the strong engagement between fishermen and processors, who are the exporters as well, seems to enhance profits for both parties. However, considering the limited period allowed for holothurian harvesting (6 months), it becomes evident that most fishermen must combine this profession with at least another métier targeting completely different species and use the same or different fishing gear to safeguard their annual income.

**Supplementary Materials:** The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/fishes10060258/s1, Supplementary Material S1: The structured questionnaire used in the personal interviewing of fishermen to gather data on their fishing tactics and socioeconomics.

**Author Contributions:** Conceptualization, K.R. and C.A. (Chryssanthi Antoniadou); methodology, K.R.; software, K.R.; validation, D.V., C.A. (Chryssanthi Antoniadou) and C.A. (Chrysoula Apostologamvrou); formal analysis, K.R.; investigation, K.R.; resources, D.V.; data curation, C.A. (Chryssanthi Antoniadou); writing—original draft preparation, K.R. and C.A. (Chryssanthi Antoniadou); writing—review and editing, C.A. (Chryssanthi Antoniadou), C.A. (Chrysoula Apostologamvrou) and K.R.; visualization, C.A. (Chrysoula Apostologamvrou); supervision, D.V.; project administration, D.V.; funding acquisition, D.V. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the Greek Operational Program for Fisheries and Sea (2014–2020), grant number MIS 5010720.

**Institutional Review Board Statement:** Not applicable.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy reasons.

**Acknowledgments:** The authors would like to thank the personnel of the Managing Authority of the Fisheries and of the Nautilus Seafood Company for providing data on *Holothuria* fishing licenses and processing, respectively.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## References

1. Grafton, R.Q.; Kompas, T.; McLoughlin, R.; Rayns, N. Benchmarking for fisheries governance. *Mar. Pol.* **2007**, *31*, 470–479. [CrossRef]
2. Schuhbauer, A.; Sumaila, U.R. Economic viability and small-scale fisheries—A review. *Ecol. Econ.* **2016**, *124*, 69–75. [CrossRef]

3. Tzanatos, E.; Somarakis, S.; Tserpes, G.; Koutsikopoulos, C. Identifying and classifying small-scale fisheries métiers in the Mediterranean: A case study in the Patraikos Gulf, Greece. *Fish. Res.* **2006**, *81*, 158–168. [CrossRef]
4. Battaglia, P.; Romeo, T.; Consoli, P.; Scotti, G.; Andaloro, F. Characterization of the artisanal fishery and its socio-economic aspects in the central Mediterranean Sea (Aeolian Islands, Italy). *Fish. Res.* **2010**, *102*, 87–97. [CrossRef]
5. Battaglia, P.; Andaloro, F.; Consoli, P.; Peda, C.; Raicevish, S.; Spagnolo, M.; Romeo, T. Baseline data to characterize and manage the small-scale fishery (SSF) an oncoming Marine Protected Area (Cape Milazzo, Italy) in the western Mediterranean Sea. *Ocean Coast. Manag.* **2017**, *148*, 231–244. [CrossRef]
6. Fulton, E.A.; Link, J.S.; Kaplan, I.C.; Savina-Rolland, M.; Johnson, P.L.; Ainsworth, C.; Horne, P.; Gorton, R.; Gamble, R.J.; Smith, A.D.M.; et al. Lessons in modelling and management of marine ecosystems: The Atlantis experience. *Fish Fish.* **2011**, *12*, 171–188. [CrossRef]
7. Quetglas, A.; Merino, G.; Ordines, F.; Guijarro, B.; Garau, A.; Antoni, M.G.; Oliver, P.; Massutí, E. Assessment and management of western Mediterranean small-scale fisheries. *Ocean Coast. Manag.* **2016**, *133*, 95–104. [CrossRef]
8. Palmer, M.; Tolosa, B.; Grau, M.A.; del Mar Gil, M.; Obregon, C.; Morales-Nin, B. Combining sale records of landings and fishers knowledge for predicting métiers in a small-scale, multi-gear, multispecies fishery. *Fish. Res.* **2017**, *195*, 59–70. [CrossRef]
9. Roditi, K.; Vafidis, D. Small-scale fisheries in the south Aegean Sea: Métiers and associated economics. *Ocean Coast. Manag.* **2022**, *224*, 106185. [CrossRef]
10. Roditi, K.; Antoniadou, C.; Matsiori, S.; Halkos, G.; Vafidis, D. Longline métiers and associated economic profiles in eastern Mediterranean fisheries: The case study of Kalymnos Island (South Aegean Sea). *Ocean Coast. Manag.* **2020**, *195*, 105275. [CrossRef]
11. Cooke, S.J.; Venturelli, P.A.; Twardek, W.M.; Lennox, R.J.; Brownscombe, J.W.; Skov, C.; Hyder, K.; Suski, C.D.; Diggles, B.K.; Arlinghaus, R.; et al. Technological innovations in the recreational fishing sector: Implications for fisheries management and policy. *Rev. Fish Biol. Fish.* **2021**, *31*, 253–288. [CrossRef]
12. Toral-Granda, V.; Lovatelli, A.; Vasconcellos, M. *Sea Cucumbers: A Global Review of Fisheries and Trade*; FAO Fisheries and Aquaculture Technical Paper; FAO: Rome, Italy, 2008; No. 516; pp. 1–317.
13. Friedman, K.; Purcell, S.; Bell, J.; Hair, C. *Sea Cucumber Fisheries: A Manager's Toolbox*; Australian Centre for International Agricultural Research (ACIAR) Monograph: Canberra, Australia, 2008; No. 135; pp. 1–32.
14. Conand, C.; Claereboudt, M.; Dissayanake, C.; Ebrahim, A.; Fernando, S.; Godvinden, R.; Lavitra, T.; Léopold, M.; Mmbaga, T.; Mulochau, T.; et al. Review of fisheries and management of sea cucumbers in the Indian Ocean. *WIO J. Mar. Sci.* **2022**, *21*, 125–148. [CrossRef]
15. González-Wangüemert, M.; Domínguez-Godino, J.; Cánovas, F. The fast development of sea cucumber fisheries in the Mediterranean and NE Atlantic waters: From a new marine resource to its over-exploitation. *Ocean Coast. Manag.* **2018**, *151*, 165–177. [CrossRef]
16. Purcell, W.S.; Williamson, H.D.; Ngaluafe, P. Chinese market prices of beche-de-mer: Implications for fisheries and aquaculture. *Mar. Pol.* **2018**, *45*, 240–250. [CrossRef]
17. Vafidis, D.; Antoniadou, C. Holothurian fisheries in the Hellenic Seas: Seeking for sustainability. *Sustainability* **2023**, *15*, 9799. [CrossRef]
18. Ochiewo, J.; Torre-Castro, M.; Muthama, C.; Munyi, F.; Nthuta, J.M. Socio-economic features of sea cucumber fisheries in southern coast of Kenya. *Ocean Coast. Manag.* **2010**, *53*, 192–202. [CrossRef]
19. Purcell, S.W.; Mercier, A.; Conand, C.; Hamel, J.-F.; Toral-Granda, M.V.; Lovatelli, A.; Uthicke, S. Sea cucumber fisheries: Global analysis of stocks, management measures and drivers of overfishing. *Fish Fish.* **2013**, *14*, 34–59. [CrossRef]
20. Kazanidis, G.; Antoniadou, C.; Lolas, A.; Neofitou, N.; Vafidis, D.; Chintiroglou, C.; Neofitou, C. Population dynamics and reproduction of *Holothuria tubulosa* (Holothuroidea: Echinodermata) in the Aegean Sea. *J. Mar. Biol. Assoc.* **2010**, *90*, 895–901. [CrossRef]
21. Antoniadou, C.; Vafidis, D. Population structure of the traditionally exploited holothurian *Holothuria tubulosa* in the south Aegean Sea. *Cah. Biol. Mar.* **2011**, *52*, 171–175.
22. González-Wangüemert, M.; Aydin, M.; Conand, C. Assessment of sea cucumber populations from the Aegean Sea (Turkey): First insights to sustainable management of new fisheries. *Ocean Coast. Manag.* **2014**, *92*, 87–94. [CrossRef]
23. Dereli, H.; Aydın, M. Sea cucumber fishery in Turkey: Management regulations and their efficiency. *Reg. Stud. Mar. Sci.* **2021**, *41*, 101551. [CrossRef]
24. Kinch, J.P.; Purcell, S.W.; Uthicke, S.; Friedman, K. Population status, fisheries and trade of sea cucumbers in the Western Central Pacific. In *Sea Cucumbers: A Global Review of Fisheries and Trade*; Toral-Granda, V., Lovatelli, A., Vasconcellos, M., Eds.; FAO Fisheries and Aquaculture Technical Paper; FAO: Rome, Italy, 2008; No. 516; pp. 7–55.
25. Allison, E.H.; Ratner, B.D.; Asgard, B.; Willmann, R.; Pomeroy, R.; Kurien, J. Rights-based fisheries governance: From fishing rights to human rights. *Fish Fish.* **2012**, *13*, 14–29. [CrossRef]

26. Chandra, A. A deliberate inclusive policy (DIP) approach for coastal resources governance: A Fijian perspective. *Coast. Manag.* **2011**, *39*, 175–197. [CrossRef]
27. Purcell, S.W. *Managing Sea Cucumber Fisheries with an Ecosystem Approach*; FAO Fisheries and Aquaculture Technical Paper; FAO: Rome, Italy, 2010; No. 516; pp. 1–157.
28. González-Wangüemert, M.; Valente, S.; Henriques, F.; Domínguez-Godino, J.; Serrão, E. Setting preliminary biometric baselines for new target sea cucumbers species of the NE Atlantic and Mediterranean fisheries. *Fish. Res.* **2016**, *179*, 57–66. [CrossRef]
29. Aydin, M. Density and biomass of commercial sea cucumber species relative to depth in the northern Aegean Sea. *Thalass. Int. J. Mar. Sci.* **2019**, *35*, 541–550. [CrossRef]
30. Domínguez-Godino, J.A.; González-Wangüemert, M. Habitat associations and seasonal abundance patterns of the sea cucumber *Holothuria arguinensis* at Ria Formosa coastal lagoon (South Portugal). *Aquat. Ecol.* **2020**, *54*, 337–354. [CrossRef]
31. Mezali, K.; Lebouazda, Z.; Slimane-Tamacha, F.; Soualili, D.L. Biometry, size structure and reproductive cycle of the sanded sea cucumbers *Holothuria poli* (Echinodermata, Holothuriidae) from the west Algerian coast. *Invertebr. Reprod. Dev.* **2022**, *66*, 67–77. [CrossRef]
32. Vafidis, D.; Antoniadou, C.; Apostologamvrou, C.; Voulgaris, K.; Varkoulis, A.; Giokala, E.; Lolas, A.; Roditi, K. Size structure of exploited holothurian natural stocks in the Hellenic Seas. *Sustainability* **2023**, *15*, 13483. [CrossRef]
33. Tzanatos, E.; Georgiadis, M.; Peristeraki, P. Small-Scale Fisheries in Greece: Status, Problems, and Management. In *Small-Scale Fisheries in Europe: Status, Resilience and Governance*; Springer: Dodrecht, The Netherlands, 2020; pp. 125–150.
34. Voultsiadou, E.; Dailianis, T.; Antoniadou, D.; Vafidis, D.; Dounas, C.; Chintiroglou, C. Aegean bath sponges: Historical data and current status. *Rev. Fish. Sci.* **2011**, *19*, 34–51. [CrossRef]
35. Maynou, F.; Recasens, L.; Antoni, L. Fishing tactics dynamics of a Mediterranean small-scale coastal fishery. *Aquat. Living Resour.* **2011**, *24*, 149–159. [CrossRef]
36. Smith, S.L.; Karasik, R.; Stavrinaky, A.; Uchidad, H.; Burden, M. Fishery Socioeconomic Outcomes Tool: A rapid assessment tool for evaluating socioeconomic performance of fisheries management. *Mar. Pol.* **2019**, *105*, 20–29. [CrossRef]
37. Bennett, N.J.; Schuhbauer, A.; Skerritt, D.; Ebrahim, N. Socio-economic monitoring and evaluation in fisheries. *Fish. Res.* **2021**, *239*, 105934. [CrossRef]
38. Hair, C.; Foale, S.; Kinch, J.; Frijlink, S.; Lindsay, D.; Southgate, P.C. Socioeconomic impacts of a sea cucumber fishery in Papua New Guinea: Is there an opportunity for mariculture? *Ocean Coast. Manag.* **2019**, *179*, 104826. [CrossRef]
39. Eggertsen, M.; Eriksson, H.; Slater, M.J.; Raymond, C.; dela Torre-Castro, M. Economic value of small-scale sea cucumber fisheries under two contrasting management regimes. *Ecol. Soc.* **2020**, *25*, 20. [CrossRef]
40. Rahman, M.A.; Chowdhury, S.H.; Hasan, M.J.; Rahman, M.H.; Yeasmin, S.M.; Farjana, N.; Molla, M.H.R.; Parvez, M.S. Status, prospects and market potentials of the sea cucumber fisheries with special reference on their proper utilization and trade. *Annu. Res. Rev. Biol.* **2020**, *35*, 84–101. [CrossRef]
41. Crona, B.I.; Nyström, M.; Folke, C.; Jiddawi, N.S. Middlemen, a critical social-ecological link in coastal communities of Kenya and Zanzibar. *Mar. Pol.* **2010**, *34*, 761–771. [CrossRef]
42. Purcell, S.W.; Ngaluafe, P.; Foale, S.; Cocks, N.A.; Cullis, B.R.; Lalavanua, W. Multiple factors affect socioeconomics and wellbeing of artisanal sea cucumber fishers. *PLoS ONE* **2016**, *11*, e0165633. [CrossRef]
43. Nishanthan, G.; Kumara, A.; Prasada, P.; Dissanayake, C. Sea cucumber fishing pattern and the socio-economic characteristics of fisher communities in Sri Lanka. *Aquat. Living Resour.* **2019**, *32*, 12. [CrossRef]
44. Ballikaya, G.; Aydın, M.; Erkan, S. Changes in length-weight relationships of three different commercial sea cucumber during processing and corrected of fisheries data. *J. Anatol. Environ. Anim. Sci.* **2021**, *6*, 43–49. [CrossRef]
45. Aprianto, R.; Amir, N.; Kasmiati; Matusalach; Fahrul; Syahrul; Tresnati, J.; Tuwo, A.; Nakajima, M. Economically important sea cucumber processing techniques in South Sulawesi. Indonesia. *IOP Conf. Ser. Earth Environ. Sci.* **2019**, *370*, 012082. [CrossRef]
46. Perez, M.L.; Brown, E.O. Market potential and challenges for expanding the production of sea cucumber in South-East Asia. In *Asia-Pacific Tropical Sea Cucumber Aquaculture*; Hair, C.A., Pickering, T.D., Mills, D.J., Eds.; Australian Centre for International Agricultural Research: Canberra, Australia, 2012; pp. 177–188.


**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.