

A socio-economic characterization of Tuscan Archipelago's artisanal fisheries: Status quo, challenges and new business opportunities

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ABSTRACT

Artisanal fisheries in the Mediterranean are suffering from a decades-long crisis, and urgent interventions are needed to reverse this trend. Despite the increasingly recognized importance of the human dimension of fisheries, socio-economic data on Mediterranean artisanal fisheries are lacking. To address this shortage, this paper offers a socio-economic snapshot of artisanal fisheries operating in the Tuscan Archipelago (GSA 9). Information was collected through semi-structured interviews based on an opportunistic + snowball sampling strategy, with questionnaires reviewed by a panel of 10 experts following the Delphi technique. Information was gathered on fishers, fishing activities, gears, seasonality, catches of alien and thermophilic species, commercial destination of the catch and fishers' opinions on the main challenges and opportunities in the sector. The results show an artisanal fishing sector facing severe crisis, reduced catches, conflicts with the recreational sector, scarce renewal of both human and technical capital, as well as a general reluctance to explore new business pathways. Yet, many fishers recognized the need for change and showed some early attempts to diversify their sea-related income sources. However, a high discrepancy was observed between the desire and the actual implementation of strategies to strengthen livelihoods and diversify. Efforts are needed to remove the obstacles that prevent the amelioration of artisanal fishers' businesses and the exploration of new opportunities for managing, protecting and adequately valorizing local marine resources. This goal could be achieved through the establishment of synergies between the fishing and tourism sectors, if the socio-ecological sustainability of artisanal fisheries is sought, both in the Tuscan Archipelago and at other sites.

1. Introduction

Fishing is a very important socio-economic activity in the Mediterranean in terms of employment, seafood supply and cultural heritage, as well as many other indirect benefits (Farrugio et al., n.d.; Colloca et al., 2004; Gómez Mestres et al., 2006; Battaglia et al., 2010; FAO 2022; European Commission, 2020; European Parliament Committee on Fisheries, 2012; Forcada et al., 2010; Sartor et al., 2019; STECF 2020). Artisanal fishing, specifically, is an activity of deep heritage and tradition in many Northern Mediterranean countries (Stergiou et al., 2006; Guyader et al., 2013; Raicevich et al., 2020). Such vessels compose around 82% of the total Mediterranean fishing fleet (FAO 2022). In Italy,

the artisanal fishing fleet accounts for 6680 vessels (65% of the total), and while it is responsible for 26% of total fishing revenues, it employs 50% (nearly 11,000 people) of the total fishing workforce (FAO 2022), thus confirming the enormous socio-economic importance of the sector in the national context.

The Mediterranean Sea is one of the most overexploited seas in the world (Coll et al., 2012; Micheli et al., 2013; FAO 2022). Mediterranean artisanal fisheries have, for decades, been experiencing a deep crisis due to the depletion of local stocks and habitat degradation, both accelerated by the increasing presence of industrial fisheries, which also is a direct economic competitor (Prosperi et al., 2019). Additional stressors include pollution climate change; the presence of alien species; illegal,

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unreported and unregulated fishing; increasing production costs; conflicts with other marine users; and inefficient management (Gómez Mestres et al., 2006; Guyader et al., 2013; Hidalgo et al., 2018; Raicevich et al., 2018). More specifically, Italian artisanal fisheries are undergoing a significant socio-economic crisis mostly due to catch and revenue reduction, as well as the absence of rational organization in the supply chain (IREPA Onlus, 2012; Vindigni et al., 2016). Reversing this concerning trend in the local artisanal fishing sector and ensuring its survival is thus considered to be a priority to pursue through the implementation of site-specific strategies tailored to the socio-economic context where they are implemented. Gathering socio-economic data on the human dimension of fisheries is thus a priority for developing science-based fisheries management in accordance with the Food and Agriculture Organization of the United Nations Code of Conduct for Responsible Fisheries (FAO CCRF; FAO 1995) and the Ecosystem Approach to Fisheries (EAF; FAO 2003). In the Mediterranean context, the data collection reference framework (DCRF) of the General Fisheries Commission for the Mediterranean (FAO-GFCM) involves the collection of fishery socio-economic data for the full assessment of the impact of fisheries (GFCM 2016).

A comprehensive monitoring and appraisal of artisanal fisheries is, however, a very complex task for many reasons, including but not limited to: uncertainty about the precise number of active vessels, geographical dispersion of fisheries and landing points, strong seasonality, gear diversification, catch multispecificity and the significant presence of undeclared landings and sales (Garcia et al., 2008; Mahon et al., 2008; World Bank 2012; Jentoft, 2014; Rosales et al., 2017; Lindkvist et al., 2020). These shortfalls generate a problematic data collection scenario and management framework that results in a considerable lack of data about the ecological, socio-economic and management issues related to these fisheries (EU, 2015; De Melo Alves Damasio et al., 2016). This highlights the urgency of enhancing the present level of knowledge on artisanal fisheries. The framework for the Regional Plan of Action on Small Scale fisheries for the Mediterranean and the Black Sea (RPOA-SSF) was designed to address these shortages. Signed by 18 countries, including Italy, it aims to achieve the long-term environmental, economic and social sustainability of artisanal fisheries by the year 2028 by enhancing the collection of fleet, effort and catch data, as well as by improving the value chain and profitability of artisanal fishers and producer organizations, seafood quality and traceability (RPOA-SSF 2018).

A substantial portion of the literature suggests that, despite largely depending on a condition of resource depletion, the widespread crisis of artisanal fisheries could be addressed by the introduction of several business strategies, mostly aimed at revenue enhancement and diversification. These include pescaturism, processing, direct sale of the catch (and, in general terms, the attempt to shorten the distance between producers and consumers across the value chain as much as possible) as well as the establishment of links between the fishing and tourism economies (Scholz et al., 2004; Jacquet and Pauly, 2008; Frangoudes, 2011; FARNET 2013; Kalikoski and Franz, 2014; Lai et al., 2016; Malvasi 2016; Piasecki et al., 2016; Briano 2017; Prospero et al., 2019). Fish preservation, including traditional methods such as salting or sun drying, can increase the nutritional value and shelf life of the product (Getu and Misganaw, 2015; Longwe and Kapute, 2016; Mavuru et al., 2022). In addition to seafood processing, distribution and marketing play a pivotal role in terms of revenue generation and employment around the artisanal fishing sector, especially for women (Rana and Choo 2001; Akande and Diei-Ouadi, 2010; Weeratunge et al., 2010; Shyam and Geetha, 2013; FAO 2022). This could also play a pivotal role in enhancing the revenues of artisanal fishers – especially for low-end fishery products – if accompanied by sound marketing and commercialization campaigns that also involve the food and tourism sectors (Cockerell and Jones, 2021; Di Cintio et al., 2022).

The link between the fishing and tourism sector is apparent in pescaturism, an activity that is gaining specific importance in Europe as a

strategy to diversify revenue flows among artisanal fishers (Horta e Costa et al., 2016; European Commission, 2017; Romanelli and Meliàdo, 2021). Acknowledging the value of these business-enhancement and diversification strategies, several initiatives have been launched at the Mediterranean level to promote seafood transformation, pescaturism and direct sales within artisanal fisheries. Examples include the above-mentioned RPOA-SFF, the WWF “Transforming Mediterranean Small-Scale Fisheries” project, the Mar das Illas’ initiative and many others (RPOA-SSF 2018; Mar das Illas, 2023; WWF 2023). Yet, although artisanal fisheries play a pivotal role in Italy, only a few studies have been implemented to depict the socio-economic characteristics of the segment and to highlight strategies for enhancing its performance (e.g. Colloca et al., 2004; Battaglia et al., 2010, 2017; Falautano et al., 2018; Raicevich et al., 2020; Di Cintio et al., 2022); more specifically, to the best of our knowledge, no similar studies have been implemented in the Tuscan Archipelago. The lack of socio-economic data on Italian artisanal fisheries represents the research gap that this study addresses by investigating the main socio-economic characteristics of artisanal fisheries in the Tuscan Archipelago. Acknowledging the shortfalls in the current level of socio-economic knowledge on artisanal fisheries and aiming to narrow the gap among the fishing community, researchers and decision makers, this paper:

1. Offers baseline data for the socio-economic characterization of the artisanal fishery in the Tuscan Archipelago;
2. Gathers fishers’ perception about the main issues affecting their business and spots opportunities for revenue improvement and diversification;
3. Investigates the extent to which artisanal fisheries’ business-enhancing strategies are applied in the Tuscan Archipelago;
4. Contributes to the RPOA-SFF requirements and goals by gathering information on Italian artisanal fisheries, thus increasing knowledge and setting the baseline for the promotion of a competitive artisanal fishing sector;
5. Provides useful information to shape adequate management policies striving to find a balance between resource protection and socio-economic development, thus reducing the conflicts among different stakeholder classes; and
6. Reports a clear data-collection procedure that can be replicated in other areas.¹

2. Methods

2.1. Study area

The present study sheds a light over the artisanal fisheries of the Italian Tuscan Archipelago (North-Western Mediterranean Sea, GSA 9). The study area encompasses those larger islands of the Archipelago that allow professional fishing i.e., Elba, Giglio and Capraia. Hence, the smaller ones (Giannutri, Montecristo, Pianosa and Gorgona) are left out due to the absence of a permanent fishing community. The Monte Argentario peninsula (which hosts the ports of Porto Santo Stefano and Porto Ercole) is also included due to geographical proximity and fleet migration to and from Giglio waters (Fig. 1).

All sites are characterized by the high seasonality of sea-based tourism, which peaks during the summer, when the population can increase up to tenfold. Population density ranges significantly across sites, from a minimum of 19 inhabitants per km² in Capraia (around the same density as Finland – 16 – i.e. the lowest in the EU) to a maximum of 204 inhabitants per km² in Monte Argentario (roughly corresponding to the national average, i.e. 197).

As a consequence of their difference in size and geographical

¹ Questionnaires used to collect artisanal fishery data are offered to the reader in the [Supplementary material](#).

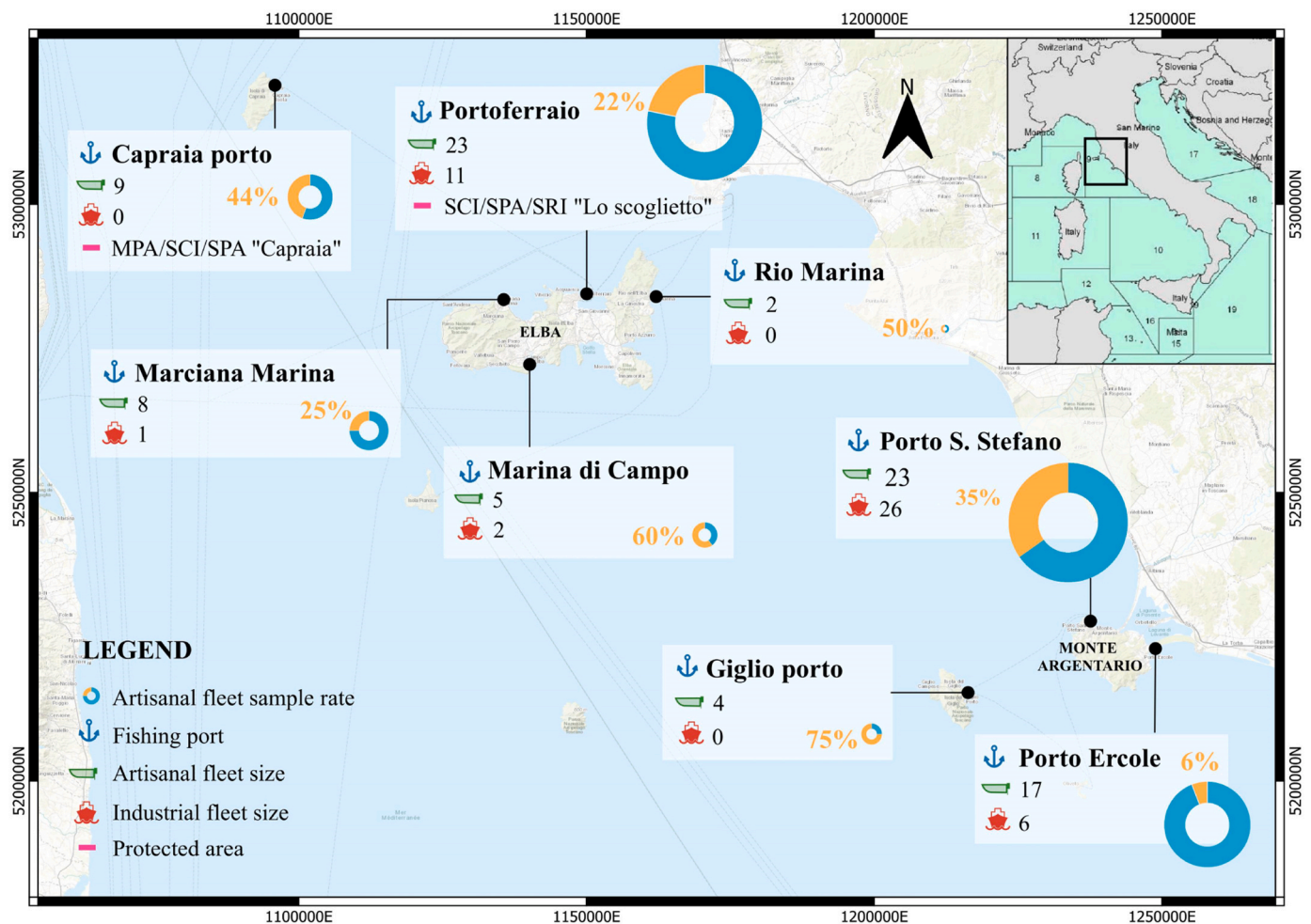


Fig. 1. Map of the data collection area in the Tuscan Archipelago in Italy (North-Western Mediterranean Sea, GSA 9). Depicted are the port name, the number of artisanal fishing vessels and the number of industrial fishing vessels. The doughnut size reports the size of the artisanal fishing fleet from each marina.

position, the islands of the Tuscan Archipelago differ in fleet structure as well as the management measures in place. First, at 223.5 km², Elba is by far the largest island in the Archipelago (Giglio and Capraia only measure 21.2 and 19.3 km² each). Porto Santo Stefano and Porto Ercole are located on the Italian peninsula, and Elba and Giglio are in its proximity, while Capraia is nearly 31 nautical miles distant from the closest Italian port on the peninsula (San Vincenzo, Tuscany). While some sites only host an artisanal fishing fleet (Giglio, Capraia), both artisanal and industrial vessels can be found in others (Elba, Porto Santo Stefano, Porto Ercole). Finally, Capraia already hosts a marine protected area (MPA) covering most of the waters surrounding the island, and a small no-take area is located near Elba (Scoglietto di Portoferraio). By contrast, although many fall within the Tuscan Archipelago National Park, all other sites are under no form of special protection in terms of fishery management (the waters around the islands of Gorgona, Montecristo and Giannutri are only protected by provisory limitations from the institutional decree of the Park, and those around the island of Pianosa were entrusted to the Park after the closure of the local prison).

2.2. Data collection

The research focus was on artisanal fisheries. The segment was identified in accordance with the criteria provided by the European Union Data Collection Framework (DCF) (EU 2022). That is, for the purpose of this study, artisanal fisheries are defined as the “fishing carried out by fishing vessels of an overall length < 12 m and not using towed gears” (EU, 2014; EMFF Regulation 508/2014) – that is, by those

vessels belonging to the DCF code PGP < 12 m length over all (LOA). Information was collected on the variables reported in Table 2.

Data were gathered through semi-structured interviews based on a questionnaire (see Supplementary material), as has been done in other, similar works aimed at the socio-economic characterization of artisanal fisheries (e.g. Battaglia et al., 2017; Coppa et al., 2021). The same questionnaire was used across all sampling sites, and the same person interviewed the fishers at each sampling site. The structure and content of the questionnaires were reviewed and improved by a panel of 10 experts from different institutions worldwide following the Delphi technique methodology reported in Yousuf (2019). Answers to questions were provided either via multiple choice or on a five-point Likert scale. However, respondents were given the opportunity to comment with further qualitative information as a complement to the answers provided (as done, for example, by Msomphora, 2015). This provided significant additional information on the topics in the account and allowed assessing the robustness of the answers received through a comparison of the explanations provided by each fisher.

Interviews were all taken in person at fishing ports, bars or fishers’ homes. Fishers were interviewed voluntarily, were asked for verbal consent before proceeding with the interview and were informed about the goal of the survey as well as the way in which data would be presented – that is, aggregated and anonymous. An opportunistic + snowball sampling strategy was followed, in which fishers were either indicated by experts or randomly selected upon availability at the port; following the interview, they were asked to suggest potential colleagues to be sampled. This strategy made it possible to conduct research

Table 1
Survey site information and composition of the fishing sample.

| Location | Size (km ²) | Population (year 2020) | Pop. Density (Pop./km ²) | Professional fishing ports | Fleet size | | | Sampled units | Sample rate (artisanal fishery) |
|------------------|-------------------------|------------------------|--------------------------------------|----------------------------|------------|------------|------------|---------------|---------------------------------|
| | | | | | Artisanal | Industrial | Total | | |
| Capraia | 19.3 | 372 | 19.27 | Capraia Porto | 9 | 0 | 9 | 4 | 44.4% |
| Giglio | 21.2 | 1 439 | 67.88 | Giglio Porto | 4 | 0 | 4 | 3 | 75.0% |
| Elba | 223.5 | 31 477 | 140.84 | Portoferraio | 23 | 11 | 34 | 5 | 21.7% |
| | | | | Marina di Campo | 5 | 2 | 7 | 3 | 60.0% |
| | | | | Marciana Marina | 8 | 1 | 9 | 2 | 25.0% |
| | | | | Rio Marina | 2 | 0 | 2 | 1 | 50.0% |
| | | | | Porto Ercole | 17 | 6 | 23 | 1 | 5.9% |
| Monte Argentario | 60.4 | 12 372 | 204.83 | Porto Santo Stefano | 23 | 26 | 49 | 8 | 34.8% |
| Total | 324.4 | 45 660 | 140.75 | | 91 | 46 | 137 | 27 | 29.7% |

Table 2
Surveyed variables from Tuscan Archipelago's artisanal fisheries.

| Group | Variable |
|--------------------|---|
| Fisher information | <ul style="list-style-type: none"> • Age • Years of fishing experience • Education level • Incidence of fishing revenues over total household revenues |
| Vessel information | <ul style="list-style-type: none"> • Age • Length over all (LOA) • Engine power (kW) |
| Fishing activity | <ul style="list-style-type: none"> • Gear used per month (y/n) • Fishing months per year (y/n) • Number of fishing days per month • Catch of low-value species • Catch of alien species |
| Business | <ul style="list-style-type: none"> • Commercial destination of the catch • Boat usage for non-fishing activities • Application for funds • Presence of infrastructure • Request for information by tourists • Request for pescaturism trips by tourists • Pescaturism as economic activity |
| Perceptions | <ul style="list-style-type: none"> • Issues affecting fishing activity • Evolution of income in the last 10 years • Implemented strategies to add value to catch • Desired strategies to add value to catch |

activities within a limited time as well as given limited financial and research capacities (Green et al., 2009). In total, 27 interviews were implemented, each lasting between 30 min and two hours. The data collection campaign lasted 15 non-consecutive working days distributed across the period May–October 2022.

2.3. Data analysis

All of the information collected in the 27 questionnaires was entered in an Excel database. Analysis and visualization of data were conducted using the R statistics software (R Core Team 2023), primarily by applying functions included in the *tidyverse* package family (Wickham et al., 2019). Likert plots were created using the *likert* package (Bryer and Speerscheider, 2016).

3. Results

3.1. Socio-demographic information

All sampled vessels were between 6 m and 12 m long, with a very comparable median and average length of around 8.3 m. Vessel engine power ranged from 0 to 149 kW, with average and median again being very close, at approximately 55 kW. Average and median vessel ages are 33 and 35 years, respectively. Most of the interviewed fishers are in the 65 + years age group (Fig. 2). Interviewed individuals have, on average, 36 years of fishing experience (38 median). Most fishers have either completed lower (n = 9) or upper (n = 8) high school. The dependence

on fishing income is high among artisanal fishers' families: in 70% of cases, this represents half or more of the total income. Specifically, for 39% of surveyed individuals, fishing is the only income activity in the household. In 96% of cases, the household is composed by two or more people, and in 43% of cases, by four or more (not included in the graph).

3.2. Fishing gear and seasonality

Trammel nets are the most common gear used (44%), followed by set longlines (14%), pots (13%) and gillnet (12%). All other gear is below 10%. Local artisanal fisheries are multi-gear and multi-specific, and there is huge variability among seasons and gear types. Discard rates are generally below 10%, with unsellable fish mostly retained for personal consumption. The merging of similar gear – for example, a traditional trammel net for common cuttlefish (*Sepia officinalis*) and a large trammel net for European spiny lobster (*Palinurus elephas*) – led to the identification of 11 gear types (Fig. 3). Each fishing technique is used in a specific time of the year, with the same fisher changing gear according to the different month and presence of target stocks. Despite being affected by seasonality, the usage of some gear is prolonged throughout the year. This is, for example, the case of trammel nets or set longlines. By contrast, the use of some gear is solely limited to certain months, as in the case of drifting longline or boat seines.

The aggregate fishing effort (i.e. the one not distinguishing among gear used) confirms the seasonality of fishing activities across the survey sites (Fig. 4). Specifically, effort peaks between May and August, reaching a maximum average of 19 fishing days per fisher in the month of June. By contrast, January registers the minimum result (7 days/fisher).

3.3. Alien species and “poor” local catch

When asked about “non-conventional” species spotted in recent years, fishers provided insights on the presence of both thermophilic native species as well as non-indigenous ones (Fig. 5).

In parallel, fishers declared the catches of many local species that are currently not given adequate value by the market (wholesalers, fishmongers or consumers). These are summarized in Fig. 6. The most common family is that of the *Murenidae* (15%; mentioned 9 times), followed by European conger (*Conger conger*, 13%) and flathead grey mullet (*Mugil cephalus*), lesser spotted dogfish (*Scyliorhinus canicula*) and the common torpedo (*Torpedo torpedo*) with 6% each. The “other” group consists of 16 species² with 3% or 2% weight over the total – that is, those that fishers mentioned only twice or once, respectively.

² These are, in decreasing order of citation: *Scorpaena scrofa*, *Spondylisoma cantharus*, *Uranoscopus scaber*, *Raja clavata*, *Diplodus annularis*, *Mullus barbatus*, *Labrus viridis*, *Diplodus puntazzo*, *Chromis chromis*, *Scomber scombrus*, *Lophius piscatorius*, *Dipturus batis*, *Auxis thazard*, *Sarda sarda*, *Balistes capricus*.

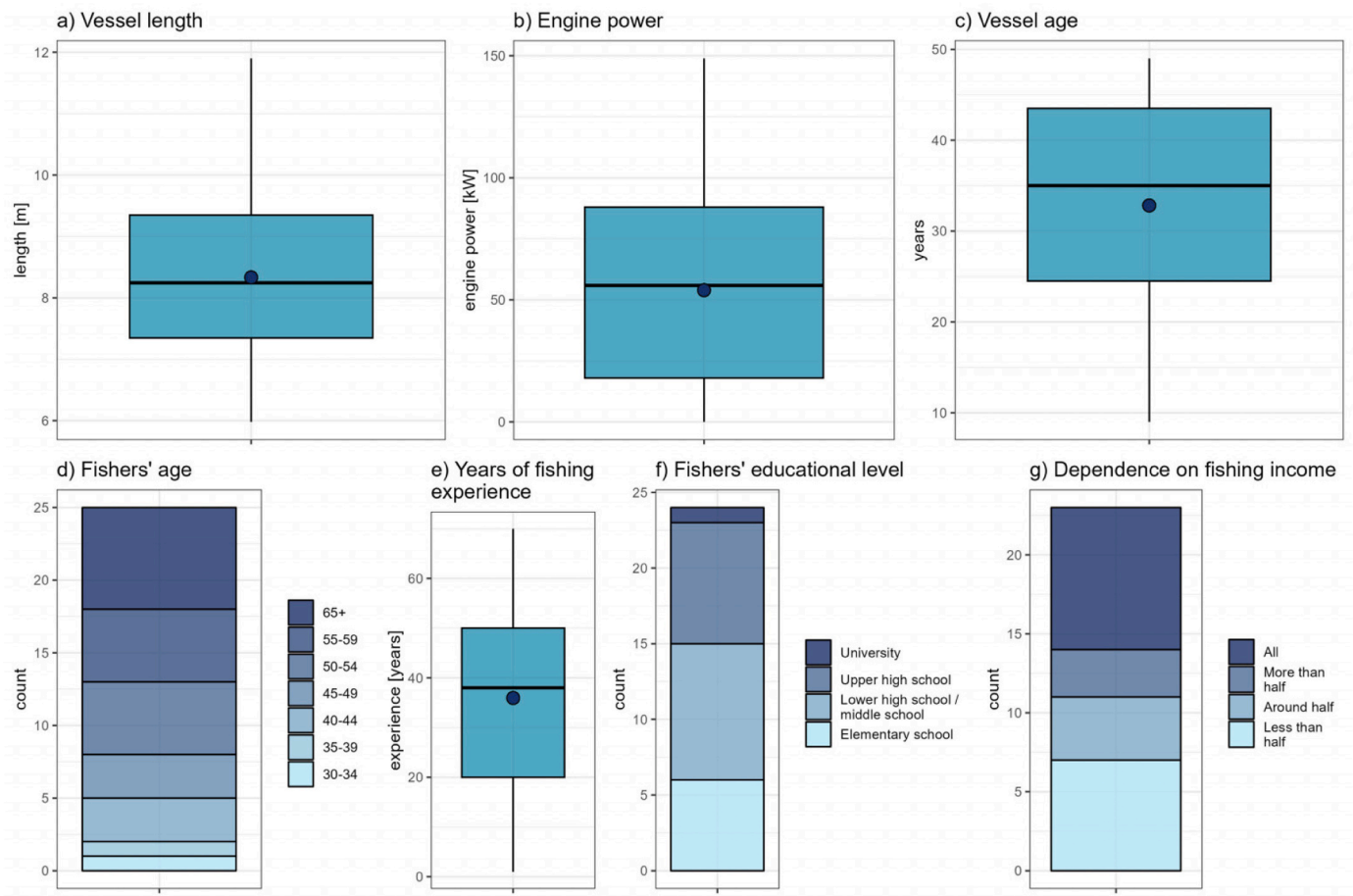


Fig. 2. Vessel length (LOA), power (kW) and age; Fishers' age, years of experience, education and importance of fishing revenues over total household revenues (in the box and whisker plot, the blue dots indicate the average; the horizontal bar the median; the vertical extremes of the boxes the 75° and 25° percentile; the vertical bars the maximum and minimum observations).

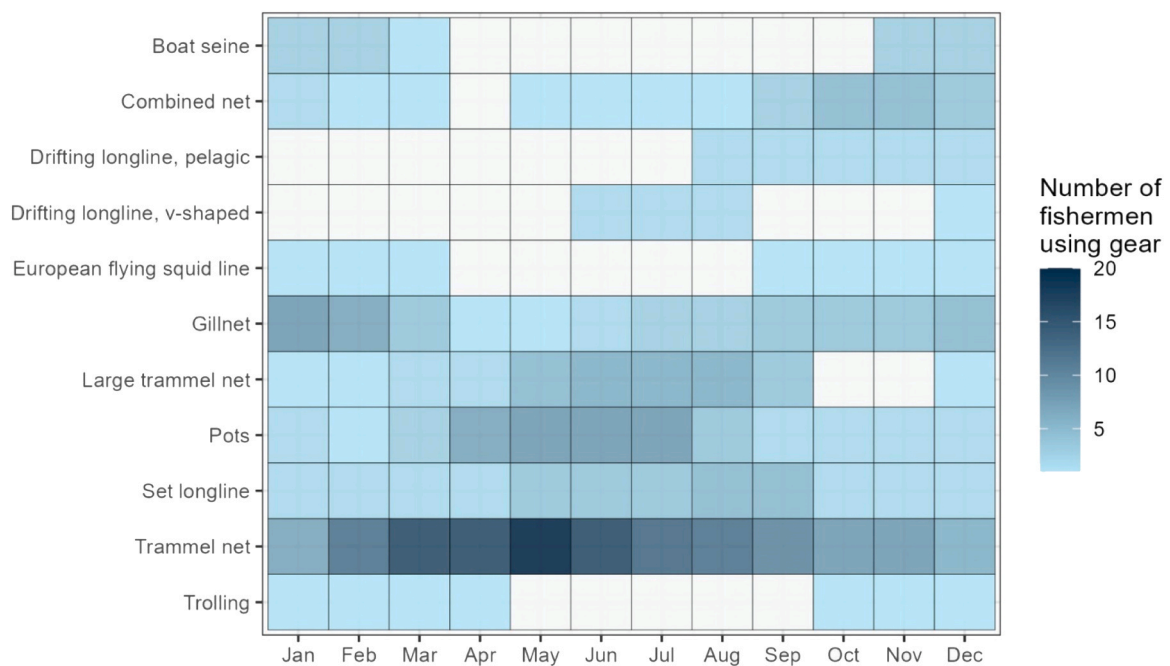


Fig. 3. Heatmap of monthly usage of fishing gear by artisanal fishers in the Tuscan Archipelago.

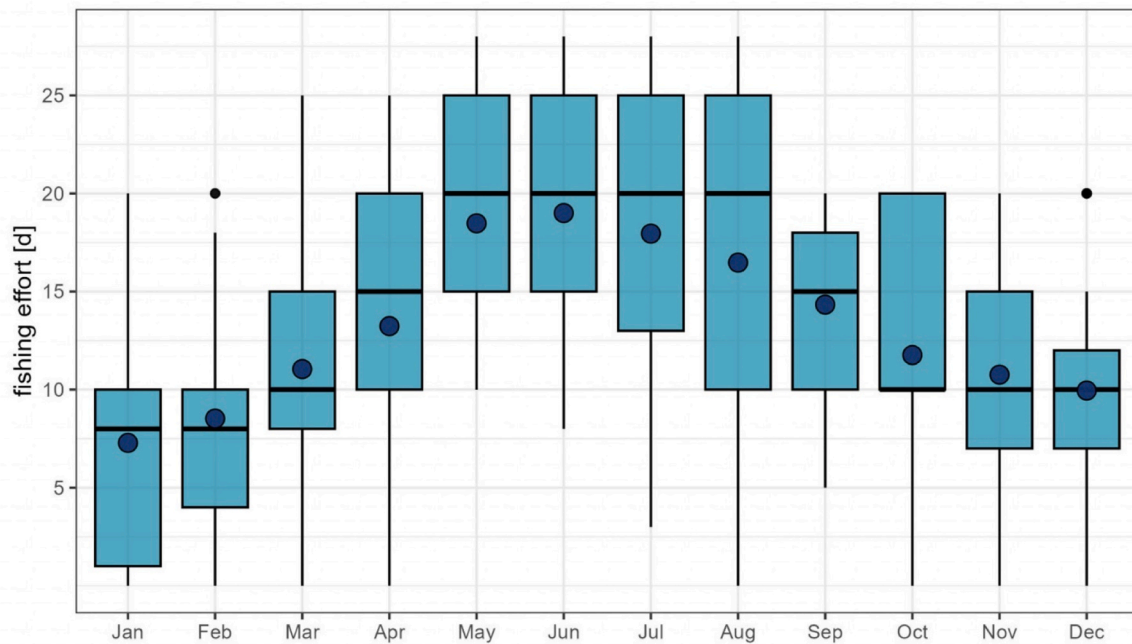


Fig. 4. Number of fishing days per individual fisher per month of the year (the blue dots indicate the average; the horizontal bar the median; the vertical extremes of the boxes the 75° and 25° percentile; the vertical bars the maximum and minimum observations; the blue dot outside the boxes the outlier).

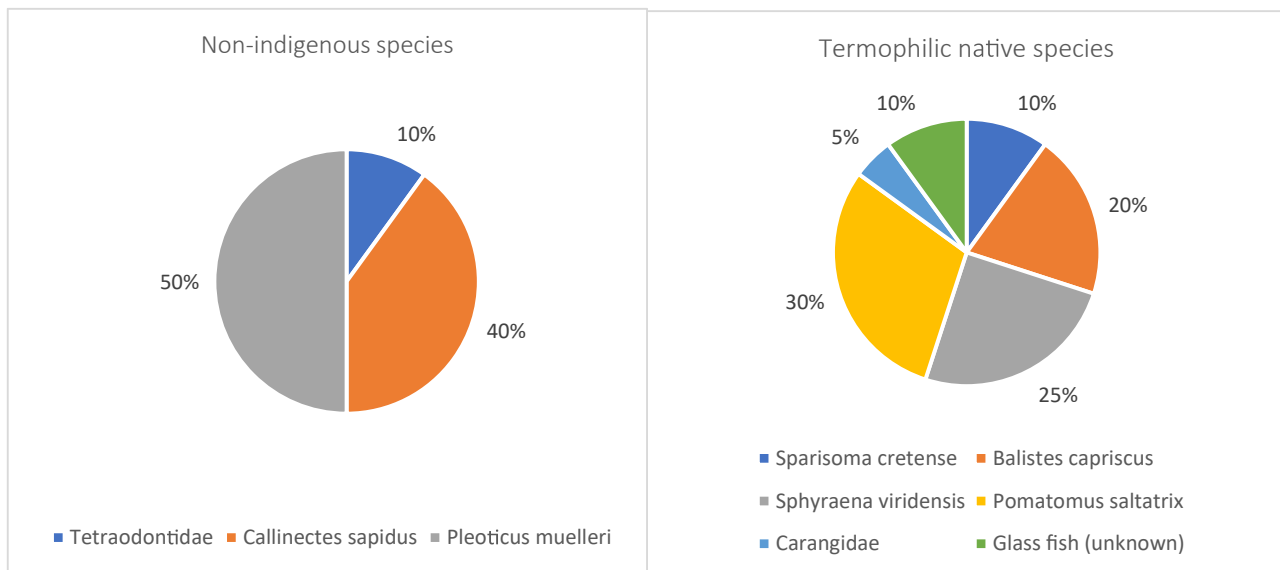


Fig. 5. Presence of thermophilic native and non-indigenous species in the waters of the Tuscan Archipelago.

3.4. Value chain, challenges and opportunities

Most fishers (28%) prefer selling their catch directly to consumers on the quay. The other favourite options are restaurants (17%), and auction and wholesalers (15% each). Sales through auction and seafood shops are mainly practised in Porto Santo Stefano. All other commercial destinations are below 10% (Fig. 7).

According to surveyed fishers, the two main threats affecting their activity are the conflicts arising with recreational fishers, as well as the significant reduction in catches experienced in recent years (24 statements – i.e. 89% each; Fig. 8). The presence of plastic at sea ranks third, with 81% of agreement among fishers, followed by illegal fishing (78%), scarce political interest in the artisanal fishing sector (74%) and excessive fishing effort (71%). All other threats (n = 12) are below 60% (i.e.

16 statements).

Most fishers (83%) declared that their fishing revenues have decreased in the last 10 years, with 13% not spotting any significant change and only 4% experiencing an improvement (Fig. 9). Yet, 74% of them do not participate in calls to gather funds to revamp their business activities (Fig. 10). While most fishers (64%; Fig. 10) consider pescaturism³ a valid economic activity, only 24% of them declare having been engaged in it at least once (and those who did, say that they

³ The term “pescaturism” first appeared in 1992 in Italian legislation to denote the boarding of non-fisher individuals > 14 years old on fishing boats with a recreational or tourism commitment (Kyvelou and Ierapetritis, 2020; Mangi 2022).

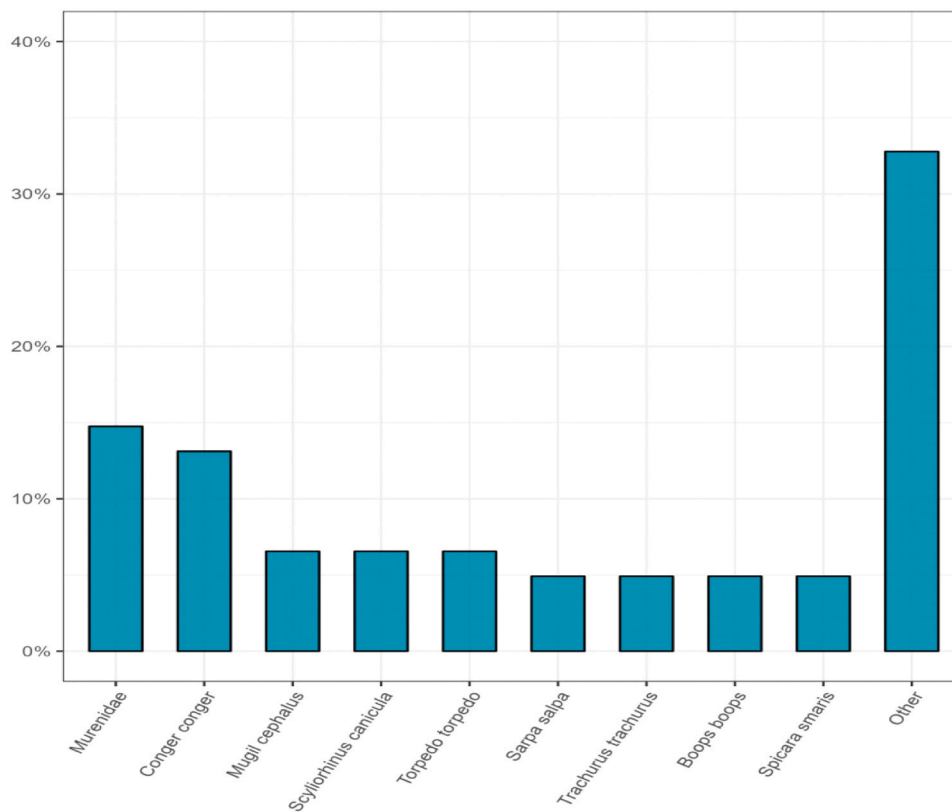


Fig. 6. “Poor” species landed by artisanal fishers in the Tuscan Archipelago.

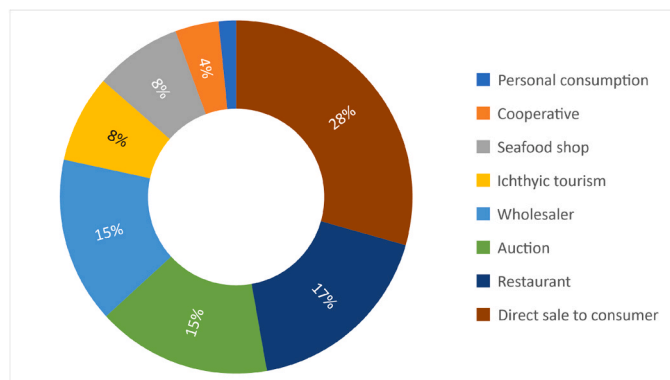


Fig. 7. Commercial destination of the catch in the Tuscan Archipelago’s artisanal fisheries.

usually take friends or relatives on board). Likewise, no fisher engages in catch transformation (i.e. processing) nor implements initiatives with the restaurant or tourism sectors, although 43% of the fishers find transformation to be the best strategy to increase value. Finally, while 43% of surveyed fishers define direct sales as the best strategy to add value to artisanal fisheries’ catches, only 27% actually do so.

4. Discussion

4.1. Socio-demographic information

The first aspect that can be highlighted is the very high age (65 +) and average years of experience (36) of the surveyed fishers, which shows a very low renewal in the human capital of the Tuscan Archipelago’s artisanal fisheries. This is coherent with what is being experienced in other European and Italian artisanal fisheries (e.g. Cavallé

et al., 2020) and in a range comparable to other Mediterranean small-scale fisheries (Maynou et al., 2013; Halkos et al., 2018). This aspect could potentially prevent revenue integration and conversion strategies such as engagement in MPA monitoring or pescaturism, as, given the higher age paired with low education, one would expect a lower propensity to change work. This is coherent with the concerns expressed in the EU Regulation establishing the European Maritime, Fisheries and Aquaculture Fund (EMFAF; EU, 2021). However, employment studies in non-fishery sectors seem to overcome this perception, as older workers show, in some cases, high adaptation skills and low resistance to change (Kunze et al., 2013; Andrei et al., 2019). Additionally, the average level of fishers’ education in the Tuscan Archipelago – with many individuals having completed upper secondary school and even one engaged in academic education in the past – could contribute to building the socio-economic resilience of the sector. The age of the surveyed vessels (average: 33, median: 35) confirms the impression of technical obsolescence and scarce renewal in the sector. The average age of local vessels is below the Italian national average (37 years; FAO 2022), which is one of the highest in the Mediterranean, despite including all vessels and not just artisanal ones. Interestingly, the high vessel age is a condition common in the fleets from the highest per-capita real gross domestic product (GDP)-countries in the Mediterranean (CIA 2023) – including Israel (49 years), Slovenia (43), France (36), Spain (35), Malta (32) and Cyprus (30). By contrast, Morocco (16), Libya (24), Palestine (26) and Tunisia (29) show some of the lowest average ages for vessels (FAO 2022). Further than a decline in the profitability of wild-capture fishing in developed countries, this could be dictated by the relative delay in which less developed countries have engaged in the construction of their respective commercial fishing fleets.

The analysis of fishing income over total household income reveals a high dependency on this activity among fishers in the Tuscan Archipelago. In nearly 40% of cases, fishing is the only source of income in the household. Given that, in 96% of cases, the household is composed of two or more people, and in 43% of the cases by four or more, securing,

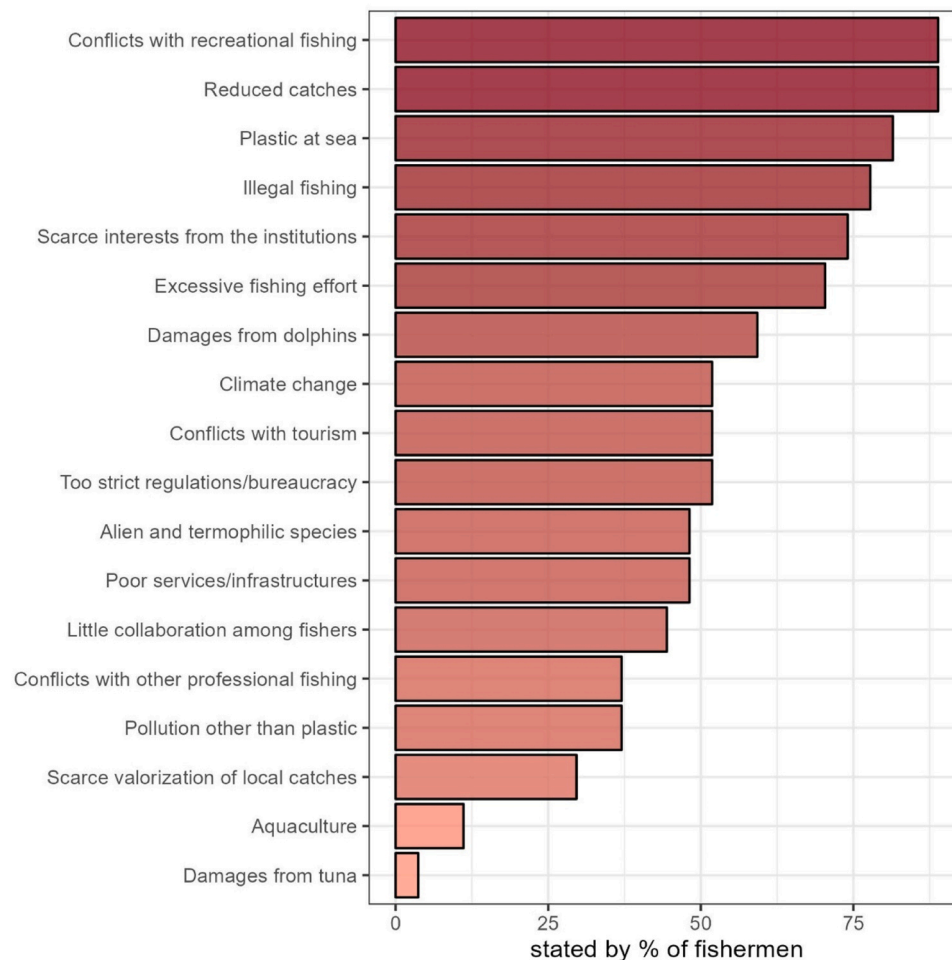


Fig. 8. Main threats affecting the performance of artisanal fishery in the Tuscan Archipelago, aggregated.

strengthening and potentially diversifying fishers' income in the Archipelago represents a social issue that goes beyond the value of the landed seafood. This is a common condition in the Mediterranean where, despite adding up to "only" 28% of total fishing revenues, artisanal vessels account for 82% of the total fishing fleet. In Italy, the artisanal sector accounts for 25% of total revenues, 65% of total fleet and 50% of total employment (FAO 2022). Hence, as argued by other authors (e.g. Guyader et al., 2013), artisanal fisheries are of striking socio-economic relevance, and efforts should be made to protect artisanal workers and the associated households depending on them.

4.2. Fishing gear and seasonality

Artisanal fisheries in the Tuscan Archipelago are polyvalent – that is, they use multiple types of gear between seasons, but also between trips. Each fisher follows a unique strategy in terms of gear usage. This encompasses mesh size for set nets, net or line length, hook size for long-liners, depth of gear deployment, soak time, target species and others, which in fact prevents profiling each *metier*, as each fishing activity is a unique combination of the above-mentioned parameters. As a consequence, the interchange of both gear and target species is very high. A strong heterogeneity was also observed among the characteristics of the same gear among different fishers (e.g. for nets: mesh size, net length, net height, depth of deployment and soak time), which highlights the presence of a multi-gear, multi-specific fishery in which each fisher truly represents a *unicum*. In this scenario, a management system based on fishing quotas would likely fail to reach a bioeconomic optimum due to the presence of choke species whose quota reach would prevent the

exploitation of the remaining resources (Prellezo et al., 2018; Hatcher, 2022). Such failure would be exacerbated by the negative effects of the EU discard ban for artisanal fisheries, whose vessels were included in the ban although the discard problem in the EU is mostly related to medium-to large-scale multi-species bottom trawling (Veiga et al., 2016). Rather, a management system based on effort limitations should be pursued, and limiting access to fishing grounds exclusively to authorized vessels represents an example of such a system, commonly referred to as "territorial use rights for fisheries" (TURFs) (Wilen et al., 2012).

In the Tuscan Archipelago, some types of gear, such as the trammel net and longline, are used throughout the year, because they ensure an adequate and rather constant catch level and hence a continuous flow of remuneration. Trammel nets include both normal and large trammel nets, the latter mainly targeting European lobster. The use of this gear peaks starting in May, when lobster fishing is opened (Fig. 3) and early fishing days generally ensure high catch per unit of efforts as well as revenues deriving from the sale of the product. "Discontinuous" gear is also used in the region. Rather than by economic choice, their employment is dictated by legal dispositions, one of the clearest examples being the transparent goby (*Aphia minuta*) boat seine fishery, allowed in GSA 9 only between 1 November and 31 March, with each boat only allowed a maximum of 60 fishing days in this time interval.

Fishing activity in the Tuscan Archipelago is very seasonal. Despite the presence of a strong marine- and coastal-related tourism season in the summer, during which time the authorities prohibit coastal fishing between 8 a.m. and 8 p.m., effort peaks during the same period, especially for trammel nets and fishing pots. Although some fishers have called for a lifting or partial modification of this regulation, the presence

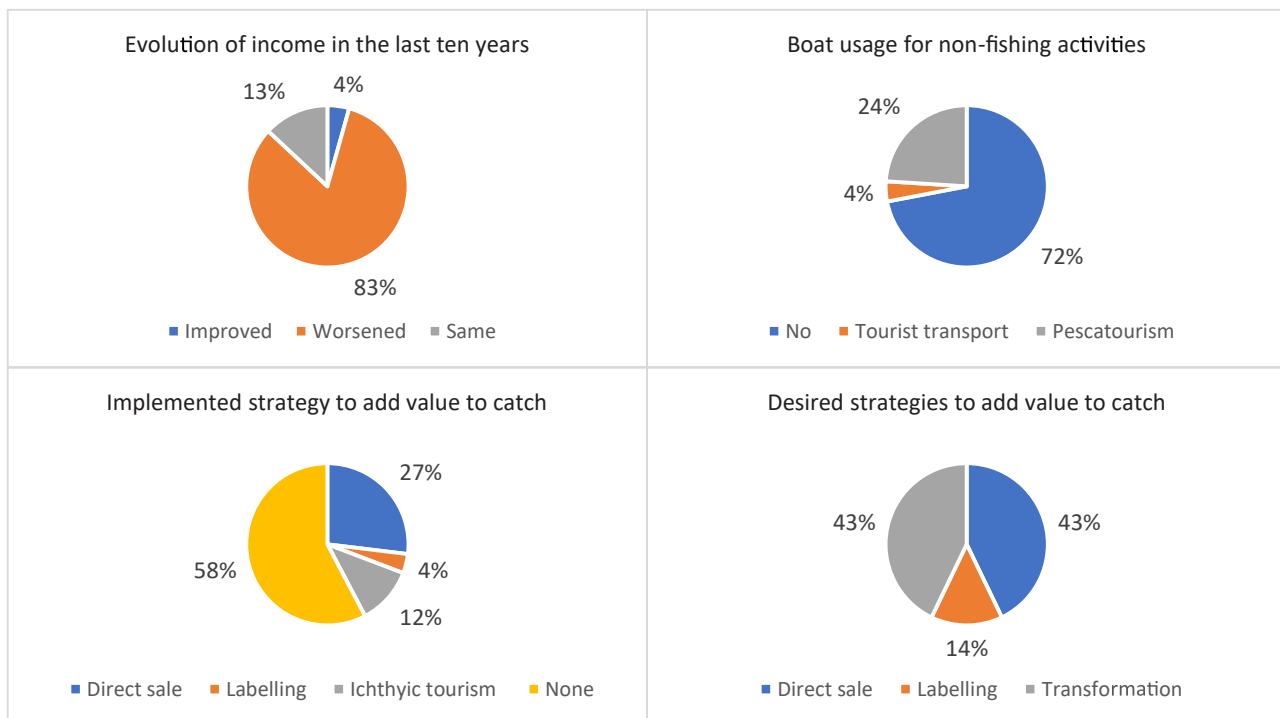


Fig. 9. Evolution of fisheries income and non-fishing activities, as well as implemented and desired strategies for adding value to the catch in Tuscan Archipelago's artisanal fisheries.

of a high number of visitors generates more income for fishers, who sell their catch directly to tourists on the quay or indirectly through restaurants and fishmongers. This underlines the strong connection and both positive and negative exchanges arising between the fishing and tourism sector.

Local fisheries are generally miscellaneous, so that discard rates are very low. Fish unfit for sale (undesired species, undersized or physically damaged individuals) is often retained for self-consumption by the fisher. Fishing efforts are reduced in the winter, reaching a minimum in January, the month fishers generally use for renovating and doing boat maintenance, taking advantage of poor weather conditions. Overall fishing effort (Fig. 3) is mostly influenced by the use of trammel nets, pots and set longlines, because these are the fishing gear most used by local fishers.

4.3. Alien species and "poor" local catch

In the Archipelago, *Tetraontidae* were first fished around Elba in 2010. Atlantic blue crab (*Callinectes sapidus*) is very abundant in the region, with one fisher stating that boats from the peninsula (port of Follonica) catch as much as 70 kg/boat/day. Another Elban fisher argued that this is the first year in which Atlantic blue crab has been fished in Elban waters. No catches were declared in Capraia or Giglio, and only one fisher in Porto Santo Stefano mentioned the species. The presence of Argentine red shrimp (likely, *Pleoticus muelleri*) was noted by several Porto Santo Stefano fishers, but not elsewhere. Parrotfish (*Sparisoma cretense*) was mentioned by one fisher in Elba (first caught in 2021) and one in Capraia (increasing abundance), but not elsewhere. Grey triggerfish (*Balistes capriscus*) have been spotted in Elba and Porto Santo Stefano. In the former island, they are said to have appeared 10 years ago and are increasing in abundance. Yellowmouth barracuda (*Sphyrna viridensis*) have been caught in Elba, Porto Santo Stefano and Giglio for 10 years, reaching an ex-vessel market price of 6–7 €/kg. Bluefish (*Pomatomus saltatrix*) has been caught in the last 10 years in Elba and 6–7 years in Porto Santo Stefano, although in small quantities. Its ex-vessel market price oscillates between 8 and 15 €/kg. One fisher in

Porto Santo Stefano noted the presence of a *Carangidae* thermophilic fish species, without adding further information. Finally, a so-called glass fish or king fish was caught only once in Porto Ercole, 10 years ago, and therefore can be regarded as an isolated incident.

This survey leveraged fishers' local ecological knowledge (LEK) to gather information about the presence of alien and thermophilic species in the waters of the Tuscan Archipelago. LEK contributes to building a sense of ownership and representation, as well as offering local communities the opportunity to share their knowledge in the early stages of the environmental resource planning process (White et al., 2002; Schafer and Reis, 2008). LEK not only has the potential to take into account long-term trends in the fisheries (McClean et al., 2020), but, in the context of artisanal fisheries, it can also improve fishers' position and involvement in resource management (Bender et al., 2014; Lima et al., 2017; Berkström et al., 2019). In addition to providing data on invasive species, the results of fishers' sightings reported in this paper can add to the knowledge of the distribution of alien and thermophilic species in the Tuscan Archipelago as well as allowing comparison with other studies in the Mediterranean region. Several species (both local and alien) have been caught in high quantities from local fishers but are not given adequate value by the market, despite being a valid option from the nutritional point of view. Some of them are caught in the winter (e.g. European conger or picarel [*Spicara smaris*]), while others are caught in the summer (e.g. flathead grey mullet). The low tourism season exacerbates the scarce interest from fishers regarding these species, given the reduced demand due to virtually non-existent arrivals of sea-based visitors. Therefore, "poor" fish-tailored initiatives should be put in place to increase the value as well as extend the shelf life of these species, stimulating the interest of consumers while at the same time relieving the pressure on heavily fished stocks of "popular" local species and limiting the diffusion of alien ones. However, this study revealed that the application of such strategies is very limited in the Tuscan Archipelago overall and totally absent in some specific locations. This has, however, proved to be a valid strategy in other artisanal fisheries within MPAs, such as the WWF-led transformation project for picarel in Porto Cesareo, which turned an "undesired" small and bony fish into

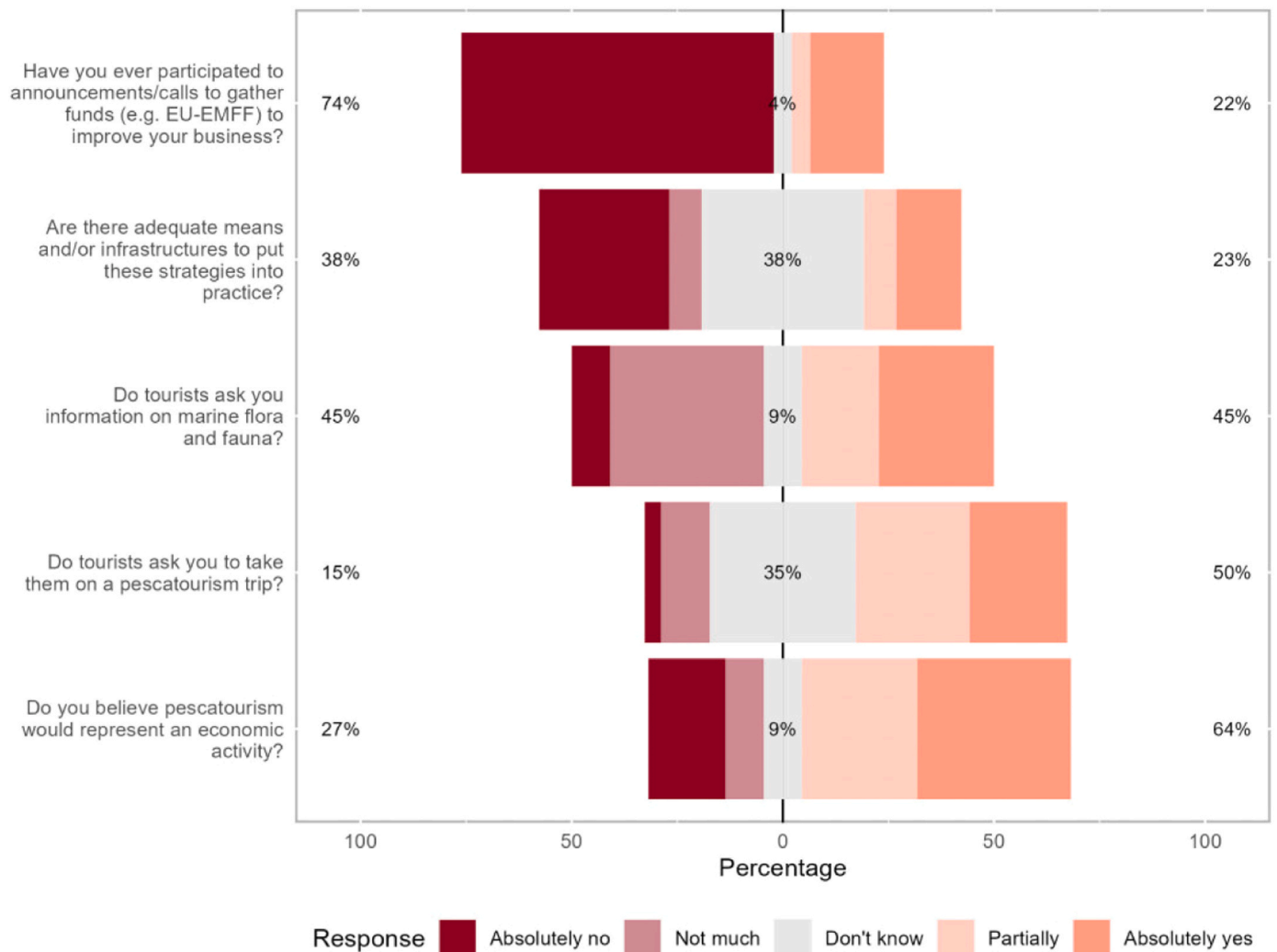


Fig. 10. Fishers' perception of business opportunities in the Tuscan Archipelago, expressed in a Likert-scale from 1 (absolutely no) to 5 (absolutely yes).

consumer-friendly meatballs, burgers and ravioli (WWF 2022). Transformation is pivotal to making seafood more accessible, as fishers lament that changes in consumers' habits (namely, less time and passion for cooking) have now kicked once-popular species out of the market. This could represent a valid market strategy especially aimed at the commercialization of low-end, "poor" local products, which could be successful among consumers if the seafood is adequately transformed, labelled and marketed – including initiatives with the food and tourism industries (Cockerell and Jones, 2021; Di Cintio et al., 2022).

Another successful example is represented by the annual "Lionfish Derby" organized in Barbados to face the invasion of the red lionfish (*Pterois volitans*), which was first observed in the islands in 2011 (Walcott et al., 2019). Location and biological data from caught individuals were collected, and free lionfish tastings were offered to the public alongside filleting demonstrations and donations to chefs to create recipes based on the invasive species. This contributed to relieving the pressure on other commercial reef species and increased and diversified revenues for reef fishers (Vallès et al., 2023). Beyond representing a strategy to encourage the commercialization and consumption of less well-known species and integrating artisanal fishers' revenues, such activities contribute to the much-needed efforts to limit the widespread of invasive species in the environment, thus preserving biodiversity. In any event, avoiding undesired, environmental-unfriendly peaks accompanied by long periods of isolation of marine and coastal communities is pivotal to extending the ecotourism season, especially when

the seafood shelf life cannot be prolonged. Investing in ecotourism promotion could generate advantages such as creating income, improving the standard of living for the local community, reducing the winter isolation of the islands, rehabilitating impacted areas and increasing MPA income (Agius and Briguglio, 2021).

4.4. Value chain, challenges and opportunities

Direct sale is the preferred sales channel among artisanal fishers in the Tuscan Archipelago. However, contrasting views were expressed on the choice by fishers from the same fishing community (e.g. in Porto Santo Stefano some prefer the auction due to higher sale prices, while others favour shops because they offer services in exchange, such as providing ice). Subjectivity is also important in shaping fishers' decisions. By contrast, only a few fishers sell their catch to seafood shops, due to the relatively inconvenient conditions dictated by the low bargaining power expressed in the low prices paid to fishers for their catch. This is coherent with what is experienced in other value chain dynamics within artisanal fisheries at a global level (Bjørndal et al., 2015; Purcell et al., 2017; Rosales et al., 2017; Di Cintio et al., 2022). In fact, the commercial power of artisanal fishers is closely related to their ability to defend their own market interests by acting as a category of business-people rather than individualist units (Bavinck et al., 2005; Kalikoski and Franz, 2014). Yet, Tuscan Archipelago fishers held opposing visions on the topic, with only some of them recognizing the need to tighten the

collaboration within the sector. In general terms, very few activities are currently implemented for adding value to local seafood products and diversifying/integrating fishing revenues. Unfortunately, this is a common feature of European artisanal fisheries, in which livelihoods are significantly corroded by the inability to adequately valorize their high-quality catch (Pascual-Fernández et al., 2019). Only 8% of fishers practise pescaturism, while none of them engages directly or indirectly in transformation. Again, 43% of the fishers identified transformation as the best strategy to increase value. Efforts should therefore be made to solve the dichotomy between the desire expressed by fishers to engage in seafood transformation and the total absence of its implementation. Both the processing and direct marketing of seafood are seen as pivotal strategies for relaunching European artisanal fisheries, as dictated in art. 68 of the EU European Maritime and Fisheries Fund (EMFF) (EU, 2014). The importance of promoting processing and marketing of seafood was further remarked in the EMFAF 2021–2027 Regulation (EU, 2021). Additionally, nearly a quarter (23%) of fishers believe the current market/infrastructural conditions are sufficient for establishing value chain-improvement strategies, but engagement in such strategies is lacking. Likewise, although 38% of fishers believe market/infrastructural conditions need to be improved, the majority (75%) have not participated in announcements/calls to change the situation, and those who did never won access to funds. The reasons for these discrepancies need to be investigated and properly dealt with: on the one hand, some fishers are unhappy with the *status quo* but are not attempting to change it; on the other hand, some fishers are indeed trying to improve their business conditions, but without success.

In any event, the survey revealed an aspect that deserves the outmost attention – that is, a marked lack of knowledge and interest from fishers in the Tuscan Archipelago about the functioning of EMFAF funds for artisanal fisheries. This is coherent with what has been experienced in other Italian case studies (Cavallé et al., 2020). As mentioned above, the value chain and marketing of local catches could be improved through labelling. Success stories from Italian artisanal fisheries include the Slow food Presidium of the Portonovo Mosciolo Selvatico (i.e. Mediterranean mussel *Mytilus galloprovincialis*) in 2004 (GSA 17) or the miscellaneous fishery in the MPA of Torre Guaceto (GSA 18). In the former case study, the cooperative was able to increase the value of the catch and access both national and international markets through certification, so much so that the price of Mosciolo Selvatico is nearly twice as high as that of the Mediterranean mussel that is farmed in the same region (Casagrande et al., 2021). In addition, the Marine Stewardship Council, which is the most widespread and recognized seafood label globally, implemented a programme specifically designated for small-scale fisheries, constituting an additional, supra-national pathway of ecolabelling (Rocliffe, 2019).

Conflict with recreational fishers and reduced catches are perceived as the main threats by local fishers. Clashes between recreational and professional fishers are common both in the EU, where most MPAs are multiple use MPAs entailing the co-existence of different users (Mangi et al., 2022), and also in the Mediterranean, encompassing shared fishing grounds, unregulated or illegal fishing activities, unauthorized fishing and sales under the counter (Colella et al., 2010; Papadopoulos et al., 2022; Frid et al., 2023). This stress condition is exacerbated by the fact that the impacts of recreational fishing activities are, if considered at all, often underestimated, which makes it difficult to assess the real effects that such activities have on the marine environment as well as on the relationship with the professional fishing sector (Garibaldi, 2012; Pauly and Zeller, 2016; Karachle et al., 2020). The reduction of catches lamented at the local level is coherent with both Mediterranean and Italian data (FAO 2022). The reduction in wild-capture fishery landings is also a common condition among most developed countries: from 1987 to 2007, catches from OECD fishing countries fell by about 2% per year on average, while catches from non-OECD fishing countries in the same time interval rose annually by about 2%, even in the presence of less efficient fishing technology (Flaaten 2016). If one considers that catches from Mediterranean and Black Sea wild-capture fisheries dropped by

29.7% between 2007 and 2020 (FAO 2023), one can further understand the threat to which the survival of local fisheries is exposed. Overfishing is one of the root causes of Mediterranean resource depletion (FAO 2022), with climate change (Hidalgo et al., 2018) magnifying its effect. Yet, artisanal fishers from the Tuscan Archipelago showed ambiguous perceptions about the problem⁴: while 81% of Elban fishers recognized it as one of the main threats to fishing, percentages decreased to 50% in Porto Santo Stefano, 33% in Giglio and 0% in Capraia and Porto Ercole (the latter, however, is based on a single observation). Likewise, feelings about the co-existence with the tourism sector vary with the surveyed site, with only a few fishers in Capraia and Elba seeing it as a threat, while 100% of Porto Santo Stefano fishers did so (see Fig. 1 SM in Supplementary Material). However, almost every fisher (96%) across all sites had been asked by tourists to take them on a trip, although nearly none of them had done so (4%). Additionally, although a good 24% of respondents affirmed that they practised pescaturism, almost all of them had only engaged in the activity a very few times, mostly to take friends or relatives on board. The high potential that this business has as a revenue-generating and ecosystem-protecting activity for artisanal fisheries (Lai et al., 2016; Piasecki et al., 2016; Kyvelou and Ierapetritis, 2020) has not been exploited. This is somewhat surprising when one considers that 65% of respondents identified pescaturism as a valid option to compensate, at least partially, for revenues from fishing activities. According to fishers, the answers for this discrepancy does not lie in a lack of initiative, but rather in the bureaucratic burden that hampers the profitability of the activity. Examples include the long waiting time for licenses and permits (not only to begin pescaturism, but also, for example, to change the boat's engine), the limit to the number of passengers allowed on board, the inability to participate in calls due to legal cavils linked to the supposedly illegal mooring site of the fishing vessel (in Elba) or the impossibility to disposing of worn-out nets (some fishers from the Archipelago send these to Slovenia for recycling). Other obstacles mentioned by fishers included the short tourist season, small boats preventing the boarding of a sufficient number of passengers and the lack of beaches hampering tourist uptake (Capraia). The practice of pescaturism should be encouraged by lightening the administrative burden for fishers and by promoting this activity among tourists. This would make pescaturism a valid option to diversify and increase fishers' revenues, make the activity profitable for those practising it, while at the same time contributing to overcome the reluctance of those not yet engaged.

In parallel, training courses on livelihood diversification could play an important role in re-shaping the entrepreneurial mindset of fishers. One example is represented by the EMFF-funded seminars offered by the region of Campania (Italy) to fishers and other fishery stakeholders on “Pescaturism and ichthyic tourism: sustainability, innovation, management and valorization”. Other topics include seafood online trade, innovative tourism, valorization of local production chains or labelling and traceability of seafood products (Regione Campania, 2023). Support from local authorities would also be pivotal, not only from a legal and administrative perspective (i.e. reducing bureaucracy) but also from a financial and operational one. Concerning the first aspect, the EMFF-funded call of the fishing local action group (FLAG) in Alto Salento (Apulia, Italy) is an example, which offered €80,000 to either individual fishers or cooperatives to diversify fishing activity and integrate it with the opportunities offered by the blue economy, including pescaturism (GAL Alto Salento, 2023). Positive examples of operational support offered to fishers include that experienced in Porto Santo Stefano, where the local administration provided artisanal fishers' a quay with columns supplying electricity, which are activated by each

⁴ Surveyed effects include factors such as: changes in species composition, changes in water temperature, modification of weather patterns, presence of extreme weather events, and how all these aspects impact the length and distribution of the fishing season.

fisher through a pre-paid card. A variety of instruments encompassing the educational, financial and operational spheres have thus been made available in recent years to assist fishers in the transition towards a more integrated and holistic approach to the diversification of their revenue sources. Such examples could contribute to the diffusion of the practice in the Tuscan Archipelago, in line with what has occurred elsewhere in Italy, where pescaturism is showing some encouraging signs of growth (Romanelli and Meliadó, 2021). Besides Giglio, illegal fishing was perceived as a threat by the majority of fishers across all sites. This perception peaks in Porto Santo Stefano (88% of respondents), where artisanal fishers lament episodes of non-resident purse seiners fishing too close to shore (i.e., not respecting the minimum distance of 3 n. m./50 mt isobath from the coast), trawlers using blind codend mesh and the presence of a local fleet targeting common octopus (*Octopus vulgaris*) with jars, exceeding, by different orders of magnitude, the legal limit of 250 jars per boat. The validity of these complaints was confirmed by the fact that, following the perpetuation of illegal activities, in September 2022 the authorities seized 7500 jars in a coordinated action with the Sea Shepherd Conservation Society (La Nazione, 2022).

5. Conclusion

This paper has offered a snapshot of the artisanal fisheries of the Tuscan Archipelago, highlighting the main characteristics of the fleet and fishing activities. It also shed light on the main issues affecting the fisheries both at sea and on land, as well fishers' perception of the main conflicts, challenges and opportunities of the sector. This information is offered to remedy the lack of socio-economic information on artisanal fisheries both in the Mediterranean and Italy. Moreover, our study provides an example for communication flow between the academic and fishing communities aimed at mutual understanding and learning. The results revealed a local artisanal fishing sector facing significant challenges, mostly related to catch reduction, the presence of illegal fishing and difficult coexistence with the recreational sector, one that fails to adequately valorize local catches. The general feeling, however, is that despite a long road ahead to provide a future for this vital sector from the social, cultural and economic points of view, different solutions are already available but lack strategies for application. Proactively engaging the local community in these solutions and pushing for a removal of the obstacles preventing their application will be pivotal, if a sustainable exploitation and adequate valorization of local marine resources and associated livelihoods is sought. To strengthen the results of the analysis and further validate its statistical results, future research could address the limits of the present study related to the size of the sample and the number of variables considered. This could be done by increasing the number of interviewed individuals and enlarging the analysis to include variables such as production costs and revenue by species. These analyses should be accompanied by in situ projects for the practical promotion of specific strategies to enhance fishers' livelihoods.

CRedit authorship contribution statement

Due to the sensitive nature of the questions asked in this study, survey respondents were assured raw data would remain confidential and would not be shared. Data not available / The data that has been used is confidential.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.rsma.2023.103275.

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