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# Small-scale fishers' perceptions to inform the design and implementation of a newly established Mediterranean marine reserve

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ABSTRACT

Marine Reserves (MRs) play a central role in international and regional biodiversity strategies, such as the EU Biodiversity Strategy for 2030. The Marine Protected Area (MPA) of "Cape Stupišće" (Croatia, Adriatic Sea), designated in 2025 as a Special Marine Reserve (SMR), aims to conserve marine biodiversity while supporting the recovery of exploited fish stocks. However, the effectiveness of strict marine protection largely depends on local stakeholder support, particularly from small-scale fishers who are directly affected by fishing restrictions. We assess small-scale fishers' attitudes toward the design of this SMR and its forthcoming implementation, and examine their perceptions of its anticipated ecological and socioeconomic outcomes. Specifically, we investigate whether support for strict marine protection is linked to stakeholder participation in the consultation process and sociodemographic characteristics. Twenty face-to-face interviews were conducted with fishers at Komiža harbor between September and October 2025, representing approximately 40% of the active fishing population in the SMR's vicinity. We found that participation in the consultation process was not associated with significant differences in fishers' perceptions of the potential ecological or socioeconomic outcomes of the SMR. However, participation was positively associated with fishers' willingness to engage in future consultation processes, suggesting that early involvement may facilitate stakeholder engagement during the implementation phase. Fishers also identified several conditions likely to influence the future effective implementation of the Cape Stupišće SMR, including the importance of adequate size to generate ecological benefits, stronger enforcement to address illegal fishing and competing uses (e.g., recreational fishing), and greater integration of fishers' local ecological knowledge into management processes. Overall, our results highlight the heterogeneity of small-scale fishers' perceptions and emphasizes the importance of participatory governance for strengthening social acceptance, compliance, and long-term effectiveness of strict marine protection in data-poor Mediterranean contexts while providing insights to inform the design and implementation of MRs in similar small-scale fisheries systems.

## 1. Introduction

Globally, accelerating biodiversity loss in marine ecosystems has prompted increasingly ambitious conservation commitments. The Kunming-Montreal Global Biodiversity Framework, established a target of protecting 30% of the world's oceans by 2030 [1]. Despite this high-level political ambition, implementation remains limited. As of February 2026, only approximately 9.6% of the global ocean had been designated as protected, and only 3.2% qualified as strictly protected (i.e., fully or highly protected according to *The MPA Guide* classification) [2]. *The MPA Guide* provides a qualitative framework for classifying levels of protection [3], with these strictly protected areas hereafter

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termed Marine Reserves (MRs). This discrepancy illustrates the gap between political ambition and effective marine protection [4–7].

Within this global policy landscape, the European Union (EU) has articulated objectives through the EU Biodiversity Strategy for 2030, which aims to protect at least 30% of EU waters, including 10% designated as MRs [8]. Yet EU marine ecosystems continue to experience pressures [9]. The European Environment Agency estimates that approximately 93% of EU marine waters are exposed to multiple stressors, including pollution, habitat degradation, overfishing, and intensive tourism [10,11]. Marine Protected Areas (MPAs) constitute a central instrument for achieving these objectives, however, most existing EU MPAs are only partially protected [12,13]. As of 2017, 59% of MPAs in EU waters were fished by destructive bottom trawling [14]. Moreover, only 2.04% of EU marine waters are currently covered by MPAs with operational management plans [15], highlighting the prevalence of so-called "paper parks" [16].

These challenges are also evident at the national scale. In Croatia, marine and coastal protected areas have progressively been incorporated into marine governance frameworks, with 19 coastal MPAs designated by 2022 [17]. Nevertheless, their effectiveness varies considerably, largely as a function of management quality, enforcement capacity, and stakeholder involvement [6,17,18]. Consequently, MPAs in Croatia, as elsewhere in the Mediterranean Sea, exhibit substantial heterogeneity in size, protection level, governance arrangements, and management objectives, highlighting the context-dependent nature of conservation outcomes [19].

Although MPAs are primarily designed to conserve marine biodiversity, they also generate significant social impacts for coastal communities [20–23]. Fishers, particularly small-scale fishers, are among the stakeholder groups most directly affected by the establishment of MRs where extractive activities are prohibited [21,24,25]. As a result, the long-term effectiveness of MRs depends not only on their legal designation and management architecture, but also on their social legitimacy, reflected in the perceptions, acceptance, and support of local stakeholders, particularly small-scale fishers, who are often among the most socioeconomically vulnerable coastal groups [22,26].

Despite strong EU-level commitments to expand MRs in line with the 10% strict protection objective of the EU Biodiversity Strategy for 2030, a growing body of literature indicates that social acceptance [22,26–29], perceived fairness [23,30,31], and local compliance [32,33] represent critical constraints on the success of marine conservation policies and MPA performance. These challenges are particularly pronounced in the Mediterranean Sea, one of the world's most contested social-ecological systems [34], where small-scale fishers play a central role in both the establishment and co-management of MPAs that include no-fishing zones [35–37].

Previous research has emphasized that fostering support from local communities and fishers may be more consequential for conservation outcomes than the design of theoretically optimal MPA networks [38]. An MPA that exists primarily as a regulatory designation differs fundamentally from one that is actively supported, managed, and governed by engaged local stakeholders [39–41]. Nevertheless, empirical research on the human dimensions of MPAs (e.g., participatory governance, social acceptance, and compliance), including MRs, remains limited relative to ecological assessments [29,42]. This imbalance risks undermining both stakeholder legitimacy and the long-term management effectiveness of MPAs [43,44].

At the same time, emerging literature demonstrates that fishers' Local Ecological Knowledge (LEK) and their perceptions can complement ecological data by providing fine-scale, long-term, and context-specific insights into marine conservation planning and coastal fisheries management [45–49]. In this regard, fishers' LEK and perceptions may serve as indicators for evaluating socioeconomic benefits relative to ecological costs (i.e., fisheries closures) associated with MRs [21,50], as well as proxies for assessing effective implementation. Such approaches are particularly relevant in data-poor contexts [45,51], of which the Adriatic Sea is one example, having been identified as a data gap in marine conservation research [15], MPA monitoring, and management capacity [19]. This highlights the need for cost-effective methods that better reflect national and local realities, including the distinctions between "designated" and "effectively implemented" MPAs.

While there is growing recognition of the importance of participatory governance and ongoing consultation with small-scale fishers [24,36,52], robust empirical evidence remains scarce regarding how small-scale fishers perceive the social-ecological outcomes of MRs and how these perceptions are shaped through consultation processes. Moreover, the mechanisms through which fishers' involvement influences the design and implementation of MRs remain insufficiently understood. This knowledge gap constrains the development of governance strategies capable of securing community buy-in, reducing conflict, and ensuring that MRs deliver both ecological and social benefits.

To address this gap, this study examines the perceptions of small-scale fishers as key stakeholders in the Special Marine Reserve (SMR) of "Cape Stupišće", declared in 2025 near the fishing town of Komiža on the Island of Vis, Croatia (Fig. 1). Focusing on fishers' perceptions of the SMR's anticipated social-ecological outcomes, their experiences with the consultation process, and their perspectives on conditions necessary for effective implementation, this study examines how participation in the consultation process, together with sociodemographic characteristics, affects small-scale fishers' engagement and support for the design of a newly designated SMR and its future implementation.

## 2. Material and methods

### 2.1. Study area

This study was conducted in the fishing harbor of Komiža, located in the central Adriatic Sea on the western coast of Vis Island, within the municipality of Komiža, Split-Dalmatia, Croatia (Fig. 1). For centuries, Komiža's fishers specialized in catching small pelagic fish, notably sardine (*Sardina pilchardus*), European anchovy (*Engraulis encrasicolus*), and Atlantic mackerel (*Scomber scombrus*), which were traditionally salted in large wooden barrels for export. Nowadays, nearly all commercial fishers in this harbor belong to the small-scale coastal fishing segment, and no trawlers operate [53]. In 2023, Komiža harbor had 60 licensed boats (59 small-scale), using mainly passive fishing gears such as nets, longlines, and traps [53]. In 2024, a process to establish the first SMR in the Split-Dalmatia Country was launched. After several consultation meetings with stakeholders, in April 2025 the SMR was declared by the Government of the Republic of Croatia under the Decree (Decree KLASA: 352–02/23–03/2 URBROJ: 517–10–2–1–24). The designated SMR (Fig. 1) covers 109.7 ha, of which approximately ~102.8 ha (93.7%) are marine waters and 6.9 ha (6.3%) terrestrial coastal habitats.

The SMR protection aims to preserve diverse coastal and benthic ecosystems, including *Posidonia oceanica* meadows and red coral (*Corallium rubrum*) of the Vis Archipelago as the primary objective [54]. *Posidonia oceanica* is listed under Annex II of the Protocol concerning Specially Protected Areas and Biological Diversity of the Barcelona Convention, while *Corallium rubrum* appears in Annex III regulating its exploitation [55]. In addition, as a secondary objective, the protection aims to enable fish stock restoration [54]. Fishers' expectations regarding the newly designated SMR are also shaped by their experience with the Fisheries Restricted Area (FRA) of Jabučke kotline, located in the central Adriatic Sea (GSA 17, see Fig. 1). Established in 2017 and later reinforced under GFCM Recommendation REC.GFCM/44/2021/2, the FRA covers approximately 314,000 ha and was created to protect essential fish habitats, including spawning and nursery grounds for demersal species such as European hake (*Merluccius merluccius*) and Norway lobster (*Nephrops norvegicus*), as well as small pelagic species such as anchovy and sardine [56]. The Jabučke kotline area is considered one of the most productive fishing grounds in the Adriatic and has long been recognized as ecologically important, containing

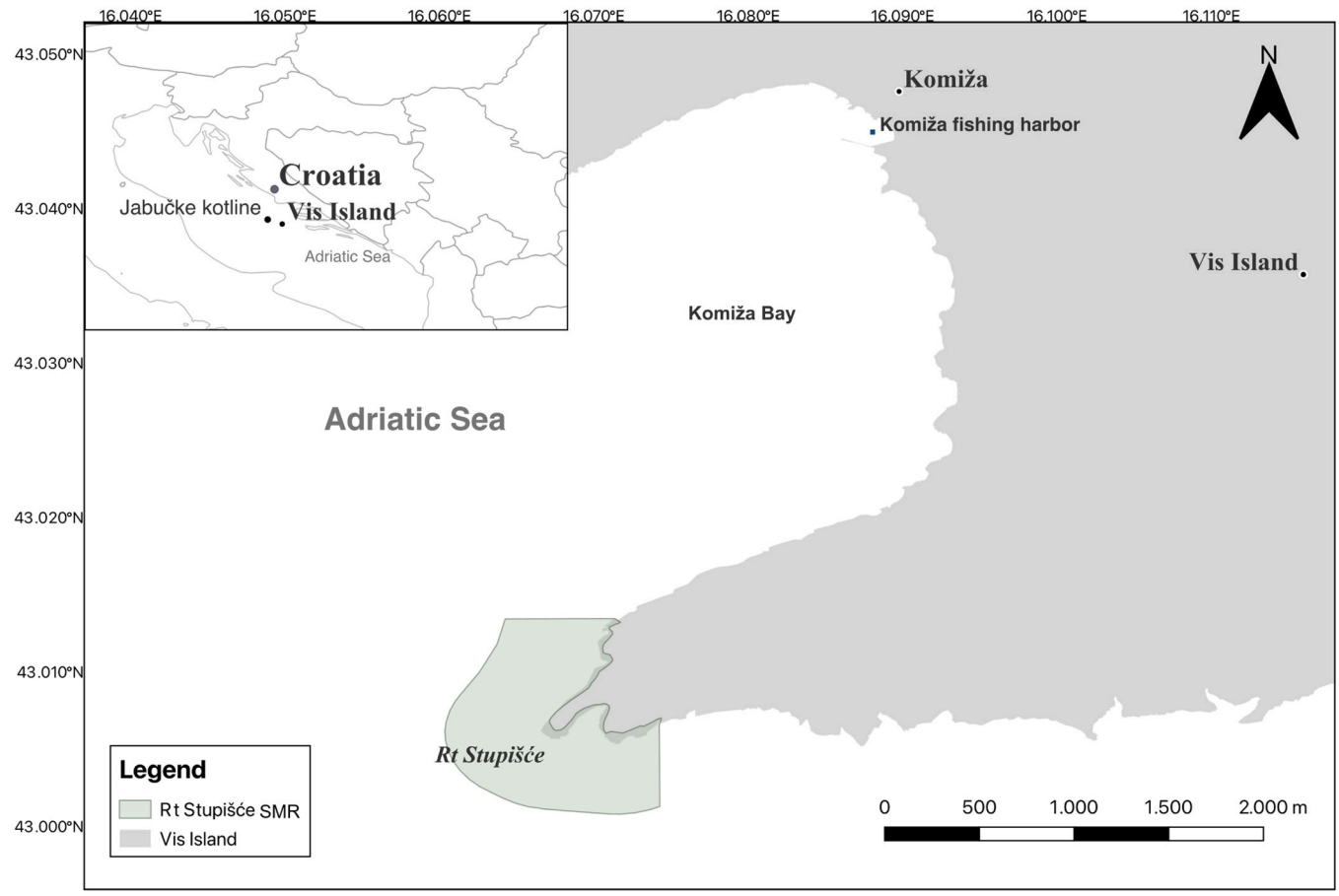



**Fig. 1.** Map showing the location of the newly designated Special Marine Reserve of "Cape Stupišće" in Vis Island (Croatia, Adriatic Sea).

approximately 23% of the biomass of commercially important species in the northern and central Adriatic [57]. Because many fishers from Komiža are familiar with this regional management measure and commonly refer to it as a positive example of fisheries recovery and spillover effects, it provides an important reference point for understanding local perceptions of the expected outcomes of the newly established SMR.

Beyond fishing activities, the area is also exposed to seasonal maritime traffic and tourism-related uses. Komiža Bay serves as an important local maritime hub, with public transport connections to the mainland and several mooring areas used by local vessels, recreational boats, and excursion traffic. Maritime activity intensifies during the summer months, when excursion boats frequently visit nearby attractions such as Biševo Island, the Blue Cave, and Stiniva Cove [58]. The waters surrounding Cape Stupišće are also regularly used for recreational diving. Several diving centers operate in Komiža, and nearby dive sites are valued for their coralligenous habitats, fish assemblages, underwater geomorphology, and the shipwreck of Vassilios T.

### 2.2. Questionnaire design and data collection

We conducted a survey to capture small-scale fishers' perceptions and attitudes toward the newly designated SMR in Komiža in order to inform and improve the SMR's design, governance, and community engagement. Twenty face-to-face interviews were conducted between September and October 2025 and lasted 40–60 min, depending on the local knowledge of fishing and marine conservation expressed by each fisher. Interviews were conducted using a questionnaire comprising four components: (i) attitudes toward the SMR design and perspectives on management and governance; (ii) perceived potential ecological and socioeconomic outcomes; (iii) fishing activity characteristics; and (iv) sociodemographic information. The questionnaire included Likert-scale, multiple choice, and open-ended questions (Supplementary material; Table S4).

To foster community engagement, informal discussions were conducted one day before fieldwork with the mayor of Komiža, a representative of the Vis Archipelago UNESCO Global Geopark, and a representative of the Fisheries Local Action Group (FLAG). The FLAG representative facilitated initial contact with fishers by providing the contact details of five fishers, who were subsequently invited to participate in the interviews. Most interviews took place in a café at the fishing harbor, at times chosen by respondents during their days off. All interviews were conducted by the same co-author to enhance trust and data reliability [59]. Interviews were conducted individually and held in Croatian, the participants' native language. The questionnaire was prepared in English, and responses were documented in English. A Croatian version was available for participants to verify questions. Statements provided in Croatian were translated into English during or immediately after the interviews. With participants' consent, some interviews were audio-recorded solely to verify responses and ensure consistency during data processing. Access to these recordings was restricted to the co-author conducting the interviews, and all recordings were permanently deleted after the responses had been checked and validated. The sample included fishers who participated ($n = 9$) and fishers who did not participate ($n = 11$) in the consultation process establishing the SMR. This distinction formed a key analytical comparison between participants and non-participants and represents a subsample of the approximately 50 active small-scale fishers in Komiža harbor (information provided by the FLAG representative and confirmed by the interviewees).

In human dimensions research, the depth and meaning of stakeholder discourse are often more important than frequencies [60]. Interviewees were selected using purposive, opportunistic, and snowball sampling techniques [61,62], starting with fishers suggested by the FLAG representative and expanding to other fishers recommended by initial participants. All participants provided consent to use their knowledge for research purposes and were informed that the study was conducted anonymously.

### 2.3. Data analysis

All analyses were conducted using R version 4.5.2 [63]. R packages included *dplyr* and *tidyr* for data manipulation, *likert* for Likert-scale analysis, and *ggplot2* for visualization. Given the small, non-probability sample and the exploratory nature of the study, statistical analyses were used to examine patterns and differences within the interviewed sample rather than to make population-level inferences. Fisher's exact test was used for categorical comparisons, while the Mann-Whitney *U* test was used to compare Likert-scale responses between groups.

Fishers were categorized into two groups: participants and non-participants in the consultation process. Mann-Whitney U tests were used to explore differences in Likert-scale scores across sociodemographic attributes (age: $<50$ vs. $\geq 50$ years and fishing experience: $\leq 20$ vs. $>20$ years) and consultation participation [64,65]. Associations between categorical variables were examined using Fisher's exact tests and Mann-Whitney U tests, depending on the nature of the variables. These included whether participation was associated with (i) willingness to attend future consultation meetings and (ii) support for a co-management arrangement between fishers and the "More i krš" administration.

Perceptions of potential ecological and socioeconomic outcomes were assessed using Likert-scale items (1 = very negative, 5 = very positive; 6 = "I don't know"). Items were aggregated into ecological and socioeconomic indices by calculating mean scores for each fisher. Differences between groups were evaluated using Mann-Whitney U tests. Internal consistency of aggregated scales was checked using ordinal Cronbach's alpha, while "I don't know" responses were treated as missing values. Non-parametric tests were used because the data did not meet parametric assumptions. The significance level was $\alpha = 0.05$.

Given the exploratory nature of the analysis, the relatively small sample size, and the number of statistical comparisons performed, quantitative results should be interpreted cautiously.

Qualitative data were obtained from the open-ended questions included in the questionnaire. Responses were documented during the face-to-face interviews and subsequently reviewed and grouped into recurring themes reflecting fishers' perceptions of the SMR, including expected ecological and fisheries outcomes, governance and management, and competing uses and enforcement. Thematic grouping was conducted manually by reviewing responses across participants and identifying recurrent topics and perspectives. These qualitative findings were synthesized descriptively and used to contextualize and interpret patterns observed in the quantitative results. Selected themes and illustrative responses are presented in the Results section to highlight recurring perceptions and concerns expressed by fishers.

## 3. Results

### 3.1. Sociodemographic background of the survey participants

A total of twenty face-to-face interviews with small-scale fishers were conducted. All respondents were Croatian males, 75% were married and the vast majority (90%) resided in Komiža (Table S1). Respondents were predominantly middle-aged to older, with most fishers (75%) aged 40 years or older. Households were often composed of fewer than three (50%), three to five (40%), or more than five people (10%). Family income was mainly derived from fishing, with 65% of respondents reporting fishing as their sole source of income. Among those reporting additional income sources (n = 7), tourism (71%) and agriculture (29%) were the sources identified (Table S1). Fishing was frequently embedded within family traditions, as 65% of respondents reported other fishers in their family and 55% stated that they were teaching their children how to fish (Table S1). Education levels were generally low to moderate, with most respondents (70%) having completed high school. Fishers were predominantly highly experienced, with 70% reporting more than 20 years of fishing experience, and the majority (60%) learned to fish independently (Table S1).

### 3.2. Small-scale fishery characteristics of Komiža (Croatia, Adriatic Sea)

Fishing activities were characterized by small-scale operations, as most respondents (90%) owned vessels smaller than 12 m and often fished with at least one other fisher (55%) (Table 1). Longlines were the dominant fishing gear (55%), and fishing operations were mainly conducted at depths exceeding 100 m (75%). A strong majority of fishers (85%) perceived a long-term decline in fish landings over the last decade. Most respondents (65%) reported fishing within the area later designated as the SMR prior to its designation (50% occasionally and 15% regularly), indicating that this area formed part of their fishing grounds. The two main factors influencing the choice of fishing grounds were fish abundance (45%) and personal experience (20%) (Table 1). Participating fishers were generally highly experienced, strongly dependent on fishing income, and reported selecting fishing grounds primarily according to fish abundance.

### 3.3. SMR design and management perspectives

Awareness of the SMR was universal among respondents (Table 2). Fishers reported learning about its existence through several channels, most commonly other fishers (45%) and local authorities (25%). Attitudes toward the SMR were generally positive, with 75% expressing either firm or tentative support, while 10% reported opposition (Table 2). However, participation in the consultation process during the design and planning of the SMR was limited, with only 9 out of 20 respondents (45%) reporting participation. Despite this, 60% of fishers indicated willingness to attend future consultation meetings (Table 2). Perceived influence on decision-making was low, with 60% reporting "definitely" or "probably no influence" on final decisions (Table 2).

Future fishing behavior near the SMR was mixed, with 40% of respondents indicating that they might continue fishing near its boundaries (Table 2). Support for a co-management arrangement between the public administration "More i krš" and fishers was high (80%). For those in favor, educational activities were the most preferred co-management activity (75%), while interest in tourism opportunities (e.g., pescatourism), patrolling, or monitoring was comparatively low (Table 2).

#### 3.3.1. Attitudes toward the SMR governance and implementation

A large majority of fishers who participated in the consultation process (89%) expressed strong agreement with the existence of a SMR in Komiža (Fig. 2A), whereas only 28% of non-participating fishers were strongly supportive (Fig. 2B), a statistically significant difference (Mann-Whitney *U* test, $p < 0.05$; Table 3). One third of participating fishers perceived their opinion as having influenced decision-making (Fig. 2A). In contrast, only 9% of non-participating fishers believed their views would be taken into account, whereas 82% of non-participating fishers reported negative expectations (i.e., "definitely no" or "probably no") (Fig. 2B). A majority of participating fishers (78%) indicated that they would probably fish more frequently near the SMR in the future (Fig. 2A), differing from most non-participants (73%) who reported that they would probably or definitely not fish near the SMR (Fig. 2B). Willingness to fish near the SMR may reflect positive expectations regarding potential benefits. Thematic grouping of the open-ended

**Table 1**
Small-scale fishery characteristics of Komiža (Croatia, Adriatic Sea). Mean ± SD. HP: Horse Power. (n = 20).

| Number of licensed boats in 2023: 59. Source [53] | | | | | | | |
|---|---|---|---|---|---|---|---|
| Overall length (m) | Engine power (HP) | Boat owner (%) | | Fishers on board (%) | | | |
| (Range, mean ± S.D.) | (Range, mean ± S.D.) | Yes | No | 1 | 1–2 | 2 | 1–3 |
| 5.8–13 (9.2 ± 1.7) | 19–592 (135.8 ± 156.3) | 90 | 10 | 45 | 25 | 25 | 5 |
| Fishing depth (m) (%) | | | Fishing gear (%) | | | | |
| < 50 m | 50–100 m | > 100 m | Nets only | Longlines only | | Lines only | Nets and longlines |
| 5 | 20 | 75 | 5 | 55 | | 10 | 30 |
| In the last decade, how do you think your landings changed? (%) | | | How often did you fish inside the SMR area? (%) | | | | |
| Decreasing | Not changing | Increasing | | Never | | Occasionally | Regularly |
| 85 | 10 | 5 | | 35 | | 50 | 15 |
| What are the two main factors influencing your choice of fishing grounds? (%) | | | | | | | |
| Fish abundance | Personal experience | Weather conditions | Season | | | Suitable habitats | |
| 45 | 20 | 16 | 11 | | | 8 | |

**Table 2**
Design and management perspectives of Komiža small-scale fishers regarding the Cape Stupišće SMR. SMR: Special Marine Reserve. (n = 20).

| Fisher perceptions regarding the SMR | | | | | |
|---|---|---|---|---|---|
| SMR awareness | Yes | No | | | |
| % | 100 | 0 | | | |
| Mean of awareness | Local media | Other fishers | Social media | Local authorities | Diving center |
| % | 10 | 45 | 15 | 25 | 5 |
| Are you in favor of the existence of a marine reserve in Komiža? | Definitely no | Probably no | Not sure | Probably yes | Definitely yes |
| % | 0 | 10 | 15 | 20 | 55 |
| Participation in consultation | Yes | No | | | |
| % | 45 | 55 | | | |
| Willingness to participate | Yes | No | | | |
| % | 60 | 40 | | | |
| Do you think your opinion counted (or would count) in the final decision? | Definitely no | Probably no | Not sure | Probably yes | Definitely yes |
| % | 20 | 40 | 15 | 5 | 20 |
| In the future, will you fish more frequently near the special marine reserve? | Definitely no | Probably no | Not sure | Probably yes | Definitely yes |
| % | 25 | 25 | 10 | 40 | 0 |
| In favor of co-management | Yes | No | | | |
| % | 80 | 20 | | | |
| If in favor of co-management, in which activities would you like to participate? | Educational events | Tourism opportunities | Patrolling | Monitoring of the MR | |
| % of responses | 75 | 10 | 10 | 5 | |

responses helped contextualize these contrasting attitudes. Participating fishers often referred to expected spillover benefits and previous positive experiences with the nearby Jabučke kotline FRA. Possibly, fishers who experienced the positive effects of this FRA, were also more inclined to take part in the consultation for the new SMR. One participating fisher stated: "*Jabučke kotline is good, though; you can clearly see the spillover effect and increased landings*" (Fisher 1). By contrast, several non-participating fishers emphasized exclusion from decision-making, with comments such as: "*Nobody talked to us*" (Fisher 2) and "*It would be good if our opinions counted, we are the experts*" (Fisher 3). These responses illustrate recurring concerns regarding participation and the extent to which fishers felt their knowledge and opinions were considered in the decision-making process.

Contrasting attitudes toward SMR governance and implementation were observed across fishers with different level of age, experience, and consultation participation (Table 3). For instance, a non-participating fisher declared: "*The SMR is too small, we need a larger one, but also a deeper one like Jabučke kotline*" (Fisher 4). Within the interviewed sample, Mann-Whitney U tests indicated differences in some perceptions according to fishing experience and consultation participation (Table 3). Less experienced fishers who participated in the consultation reported more positive perceptions of the participatory design of the SMR than more experienced fishers who did not participate. A non-participating fisher also expressed a wish to participate in decision-making: "*Few people are interested in fishers' opinions, which is sad; we have a lot of knowledge but feel left out*" (Fisher 5).

### 3.3.2. *Sociodemographic factors influencing SMR design and implementation*

No significant differences were observed between participant and non-participant fishers regarding willingness to attend future consultation meetings or support for co-management (Table S2), indicating similar engagement intentions across both groups. This suggests that the initial consultation process did not generate negative attitudes among non-participating fishers. Moreover, fishers' age and experience were also not significantly associated with consultation participation or additional income sources (Table S2). This suggests that both younger and older, as well as less and more experienced fishers, were equally likely to participate, regardless of whether they relied solely on fishing income or had additional income sources. However, the desire to teach fishing to children was marginally associated with age and significantly associated with experience (Table S2). Support for co-management among those wishing to transmit their craft did not differ significantly (Table S2), suggesting that experience drives intergenerational knowledge transfer, while attitudes toward co-management remain independent of these intentions.

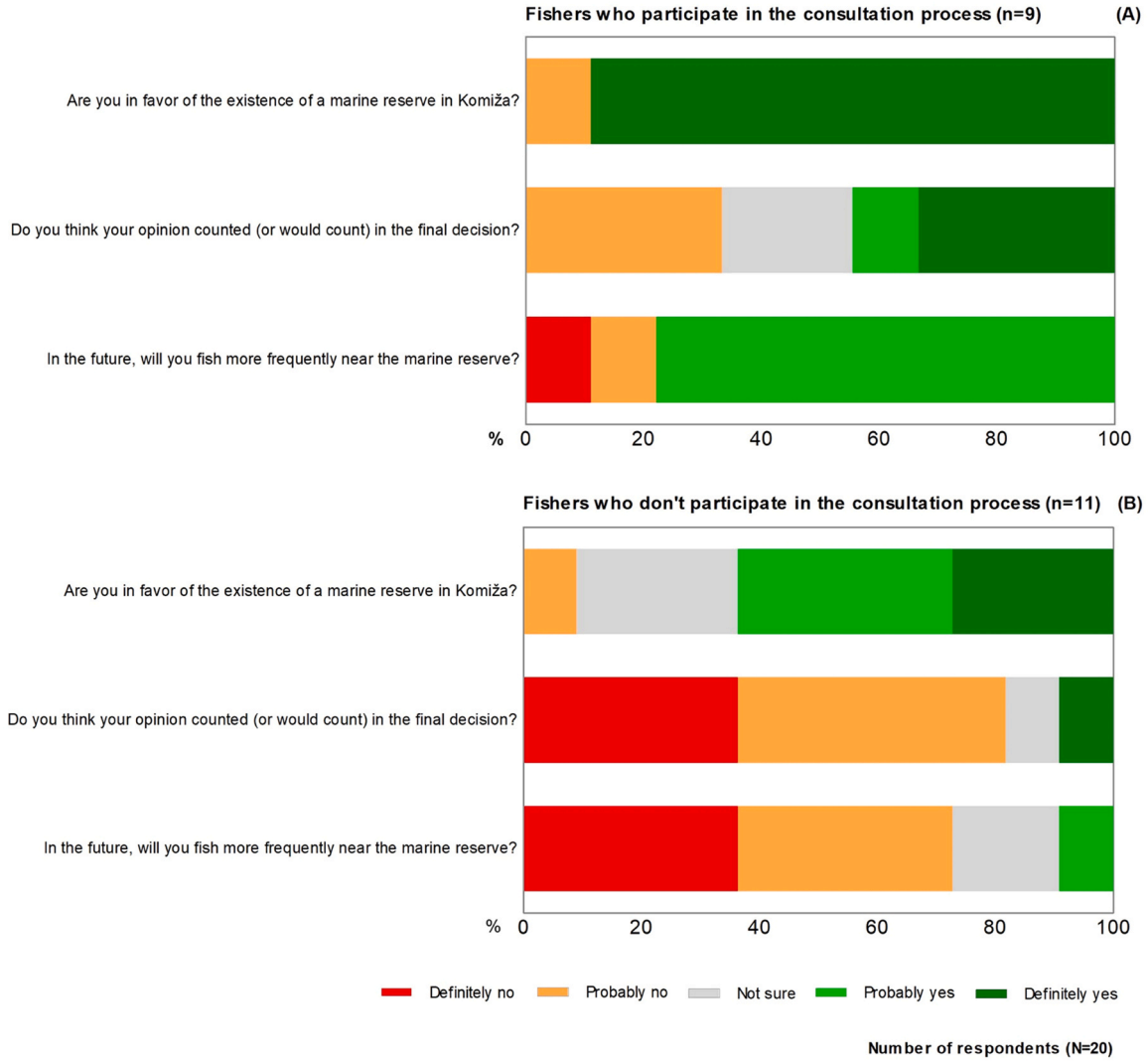



**Fig. 2.** Small-scale fishers' perceptions and attitudes toward the design and implementation of the newly designated SMR of "Cape Stupišće" (Croatia, Adriatic Sea). A: interviewed fishers who participated in the consultation process, B: interviewed fishers who did not participate in the consultation process. (n = 20).

### *3.4. Perceived potential ecological and socioeconomic outcomes of the Cape Stupišće SMR*

Overall, perceptions of the potential ecological and socioeconomic outcomes of the SMR were predominantly neutral to positive (Figs. 3 and 4). Most fishers perceived positive effects on fish landings and marine habitats, referring to the FRA of "Jabučke kotline" as a successful example (Figs. 3 and 4). However, perceived impacts of the new SMR of "Cape Stupišće" on fishing activity, fish abundance, and illegal fishing were largely neutral (Figs. 3 and 4). In contrast, perceived effects on personal income and tourism income were generally positive (Figs. 3 and 4).

Perceptions of potential ecological and socioeconomic outcomes did not differ significantly between fishers who participated in the consultation process and those who did not (Table S3). For potential ecological outcomes, participants reported a median score of 3.5 (n = 8) compared with 4.2 for non-participants (n = 10) on a Likert scale ranging from 1 (very negative) to 5 (very positive) (Mann-Whitney U = 54.5, p = 0.2071). Similarly, for potential socioeconomic outcomes, median scores were 3.7 for participants (n = 9) and 4.0 for non-participants (n = 11) (Mann-Whitney U = 67.0, p = 0.1913). Within the interviewed sample, no statistically significant differences were detected in perceived ecological and socioeconomic outcomes between fishers who participated in the consultation process and those who did not, possibly reflecting that fishers' expectations are rather shaped by prior experiences such as the Jabučke kotline FRA.

Thematic grouping of open-ended responses further highlighted both optimism and caution in fishers' expectations. Several respondents referred to the Jabučke kotline FRA as evidence that spatial protection can generate spillover benefits and improve catches. At the same time, multiple fishers expressed skepticism about the relatively small size of the newly established SMR, suggesting that it may be insufficient to generate substantial ecological effects. Others referred to broader pressures, including industrial trawling, illegal fishing, ghost nets, and perceived ecosystem changes associated with climate warming.

### *3.5. The main objectives of the SMR of "Cape Stupišće" as perceived by fishers*

Analysis showed that 44% of participating fishers reported "Habitat protection" and "Promotion of diving tourism" as the main objectives of the SMR, whereas only 9% of non-participants reported "Habitat protection" (Table 4). In contrast, 55% of non-participating fishers identified "Fish stock restoration" as the primary objective, followed by "Individual interests" (45%), while these responses did not exceed 33% among participating fishers. Finally, "Biodiversity protection" was the

**Table 3**
Mann-Whitney U comparisons on each questionnaire statement by: (1) fishers' age (<50 vs. ≥50 years old); (2) fishing experience (≤20 vs. >20 years); and (3) participation in the consultation process (participant vs. non-participant). Statistically significant results are highlighted in bold. p-value: *< 0.05.

| Questionnaire statements | Mann-Whitney U | | | |
|---|---|---|---|---|
| | Fishers' age | Fishers' experience | Consultation process | Multiple comparisons |
| **Are you in favor of the existence of a marine reserve in Komiža?** | 38.50 | 22.50 | **22.50*** | (participant vs. non-participant)[a] |
| [a]**Do you think your opinion counted (or would count) in the final decision?** | 32.50 | **14.00*** | **19.00*** | (≤20 vs. >20 yr.)[b] (participant vs. non-participant)[c] |
| [a]**In the future, will you fish more frequently near the special marine reserve?** | 35.50 | 33.00 | **17.50*** | (participant vs. non-participant)[d] |

[a] Fishers who participated in the consultation process are more supportive of the SMR than those who have not participated
[b] Less experienced fishers who participated in the consultation are more certain about the participatory design of this MR than those with more experience
[c] Less experienced fishers who participated in the consultation are more certain about the participatory design of this MR than those with more experience
[d] Fishers who participated in the consultation are more convinced of the benefit of marine reserves for fishing than those who have not participated

least reported objective among participating fishers (11%) and the second-least reported among non-participants (27%) (Table 4).

Given that the SMR was designated primarily to protect coastal and benthic habitats [54], the small-scale fishing community at Komiža appears to hold differing perceptions of the SMR, with participants and non-participants viewing its objectives differently. These contrasting perceptions may influence compliance and have implications for its effective implementation, while also suggesting that the consultation process may have contributed to greater awareness of the SMR's primary objective among participating fishers.

Thematic grouping of the open-ended responses also highlighted concerns regarding competing uses and SMR governance. Several participating fishers perceived the SMR partly as a mechanism supporting tourism development, particularly diving activities, rather than fisheries recovery. Others highlighted concerns about recreational fishing, excursion boats, and insufficient enforcement, especially during night hours. At the same time, some respondents explicitly supported the idea of MRs in principle, while stressing that a larger SMR size, stronger enforcement, and greater inclusion of fishers' knowledge would be necessary for effective implementation.

## 4. Discussion

### *4.1. Fishers' attitudes and perceptions about the SMR design and implementation*

Our results reveal contrasting views of the design and future implementation of the Cape Stupišće SMR among participating and non-participating fishers, particularly regarding decision-making processes and expectations of participatory governance. Such patterns are consistent with studies showing that support for MPAs strongly depends on perceptions of good governance, transparency, and meaningful involvement in decision-making [26,36,66]. Engagement and co-production processes can strengthen local acceptance of conservation measures [36,67].

Conducted immediately after the designation of the SMR, this study provides insight into how participation in consultation processes may shape attitudes toward the upcoming implementation phase. Overall, fishers expressed neutral to negative attitudes toward the MPA's decision-making process, a pattern frequently observed when management processes are perceived as top-down or insufficiently inclusive [68,69]. The differences observed between consultation participants and non-participants suggest that involvement in the consultation process may be related to how fishers perceive the SMR and its future implementation. This interpretation is consistent with previous research highlighting the role of participatory governance in shaping stakeholder acceptance of conservation measures [26,36].

Participation in the consultation process was also associated with different expectations regarding future fishing near the SMR. Participating fishers reported a greater willingness to fish near the SMR, possibly reflecting stronger expectations of spillover benefits or greater familiarity with the potential effects of spatial protection. Similar behavioral shifts have been documented where fishers are actively involved in monitoring, decision-making, or co-management [52]. However, given the exploratory nature of our study and the non-probability sampling strategy, these patterns should be interpreted as differences observed within the interviewed sample rather than as evidence of a general effect of consultation participation.

Assessing fishers' perceptions prior to MPA implementation can therefore provide valuable insights for future management [42,70]. Quantitative evidence from Mediterranean MPAs shows that perceptions of governance and social impacts often influence local support more strongly than perceived ecological effectiveness alone [26]. In our study, respondents generally perceived the SMR as potentially negative for their individual fishing activity while still expecting broader positive effects on fisheries income. Such seemingly contradictory views are consistent with broader findings that communities often perceive MPAs as costly in the short-term but potentially beneficial in the longer term, particularly when spillover and increased fish abundance are expected to influence fishing-site choice [52,71]. The widespread perception among interviewed fishers that the nearby FRA of Jabučke kotline has had positive fisheries impacts further suggests that previous experience with spatial protection may shape how fishers evaluate the potential benefits of the new SMR.

Our analysis also highlights the importance of intergenerational dynamics within the fishing community. More experienced fishers were significantly more likely to express willingness to transmit fishing knowledge to younger generations, reflecting strong occupational attachment and the persistence of LEK. These fishers may therefore play an important role in participatory governance or co-management arrangements in the future. Overall, the observed differences between participating and non-participating fishers highlight the importance of inclusive governance processes for fostering support and compliance during the implementation phase of this SMR [26,72].

### *4.2. Fishers' perceptions of the potential outcomes of the Cape Stupišće SMR*

Understanding stakeholders' perceptions of the ecological and socioeconomic outcomes of MPAs has become increasingly important, particularly during the early phases of their establishment [50,73–75]. In our study, expectations regarding ecological outcomes were generally neutral to positive, although fishers were more cautious about increases in fish abundance.

Such cautious expectations are consistent with ecological evidence showing that detectable increases in fish biomass and abundance within MRs typically require several years of effective protection [76–78]. Given that the Cape Stupišće SMR was only recently designated, substantial ecological changes are not yet expected to influence fishers' perceptions. Concerns expressed by fishers about the relatively small size of the SMR are also consistent with studies indicating that MPA size

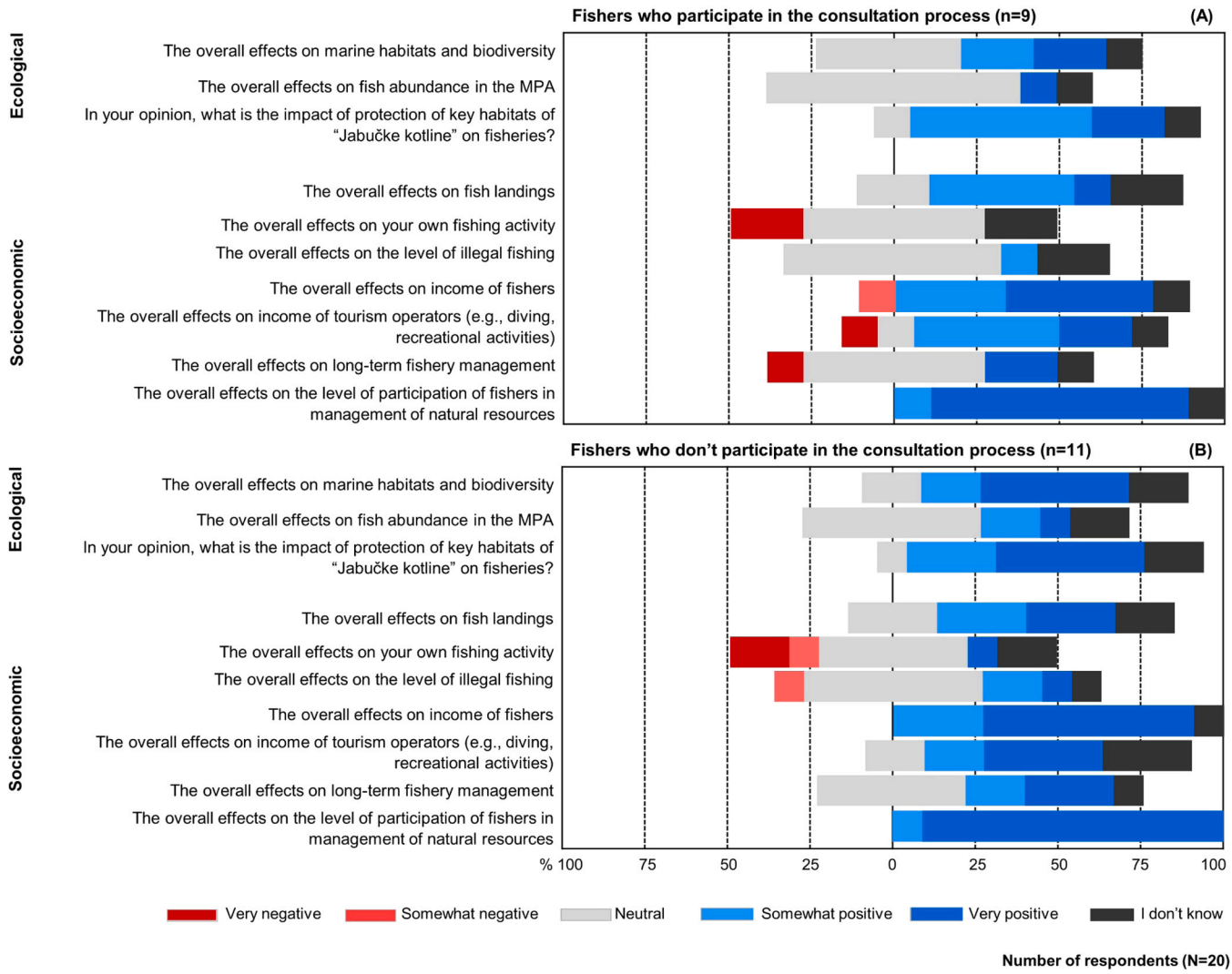



**Fig. 3.** The potential ecological and socioeconomic outcomes of the SMR of "Cape Stupišće" (Croatia, Adriatic Sea) as perceived by: (A) interviewed fishers who participated in the consultation process and (B) interviewed fishers who did not participate in the consultation process. MPA: Marine Protected Area. (n = 20).

is an important factor influencing ecological and fisheries outcomes [79–81]. Larger and older MRs generally show stronger increases in fish abundance, biomass, and body size [77,82].

Despite these concerns, fishers widely recognized the positive effects of the FRA of Jabučke kotline, established in 2017. This FRA protects an area containing approximately 23% of the biomass of commercially important species in the northern and central Adriatic, highlighting why fishers may perceive it as a meaningful regional example of the potential benefits of spatial protection [57]. Observed ecological improvements in nearby areas can strengthen trust in conservation measures and foster expectations of similar outcomes in newly established MRs.

Fishers' expectations of socioeconomic outcomes were generally positive, although concerns remained regarding their own fishing activity and illegal fishing. These concerns likely reflect the economic vulnerability of the local small-scale fishing sector, given that 65% of Komiža small-scale fishers in our sample rely solely on fishing income. As a result, fishers may be particularly sensitive to potential short-term economic impacts from the Cape Stupišće SMR establishment.

Interestingly, perceptions of potential ecological and socioeconomic outcomes did not differ significantly between participating and non-participating fishers. This finding aligns with previous research suggesting that participation in governance processes mainly influences relationships with managers, level of trust, and support for the MPA, whereas perceptions of ecological and socioeconomic outcomes tend to evolve over longer time scales as ecological changes become observable [36,37,70]. In this context, regional examples such as the Jabučke kotline FRA may provide more tangible evidence of potential outcomes than consultation processes alone.

As the Cape Stupišće SMR transitions from designation to implementation, the development and adoption of a management plan will represent a critical step. This phase determines how conservation rules are translated into practice and how ecological and socioeconomic objectives are pursued over time [3]. Effective implementation will therefore depend on continued engagement with local stakeholders, particularly small-scale fishers whose support is essential for ensuring compliance and long-term effectiveness of MRs [83,84].

Compliance and enforcement, factors consistently identified as core determinants of MPA success, are closely associated with stakeholders' perceptions of ecological and socioeconomic benefits, such as improved fish abundance, habitat recovery, and more stable livelihoods [79, 85–87]. From this perspective, our focus on fishers' perceptions provides an entry point to understand the social and cognitive mechanisms that can either facilitate or constrain the implementation phase. Positive expectations about the SMR's anticipated ecological performance can foster voluntary compliance, reduce enforcement costs, and create a conducive context for adaptive co-management, which is now widely acknowledged as a key precondition for successful MPAs [36,88–90].

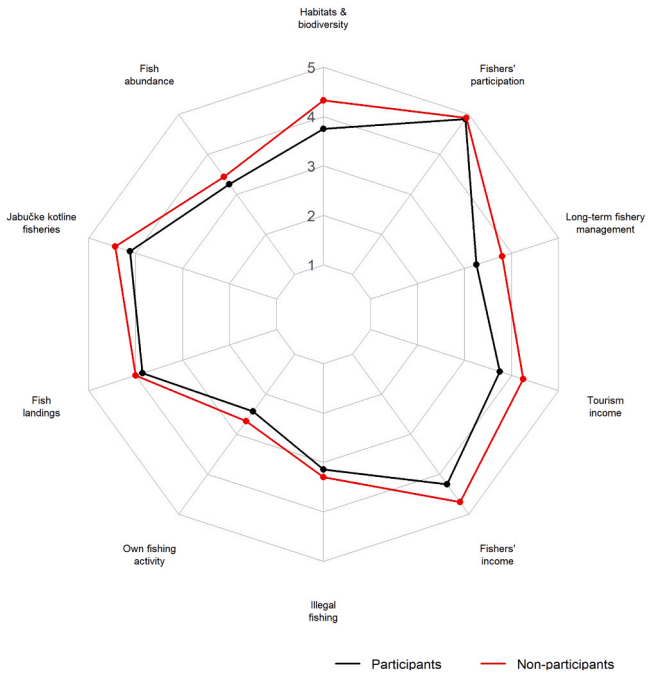



**Fig. 4.** Kite chart comparing fishers' perceptions across ten dimensions of potential ecological and socioeconomic outcomes of the SMR of "Cape Stupišće" (Croatia, Adriatic Sea) between participants and non-participants. Values represent mean scores on a 5-point Likert scale (1 = very negative, 2 = somewhat negative, 3 = neutral, 4 = somewhat positive, 5 = very positive). Responses of I don't know were treated as missing values.

**Table 4**
Representative sample responses showing the main objectives of the SMR as reported by small-scale fishers of Komiža, Vis Island, Croatia. The percentage of responses within each fishing group is indicated. MPA: Marine Protected Area.

| Responses samples | Participants (%) | Non-participants (%) |
|---|---|---|
| Habitat protection: The example of Jabučke kotline shows that MPAs can work. You can clearly see the spillover effect and better catches there | 44 | 9 |
| Promotion of diving tourism: Honestly, the whole MPA project seems more designed for divers than for fishers and the real environmental protection | 44 | 27 |
| Fish stock restoration: Marine reserves and MPAs are generally a good idea. We actually need more of them, but they should be larger and managed properly. Many of them could be much more effective | 33 | 55 |
| Individual interests: The MPA seems more like a tool to promote the island (especially diving tourism), people who don't know much about fishing or the sea are the ones deciding where MPAs are placed. That doesn't make sense | 33 | 45 |
| Biodiversity protection: Invasive species are a major problem, bigger than most people think | 11 | 27 |

### *4.3. Key lessons and recommendations for the future SMR implementation*

The themes identified from the open-ended responses and summarized in Table 5 highlight broader ecological, governance, and management challenges that may shape the future implementation of the Cape Stupišće SMR and, more generally, newly established Mediterranean MRs.

**Table 5**
Comparison between fishers' responses and scientific literature on key dimensions influencing the implementation of the Cape Stupišće SMR (Croatia, Adriatic Sea).

| Key implementation dimensions | Themes identified from fishers' responses | Relevant scientific literature |
|---|---|---|
| **SMR size and spillover expectations** | ***Adequate minimum SMR size*** Fisher 6: "*The fishers are a bit pessimistic about the MPA, it's too small, so it won't have a big effect*" (4 statements) | [79,85,91–97] |
| | ***Recognition of spillover effects*** Fisher 7: "*The spillover effect at Jabučke kotline works well, it's a good example*" (2 statements) | [76,80,88, 98–105] |
| | ***Addressing overfishing pressures*** Fisher 8: "*Overfishing is a serious issue. As a longline fisher, I fish sustainably, selective fishing with minimal environmental impact. We are not the main problem; industrial fishing is*" (1 statement) | [106–108] |
| **Participatory governance and the role of fishers' knowledge** | ***Participatory management approach*** Fisher 9: "I wish for a better cooperation between fishers, institutions, and managers, better coordination and management overall. More fishers should get involved and engage more actively" (1 statement) | [36,39,98, 109–117] |
| | ***Integration of fishers' local ecological knowledge*** Fisher 10: "*I think we have valuable opinions but we are the last people they would ask for input. People who don't know much about marine conservation are the ones deciding where to place MPA*" (5 statements) | [36,46, 118–127] |
| **Enforcement and management of competing uses** | ***Effective law enforcement*** Fisher 11: "*We need more inspections and enforcement, what happens at night when the ranger isn't working?*" (3 statements) | [128–132] |
| | ***Control of recreational fishing activities*** Fisher 12: "*Large tourist boats that also fish are a big problem, many of them are day-tour fishers or sport fishers. There should be better controls at the harbor*" (3 statements) | [133–142] |
| | ***Management of tourism activities*** Fisher 13: "Tourism (e.g., diving tourism) is not bad, but tricky, more and more tourist boats are filling the marina, making it harder for fishers to keep their spots" (2 statements) | [143–145] |
| | ***Awareness and understanding of the SMR's goal*** Fisher 14: "I would be happy if they just talked to us" (4 statements) | [24,146] |

#### *4.3.1. SMR size and spillover expectations*

Fishers in this study expect potential spillover benefits from the Cape Stupišće SMR. Given their strong dependence on fishing income and their tendency to select fishing grounds according to fish abundance, any future spillover effects from the SMR could concentrate fishing effort along its boundaries, a phenomenon often referred to as "fishing the line". Previous studies have shown that artisanal fishers may

increasingly target areas adjacent to no-take zones in anticipation of spillover benefits, which can locally intensify fishing pressure and partly reduce the ecological benefits expected from MRs [105,147,148].

The relatively small size of the SMR may therefore be an important consideration when assessing its potential ecological and fisheries benefits. In addition, fishers' concerns about persistent overfishing pressures suggest that the effectiveness of the SMR may depend not only on its size but also on the broader fishing pressures affecting local fish stocks.

#### 4.3.2. Participatory governance and adaptive implementation

Beyond ecological design, the long-term effectiveness of newly established MRs depends strongly on governance arrangements that maintain stakeholder engagement beyond the designation phase. In this respect, the themes identified in fishers' responses suggest that future implementation may benefit from institutional mechanisms that incorporate LEK, facilitate dialogue between managers and users, and support adaptive responses as ecological and socioeconomic conditions evolve. Similar lessons have been reported across Mediterranean and global MPA contexts, where participatory governance is increasingly recognized as a key condition for legitimacy, compliance, and long-term management effectiveness [26,36,39,149].

#### 4.3.3. Enforcement and management of competing uses

The themes identified in fishers' responses also highlight that enforcement capacity and the management of competing marine uses will likely influence the effectiveness of future implementation of the SMR. Effective implementation will therefore require adequate surveillance and enforcement, alongside clear management arrangements for recreational fishing and tourism-related activities. Similar challenges have been widely documented in Mediterranean MPAs, where compliance often depends not only on formal regulations but also on enforcement capacity, clarity of rules, and coordination among multiple user groups [88]. Strengthening monitoring systems and improving integration between fisheries management and broader coastal-use planning may therefore help reduce user conflicts while supporting reserve effectiveness.

### 4.4. Study limitations and future directions

While our results suggest that participation in the consultation process may positively influence attitudes toward the implementation of the Cape Stupišće SMR, participation alone is unlikely to guarantee successful governance outcomes. The present analysis focused exclusively on commercial small-scale fishers, although recreational fishing is increasingly recognized as an important contributor to fishing pressure in Mediterranean ecosystems [150]. In some European fisheries, recreational catches represent a substantial share of total removals, highlighting the importance of including this sector in future research and management strategies [151].

Several limitations related to the study design should also be acknowledged. Fishers' perceptions are inherently subjective and may be affected by survey-related biases such as social desirability bias, recall bias, and sampling bias [152–156]. In addition, perceptions are shaped by broader social-ecological contexts and may not necessarily correspond to ecological monitoring outcomes [157]. The findings should therefore be interpreted as reflecting fishers' expectations and attitudes at an early stage of MPA establishment rather than measured ecological or implementation outcomes. The relatively small sample size may reduce statistical power and limit the detection of relationships among variables, while the non-probability sampling strategy limits the extent to which these exploratory findings can be generalized beyond the interviewed fishers. In addition, the sampling strategy, based on purposive, opportunistic, and snowball techniques, may have favored the participation of fishers connected to the initial respondents. Because the sample was not randomly selected, statistical comparisons should be interpreted as exploratory comparisons within the interviewed sample rather than as evidence that the observed patterns can be generalized to the wider population of small-scale fishers in Komiža. The use of non-parametric tests was therefore intended to assess differences in the observed responses while minimizing assumptions about the distribution of the data, rather than to support population-level inference. Despite these limitations, the sample represents approximately 40% of the active commercial fishing population in Komiža harbor and includes a balanced representation of both participating and non-participating fishers in the consultation process. Future studies should therefore aim to include larger and more diverse samples of stakeholders in order to further explore the role of perceptions in shaping the design and implementation of marine reserves.

## 5. Conclusions

This study examined small-scale fishers' perceptions of the design and anticipated outcomes of the Cape Stupišće SMR at an early stage of its establishment, providing insights into the social conditions likely to shape the implementation of strict marine protection. Our findings show that participation in consultation processes is associated with more positive attitudes toward the SMR, while perceptions of potential ecological and socioeconomic outcomes did not differ significantly between participating and non-participating fishers. At the same time, the diversity of fishers' perceptions highlights persistent concerns related to potential fishing restrictions, enforcement capacity, and the regulation of competing marine uses.

These findings suggest that the early design and implementation of marine reserves should not only consider ecological objectives, but also the social conditions that influence legitimacy, compliance, and local support. In this regard, participatory governance processes that incorporate fishers' LEK may help anticipate potential conflicts, strengthen trust in management institutions, and improve implementation effectiveness.

More broadly, understanding the diversity of fishers' perceptions is increasingly important in the Mediterranean context, where social acceptance and compliance are essential to achieving conservation targets such as the EU Biodiversity Strategy for 2030. By identifying both support for and skepticism toward strict marine protection, this study highlights the importance of integrating stakeholder perspectives into the design and implementation of newly established MRs. Future research could revisit this case study at later stages of the SMR's development (e.g., after 5 or 10 years) to assess whether fishers' perceptions evolve as ecological and socioeconomic outcomes become more visible.

## CRediT authorship contribution statement

**Ibrahim Boubekri:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mara Milena Babić:** Writing – original draft, Investigation, Formal analysis, Data curation. **Ante Ivčević:** Writing – review & editing, Validation, Methodology, Conceptualization. **Miriam von Thenen:** Writing – review & editing, Validation. **Amelia Agranovich:** Writing – review & editing, Validation. **Lutz Breuer:** Writing – review & editing, Supervision. **Gerald Schernewski:** Writing – review & editing, Validation, Supervision, Funding acquisition.

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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.marpol.2026.107355.

## Data availability

Data will be made available on request.

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