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The Potential Re-Colonisation of Mediterranean Monk Seals: Evaluating Threats and Management Options

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ABSTRACT

Mediterranean monk seals (*Monachus monachus*; MMS) are a vulnerable marine species historically widespread throughout coastal areas of the Mediterranean, Black Sea and parts of the North Atlantic. MMS have suffered significant population declines and extirpations due to anthropogenic pressures, particularly persecution, overfishing and impacts of tourism. Extant populations are fragmented, but recent trends indicate some re-colonisation in the historic range. This study sought to understand opportunities and threats to MMS re-colonisation in Croatia. It gauged support for MMS return and perceptions of different management options from two stakeholder groups. Structured questionnaires were used with fishers to assess the threat of persecution and overfishing, and with visitors to understand their willingness to pay (WTP) conservation fees to support environmental initiatives. Our results indicate that while persecution may no longer be a pertinent threat to MMS in Croatia, overfishing threatens fish stocks and the marine environment. Results also suggest that tourism could generate funding for conservation initiatives, particularly through on-arrival visitor fees. We consider key management options to support MMS re-colonisation, including expanding the current marine protected area network and demarking new no-take zones, working closely with fishers, establishing financial mechanisms for compensation and subsidies, developing awareness raising campaigns, and implementing one-off conservation fees.

1 | Introduction

Our oceans and seas are home to an extraordinary array of biodiversity and habitats, providing ecosystem services such as food resources and acting as a sink for anthropogenic carbon (Sala et al. 2021; IOC-UNESCO 2024). An estimated 4–18% of the world's macroscopic marine biodiversity is represented in the Mediterranean Sea (depending on the taxonomic group; Bianchi and Morri 2000), 20% of which is endemic (Notarbartolo di Sciara and Agardy 2009). Yet, the Mediterranean Sea is one of the most overexploited seas in the world (Bastari et al. 2016), with fishing, tourism, and coastal urbanisation and development leading to increased noise, plastic and chemical pollution, and disturbing critical ecosystem functions and services (Karamanlidis et al. 2020; Bearzi et al. 2024; Johnson and Lavigne 1999). Unsustainable harvesting and destructive fishing practices are resulting in biodiversity loss and habitat degradation (Bastari et al. 2016), and climate change is driving mass mortalities of marine organisms in the Mediterranean Sea (Garrabou et al. 2022).

Mediterranean monk seals (*Monachus monachus*; MMS) are the only pinnipeds in the Mediterranean Sea and are likely to be particularly sensitive to cumulative threats. They are large coastal marine mammals (adults 240–300 kg), feeding predominantly off cephalopods, bony fish and crustaceans from the continental shelf (Karamanlidis et al. 2016; Karamanlidis 2024). The species typically lives in colonies, although this is now rare, so the species resides in smaller groups, often using isolated caves for resting and pupping (Karamanlidis et al. 2016). In the eastern

Mediterranean, the peak pupping and cave use seasons are autumn and winter (Karamanlidis et al. 2016). MMS are estimated to have a generation length of 11.2 years, and female MMS are estimated to reach sexual maturity from 2.1 years, producing a single pup at a time with a gestation period of 9–11 months (Karamanlidis et al. 2016; Karamanlidis 2024). Their historical range included the whole of the Mediterranean, Black Sea and the North Atlantic from Morocco to Senegal, including the Canary Islands, Madeira Islands and the Azores (Johnson 2004; Karamanlidis et al. 2023). MMS have a strong cultural significance to the Mediterranean, with early literary mentions by Aristotle (fourth century B.C.) and Homer (eighth/seventh century B.C.; Enalia Physis 2022). The species was exploited at an industrial scale during the Roman era, leading to significant declines in MMS populations, and were exploited for their meat, fur and oil into the Dark Ages and Renaissance (Johnson 2004). The Atlantic populations of MMS of Africa were also subject to exploitation for skin and oil by French, Portuguese and Spanish explorers (Johnson 2004). The species was already considered 'rare' by science in 1779 (Johnson 2004) and was listed on the IUCN Red List of Threatened Species as Endangered from 1986, and at the global scale, it was classified as Critically Endangered on subsequent assessments between 2008 and 2013 (Karamanlidis et al. 2023). Nowadays, MMS are one of the most endangered marine mammals in the world, and the global MMS population is divided into three subpopulations, one in the eastern Mediterranean and two smaller subpopulations in the north-eastern Atlantic Ocean (Karamanlidis et al. 2023). Contemporary threats to remaining MMS populations are considered to be (1) the increasing levels of tourism resulting in coastal development and high levels of boating activity, leading to MMS displacement from suitable habitat, habitat destruction, and disturbance; (2) overfishing, resulting in MMS bycatch, decreased prey availability, and fishing gear entanglement; and (3) MMS persecution from fishers leading to adult mortality (Johnson and Lavigne 1999; Karamanlidis et al. 2023; Panou et al. 2023; Karamanlidis 2024). For example, industrialised fishing catch off northwest Africa has been high between 1950 and 2015 relative to much of the world (Watson and Tidd 2018).

Despite the presence of significant threats across the MMS range, the most recent IUCN assessment shows a steady increase in population size and range of MMS across the last decade and a half, at least partly attributed to the success of conservation measures that have been implemented in key areas in the last four decades (Karamanlidis et al. 2023). In 2015, the species was reclassified on the IUCN Red List as Endangered, and in 2023 to Vulnerable, with the current global population estimated at 815–997, including 443–599 mature individuals (Karamanlidis et al. 2023; Karamanlidis 2024). While these positive trends are a cause for optimism, MMS still show some characteristics of an endangered species. The global population is fragmented and the eastern Mediterranean subpopulation (Greece, Turkey, Cyprus and Albania), the last stronghold of MMS, is divided into small and isolated clusters, resulting in poor genetic diversity due to inbreeding (Karamanlidis et al. 2021). Whilst conservation efforts appear to have been successful in supporting population growth and range expansion, further work is needed to encourage genetic flow between isolated groups (Karamanlidis et al. 2021; Karamanlidis 2024). Coastal areas located within the historic MMS range proximate to extant populations could be key to ensuring the long-term viability of the species, for example by providing suitable and connected habitat (Bundone et al. 2019). Croatia's coastline could be important for MMS conservation given its close proximity to Greece, an MMS stronghold, and Albania, where MMS have been documented using caves and through citizen science between 2019 and 2021 (Bundone et al. 2022).

Historically, large colonies of MMS were found on the Croatian islands of Lošinj and Vis (Mohr 1852), and reported from other islands such as Cres (Hermann 1779; Klinger 2010). Multiple sightings of vagrant individuals have been confirmed in Croatia in the last decade (Bundone et al. 2019; Karamanlidis 2024), including in 2023 (Anđelković 2023). This has prompted the IUCN to classify the status of the species in Croatia as 'Native, Presence Uncertain' (Karamanlidis et al. 2023). However, there have been no signs of re-colonisation and no confirmed successful pupping (Karamanlidis 2024). Habitat availability surveys have found that suitable habitat remains in parts of Croatia, including the Vis archipelago, and nearby Albania, i.e., the Ionian Sea coastal area near Rrëza e Kanalit (Antolović et al. 2005; Bundone et al. 2013). Given the presence of suitable habitats and confirmed sightings in Montenegro in 2023 and 2024 (Varda 2024) and Italy as recently as 2020 (Fioravanti et al. 2020; Bundone et al. 2023), an MMS re-colonisation of Croatia's coastlines is anticipated. Indeed, there are ongoing projects investigating the re-colonisation of MMS in Lebanon (Monk Seal Alliance 2024). Consequently, it is essential to evaluate the current threats and opportunities to facilitate their recovery.

In the Adriatic Sea, the main driver of contemporary MMS population declines is displacement and degradation of habitats as a result of tourism (Johnson and Lavigne 1999). Croatia is one of the primary tourist destinations in Europe, receiving over 20 million visitors in 2023 (Croatian National Tourist Board 2024). Tourism accounts for 20% of Croatia's GDP (The World Bank 2022), which is projected to increase to 26.2% by 2028 (Degengard 2023). Further, fishing pressure has been amongst the highest in the Adriatic Sea (Watson and Tidd 2018; Rousseau et al. 2024; Global Fishing Watch 2025), and the proportion of marine mammals threatened by incidental catch and fishing gear interactions, direct harvesting, pollution, and traffic was also found to be high in the area (Avila et al. 2018). Overfishing creates opportunities for MMS-fisher conflict and persecution, and young seals are often victims of bycatch (Papageorgiou et al. 2023), as seen for dolphins (Li Veli et al. 2023). Croatia has a strong culture of commercial and small-scale fishing, and, in 2019, Croatia's Fishing Fleet Register listed 7455 vessels with a total harvest from the Adriatic of approximately 64,000 t (FAO 2024). Countries facing similar pressures on their marine environments have adopted different management strategies to balance the economic value of fishing and tourism with conservation objectives (Getzner et al. 2017). This can include the use of fishing quotas/bans/restrictions, fishing gear changes, restrictions on visitor numbers, development of marine protected areas, and funding mechanisms, such as conservation fees for visitors (Bastari et al. 2016; Schuhmann et al. 2019; Goldsworthy et al. 2022). Here, we seek to develop an understanding of the possible anthropogenic threats (persecution, overfishing and impacts of tourism) to MMS in contemporary Croatia, and to identify key management options that could support re-colonisation.

2 | Methods

2.1 | Data Collection

Structured questionnaires were used with two stakeholder groups. We designed the questionnaires with a mix of open, closed and scale questions. One of the questionnaires was targeted at fishers to collect data on the potential for persecution, as well as fishers' perceptions of fish stock levels, as a potential indicator of issues connected to overfishing (Farella et al. 2020). The other questionnaire was targeted at visitors to capture data on willingness to pay (WTP) conservation fees. The study was conducted at two locations between 6 and 27 May 2024, during a period when fishers are available due to unpredictable weather reducing time at sea and coinciding with the beginning of the tourist season in Croatia. The locations were (1) Mali Lošinj, a small town on Lošinj island, in Primorje-Gorski Kotar County, situated in the northern Adriatic Sea, and (2) Vis, an island in Split-Dalmatia County, situated in the south area of the Croatian part of the Adriatic (Figure 1). The locations were selected due to historical reports of big MMS colonies (Mohr 1852) and to ensure geographical and regional representation.

Prior to the field study, the questionnaires were piloted in English and Croatian to ensure they were easily understood by both English and Croatian speakers. Minor adjustments were made to improve structure and allow for nuances in translation. All questionnaires were conducted with fishers in Croatian, and most questionnaires with visitors in English; three respondents (two of Croatian nationality and one of Slovenian nationality) preferred Croatian.

Fishers were reached using the chain-referral method (Newing et al. 2011). Acquaintances made introductions to fishers in each location; these fishers were then asked to refer other contacts, and so on. The introductions were mostly made during the morning hours, primarily between 7 and 11 am, at times when fishers were congregating at local cafes. Visitors were reached through semi-random sampling, via the street-intercept method (Buschmann 2019), by engaging people of different gender and age groups along well-visited promenades in both locations. This method was primarily used later in the afternoon and evening, as most tourists are busy with morning and early afternoon activities. Questionnaires were administered verbally, with responses captured on a tablet, typically lasting 10–15 min.

Both questionnaires were created, designed and deployed using KoboToolbox (2018). They were downloaded on a tablet to ensure offline functionality. The fisher questionnaire (Supplementary Material 1) was designed to minimise bias and capture fishers' true attitudes and was divided into four sections: (1) questions on each fisher's fishing activities, (2) questions gauging current attitudes towards the seals, (3) socio-demographic information of the respondent and (4) open-answer questions for sharing stories or anecdotes about MMS, or to add anything else. The visitors' questionnaire (Supplementary Material 2) was divided into five sections: (1) questions relating to their current trip, e.g., reasons for visiting, types of transport, activities, etc.; (2) assessing visitors' attitudes towards conservation, including contingent valuation questions to assess WTP of conservation fees in two different scenarios (Whitehead and Haab 2023); (3) assessing visitors' awareness of, and attitudes towards, the seals; (4) socio-demographic information of the respondents; and (5) any additional information. The two scenarios offered to visitors for the WTP assessment were evaluating different fee payment structures, one presenting payment of fees per activity and the other collection of a one-off fee on arrival.

2.2 | Ethics and Permits

The University of Kent Ethics Committee (ID: 20241712057482638) approved the research involving human subjects. Only individuals aged 18 or over were asked to participate in the study and all gave free, prior informed consent. Prior to taking part, participants were informed about the study's objectives, that they would remain anonymous, and that their data would be protected. Participants remains unidentifiable from the data, as names and other directly identifiable information were not recorded. We did not collect any data that could be combined to identify individuals. Participants were told that they could remove themselves from the study at any time without providing a reason. Following this process, participants were asked to provide oral consent to take part, which was marked down on the questionnaire. No permits were needed for this research.

2.3 | Data Analysis

All analyses were conducted in R v4.3.2 (R Core Team 2023). Due to a small sample size and to allow appropriate analytical methods, we conducted data preparation prior to analyses, including the following: (1) All Likert scale responses in the fishers' questionnaire were considered either positive (agreement) or neutral and negative; (2) responses to changes in fish stock over time were grouped into either negative (less fish in the sea) or neutral and positive responses. R package *Likert* (Bryer and Speerschneider 2016) was used to visualise the full range of fishers' attitudes towards the marine environment, wildlife and MMS. We also analysed fishers' awareness of different aspects of MMS-fisher conflict (competition, equipment damage and persecution). Due to a small sample size, other data preparation was needed: (1) In the visitors' questionnaire, age categories were merged to create three categories ('18–34', '35–54' and '55+'); (2) education level was re-coded into binary (yes/no) responses to capture whether respondents had completed university level education; (3) for analysis of WTP of conservation fees charged per activity, fee levels were re-grouped as '€1-3 extra per ticket' and 'More than €5 extra per ticket'; and (4) analysis of WTP of one-off conservation fees upon arrival were re-grouped into two fee levels, '€5–10' and 'More than €15'.

Our study included six models. We used fishers' responses to test (1) support for MMS as influenced by income and location, (2) awareness of different aspects of MMS-fishers conflict as influenced by location and (3) perception of fish stock

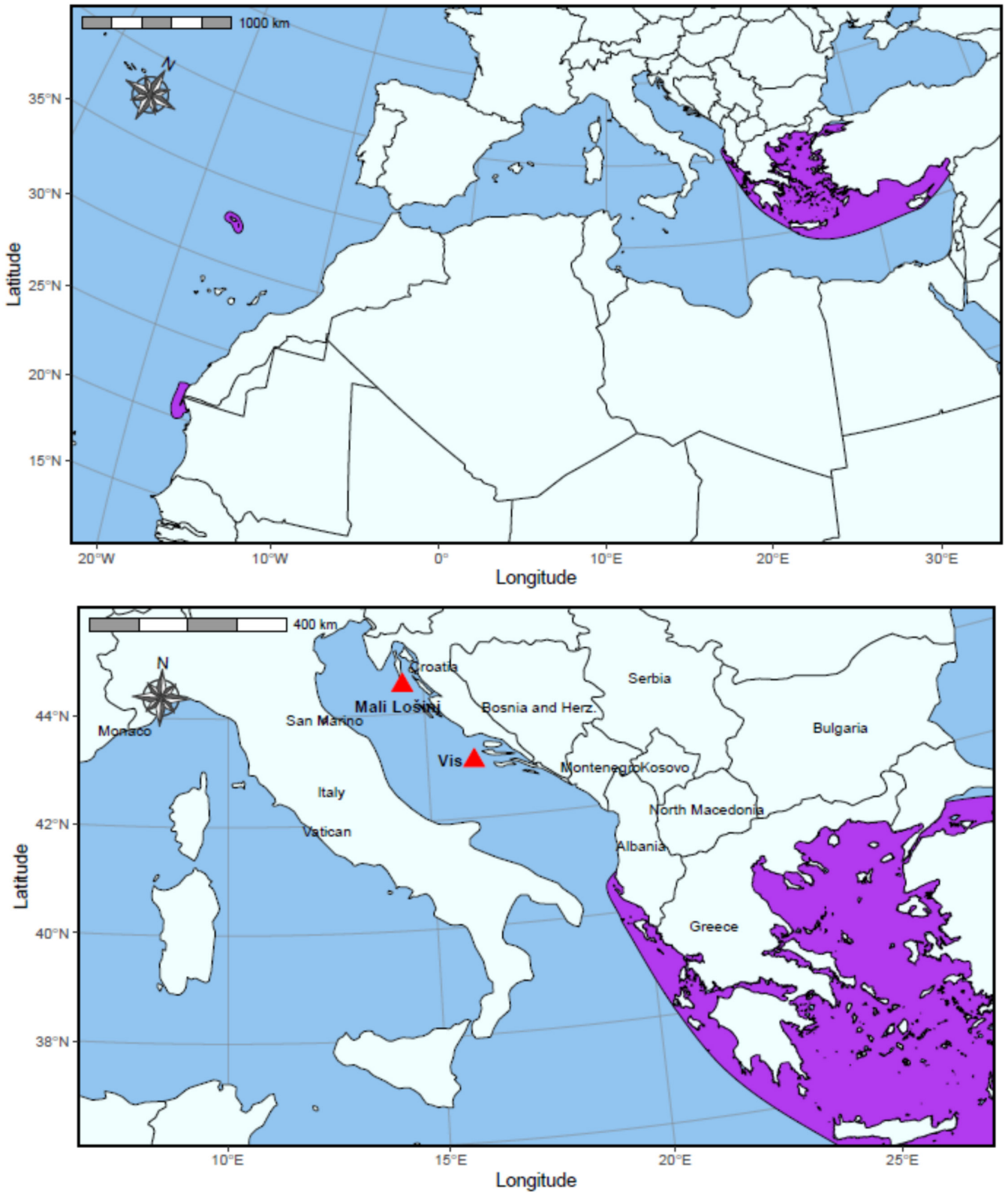

FIGURE 1 | Maps showing the current distribution of the Mediterranean monk seal (MMS) *Monachus monachus* populations (Karamanlidis et al. 2023; top-panel, purple polygon) and the study sites in Croatia, Mali Lošinj and Vis (bottom-panel, red triangles). The historical distribution of MMS included the whole of the coastal Mediterranean, Black Sea and the North Atlantic from Morocco to Ras Nouadhibou, including the Canary Islands, Madeira Islands and the Azores. The marine protected area network for Croatia can be viewed at UNEP-WCMC (2025).

levels as influenced by location. Visitors' responses were used to test (1) WTP of conservation fees added to each activity (2) WTP of one-off conservation fees collected on arrival and (3) preference of conservation fee type, all as influenced by age, gender and education. Binomial logistic regressions with a logit link function in R were used when the response variable

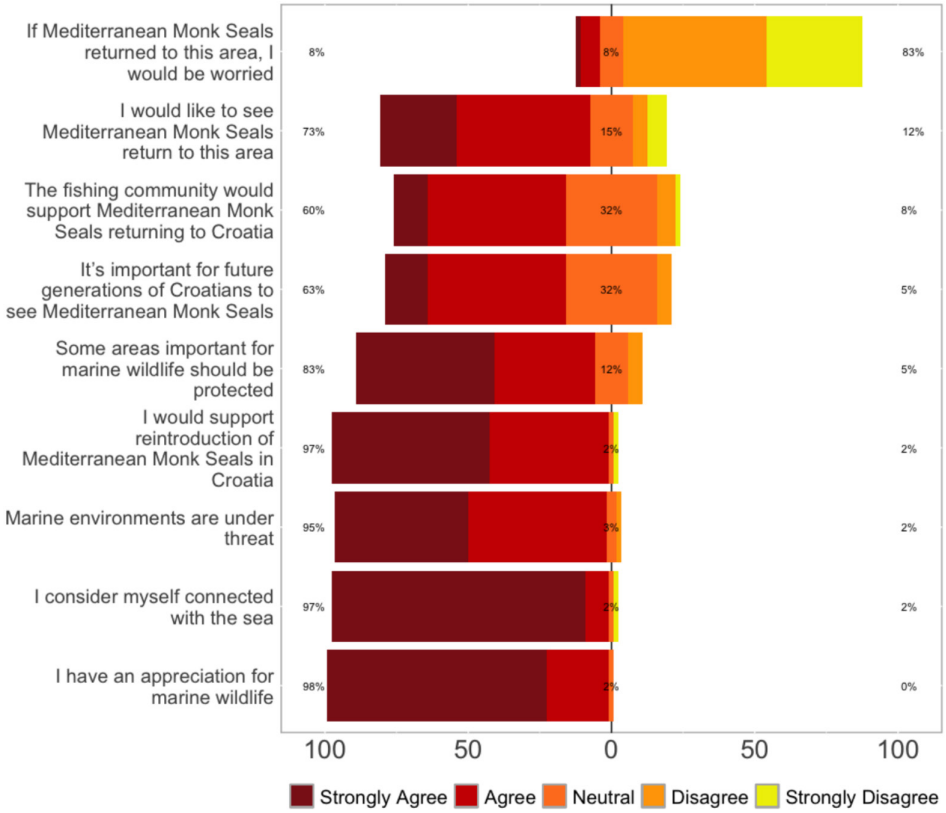

FIGURE 2 | Fishers' attitudes towards the marine environment, wildlife and Mediterranean Monk Seals based on their level of agreement with the above statements ($n = 60$).

was binomial (e.g., yes/no). When a predictor had more than two levels (e.g., age groups), R package *car* (Fox et al. 2023) was used to run an ANOVA. For all analyses, significance level was set at 95% ($\alpha = 0.05$) and predictor variables were selected a priori. When analysing the potential threat of persecution, the predictor variables chosen were fishing as a primary source of income and location. Due to small-scale fishers in the area being economically challenged (Li Veli et al. 2023), we hypothesised that fishing being a primary source of income would negatively affect fishers' support of an MMS return. We also hypothesised that location would influence fishers' willingness to see MMS return, with fishers in the south expected to be less supportive, and more aware of aspects of MMS-fishers conflict, as local knowledge suggests that extirpation of MMS started occurring in the north Adriatic (early 1950s), before it occurred in the south Adriatic (mid to late 1960s). In the fish stock analysis, the main predictor variable was location. As overfishing is widespread across the Adriatic (Bastari et al. 2016), we hypothesised that location would not affect fishers' perception of fish stock levels. In the WTP analysis, the predictor variables were age, gender and education level. Previous studies have indicated age, gender and level of education can impact WTP in conservation (Yingyi et al. 2025). As such, we hypothesised that the highest WTP will be found amongst younger, more educated women. We did not conduct model selection, due to selecting a small number of predictor variables based on a priori hypotheses, and to avoid omitted variable bias (Wilms et al. 2021). A visual check of model assumptions was performed for all models.

3 | Results

3.1 | Questionnaires With Fishers

3.1.1 | Socio-Demographic Information

In total, 61 fishers completed the questionnaire: 31 in Mali Lošinj and 30 on Vis. The respondents were primarily male ($n = 60$), with 1 female respondent, which is believed to be broadly representative of the gender ratio in the fishing industry in Croatia. Most respondents belonged in the 35–44 and 45–54 age categories (24.6% and 21.3% respectively), but other categories were also represented with 16.4% of respondents in the 25–34 age category and just under 20% in the 55–64 (19.7%) and 65 + (18%) categories. The fishers had a varying amount of experience; 11.5% had less than 10 years, 32.8% had 10–29 years and 55.7% had more than 30 years of experience.

3.1.2 | Assessing Fishers' Attitudes to the Marine Environment, Wildlife and MMS

Most fishers had positive attitudes towards the marine environment, wildlife and MMS (Figure 2). Respondents ($n = 60$) agreed and strongly agreed that marine environments are under threat ($n = 57$, 95%) and that key marine biodiversity areas should be protected ($n = 50$, 83%). Most fishers felt connected to the sea ($n = 58$, 97%) and considered themselves to have an appreciation of marine wildlife ($n = 59$, 98%). Many fishers were in favour of MMS returning to the area ($n = 44$,

73%), and most stated they would support the reintroduction of MMS in Croatia (n = 58, 97%), articulating a desire for future generations to see the species ($n = 38$, 63%). Views were less certain as to whether the fishing community would support the return of MMS to Croatia ($n = 36$, 60% agreed or strongly agreed that the community would be supportive). However, most fishers were not personally concerned about a return of MMS ($n = 50$, 83%).

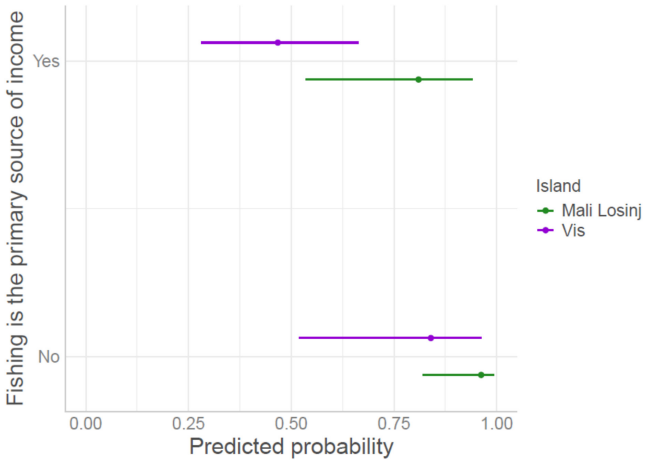

FIGURE 3 | Predicted probability of fishers agreeing with the statement: 'I would like to see Mediterranean monk seals return to this area' based on whether fishing is their primary source of income and the island they are located on.

3.1.3 | Analysing Whether Income and Location Affect Fishers' Attitudes Towards MMS Returning

The binomial GLM showed that support for MMS return (agreement with the statement 'I would like to see Mediterranean Monk Seals return to this area') was affected by location ($\chi^2 = 5.095$, $df = 1$, $p = 0.024$) and whether fishing was the primary source of income ($\chi^2 = 5.532$, $df = 1$, $p = 0.019$) (Figure 3). The odds of fishers agreeing with the statement were lower if fishing was their primary source of income (GLM: odds ratio 0.167; 95% CI 0.023–0.755, $p < 0.001$). The odds were also lower for fishers on Vis, compared with Mali Lošinj (odds ratio 0.206; 95% CI 0.041–0.818, $p < 0.001$).

The binomial GLMs of fishers' awareness of different aspects of MMS-fishers conflict found that location affected awareness of MMS competing with fishers for fish ($\chi^2 = 18.833$, $df = 1$, $p < 0.001$, Figure 4), of MMS being persecuted by fishers ($\chi^2 = 29.725$, $df = 1$, $p < 0.001$, Figure 4), and of MMS damaging nets or other fishing equipment ($\chi^2 = 23.282$, $df = 1$, $p < 0.001$, Figure 4). Fishers on Vis were 11.27 times more likely to be aware of competition with MMS (GLM: odds ratio 11.27; 95% CI 3.61–40.04, $p < 0.001$), 34.22 times more likely to be aware of persecution incidents (odds ratio 34.22; 95% CI 8.07–242.13, $p < 0.001$), and 18.9 times more likely to be aware of MMS damaging nets or other fishing equipment (odds ratio 18.9; 95% CI 5.18–93.45, $p < 0.001$). Whilst the analyses show wide confidence intervals (attributed to the small sample size), we believe these significant differences are a true representation of location impacting fishers' awareness of MMS-fishers' conflicts.

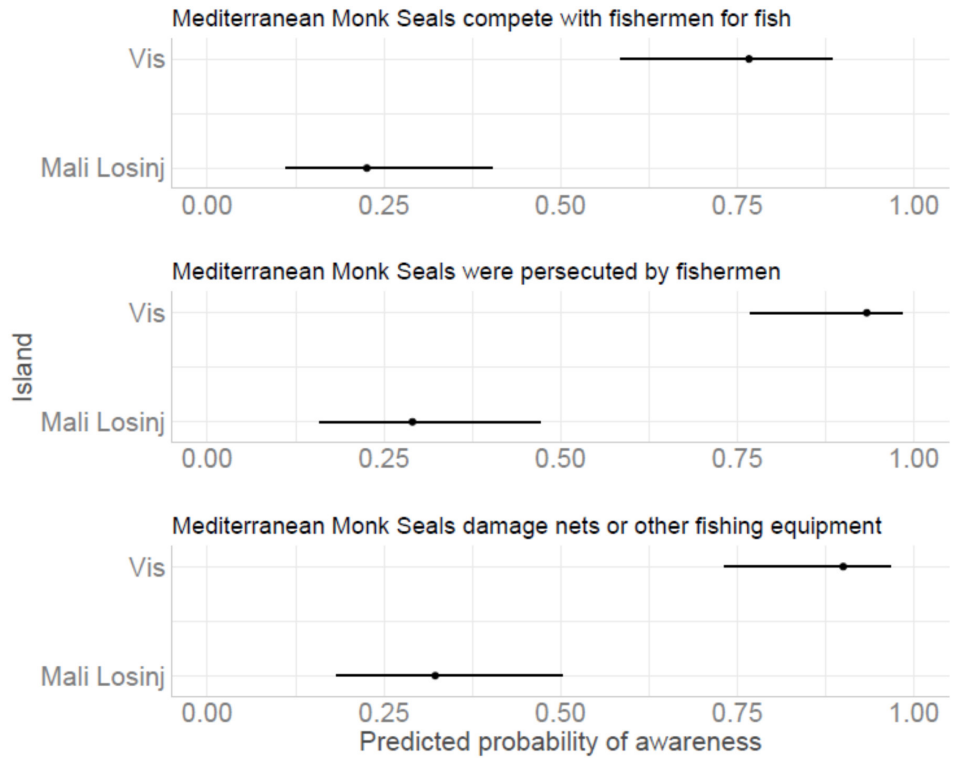

FIGURE 4 | Probability of fishers on each island stating awareness of Mediterranean monk seals competing with fishers for fish (top), of Mediterranean monk seals being persecuted by fishers in the past (middle) and of Mediterranean monk seals damaging nets or other fishing equipment (bottom).

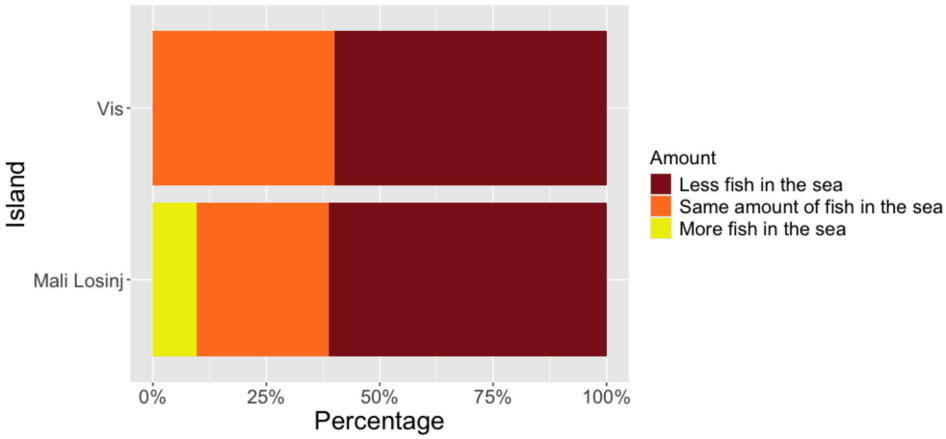

FIGURE 5 | Fishers' perception of the status of fish stocks compared to when they first started fishing, by island in Croatia.

3.1.4 | Analysing Fishers' Perceptions of Fish Stock Levels

When respondents ($n = 61$) were given the following statement: 'Comparing your experience now to when you first started fishing, would you say that, on average, there is ...', respondents stated that there were (a) *fewer fish in the sea* ($n = 37$, 60.7%), (b) the *same amount of fish in the sea* ($n = 21$, 34.4%) or (c) *more fish in the sea* ($n = 3$, 4.9%) (Figure 5). Nine of the respondents who answered that there was the same amount of fish in the sea ($n = 21$, 42.9%) provided additional context to their answers by identifying that technological advances and new tools meant that they were able to maintain yields despite a perceived reduction in fish stocks. One respondent said: 'There is actually less fish in the sea, but we are catching the same amount due to better technology on boats'. Another said: 'The tools we now have are so advanced that we're maintaining our fishing yields'. Fishers' perceptions of how current fish levels compared with previous levels were not significantly affected by location (GLM: $\chi^2 = 0.011$, $df = 1$, $p = 0.918$).

3.2 | Questionnaires With Visitors

3.2.1 | Socio-Demographic Information

A total of 61 respondents completed the questionnaire, 30 in Mali Lošinj and 31 on Vis. Respondents identified as female ($n = 32$, 52.5%), male ($n = 28$, 45.9%) and one respondent chose the 'Prefer not to say' option (1.6%). Following the re-grouping of age categories, most respondents belonged to the 18–34 age category (37.7%), but other categories were also represented with just over 30% in both the 35–54 (31.1%) and the 55+ (31.2%) age categories. Most respondents were educated to university level ($n = 48$, 78.7%), with one respondent choosing the '*Prefer not to say*' option (1.6%).

3.2.2 | Analysing the Level of Visitors' WTP and Their Preference on fee type

Two scenarios for payment of conservation fees were introduced to visitors. In the scenario where conservation fees would be added to activities, the average fee respondents were willing to pay was €6.02 ($n = 59$). Two respondents (3.3%) said they would not visit in this scenario. The binomial GLM found that respondents' WTP was not significantly affected by age ($\chi^2 = 5.233$, $df = 2$, $p = 0.073$), gender ($\chi^2 = 2.527$, $df = 1$, $p = 0.112$), or university education ($\chi^2 = 2.016$, $df = 1$, $p = 0.156$). In the scenario where a singular conservation fee would be collected on arrival to the island, the average visitors were willing to pay was €11.12 ($n = 58$). Three respondents (4.9%) said they would not visit in this scenario. The binomial GLM found that age ($\chi^2 = 1.520$, $df = 2$, $p = 0.468$), gender ($\chi^2 = 0.695$, $df = 1$, $p = 0.405$), and university education ($\chi^2 = 0.296$, $df = 1$, $p = 0.587$) did not significantly affect how much a respondent was willing to pay.

When asked which fee type they would prefer, most respondents preferred a one-off fee on arrival ($n = 39$, 63.9%); 20 respondents selected a fee applied to each activity (32.8%) (Figure 6). Two (3.3%) visitors stated they would not visit. Fee type preference was not significantly affected by age (GLM: $\chi^2 = 4.979$, $df = 2$, $p = 0.083$), gender ($\chi^2 = 1.819$, $df = 1$, $p = 0.177$), or university education ($\chi^2 = 1.614$, $df = 1$, $p = 0.204$). Following the WTP section of the questionnaire, visitors were asked a series of questions relating directly to MMS, and 75.4% of respondents stated that they would visit again if MMS were to return.

4 | Discussion

We set out to investigate the main threats (potential persecution, overfishing, and the impacts of tourism) to MMS in Croatia, and to identify key management options Croatia could develop to support MMS re-colonisation. We sought to investigate whether persecution could be a threat if MMS were to return to Croatia, how fishers along the Croatian coastline perceive fish stock levels, and whether visitors would be willing to pay conservation fees to support the marine environment and wildlife in Croatia.

4.1 | Persecution

MMS have been persecuted from Roman times, with more recent examples (from the 1940s onwards) showing persecution (e.g.,

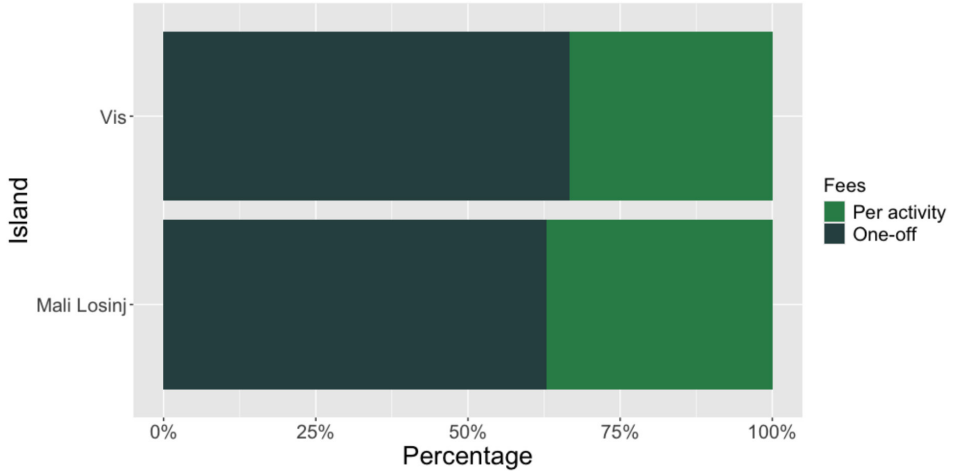

FIGURE 6 | Visitors' preference for the type of conservation fees that could be applied in Croatia.

intentional and retaliatory killings) by fishers to be one of the main causes of adult mortality in MMS (Johnson 2004; Panou et al. 2023). However, our results indicate that fishers in Croatia would support the return of MMS, and that the threat of persecution may no longer be an immediate issue if re-colonisation were to occur. Whilst acquiescence bias (participants' tendency to respond affirmatively to questionnaire items) (Hinz et al. 2007) cannot be fully precluded, the questionnaire was designed to minimise bias and capture fishers' true attitudes. Fishers' positive attitudes could be explained by the long absence of an MMS population from the area. Even though 55.7% of fishers who participated in the questionnaire had over 30 years of fishing experience, no personal incidents with seals were reported. This was due to extirpation occurring in the 1960s, so most fishers could only talk about stories from previous generations. Fishers in Mali Lošinj shared stories about persecution around the time of World War II, while fishers in Vis discussed stories of seal killings in the late 1960s and early 1970s. This could explain why fishers on Vis were more aware of MMS-fishers conflict and less supportive of a return. Whilst our results suggest that persecution may no longer be an immediate threat to MMS in Croatia, fisher-dolphin conflict does occur in Croatia and Italy resulting in economic loss for fishers and leading to retaliatory behaviours and persecution (Li Veli et al. 2023). Eighteen fishers in Mali Lošinj and three in Vis raised the issue of dolphin-fisher conflict unprompted. However, following the protection of Bottlenose dolphins (*Tursiops truncatus*) under Croatian law, persecution levels reportedly dropped and solutions to depredation are being explored (Li Veli et al. 2023; Blue World Institute 2024).

Global analyses show that 50% of pinniped populations for which data was available are significantly increasing (Magera et al. 2013). Analyses also show hotspots for high potential pinniped-fishery interactions/conflict, which includes one in the Aegean Sea (Jackson et al. 2024). Whilst the current attitudes of fishers in Croatia towards MMS seem to be positive, there have been examples of attitudinal shifts following the return of predator species, showing that attitudes are liable to change depending on the circumstances (Majić and Bath 2010). Our study also found that attitudes differ amongst fishers, so it will be important to regularly monitor fishers' attitudes in case of an MMS re-colonisation or intentional reintroduction initiatives (Delibes-Mateos et al. 2022). One mechanism for maintaining and enhancing positive attitudes could be through damage compensation. In Greece, where fishers have been allowed to claim EU funding for loss of profit resulting from interactions with dolphins and MMS (Karamanlidis et al. 2020), there has been a significant decline in levels of persecution over the past few decades, despite MMS-fisher conflict occurring in 21% of fishing trips (Capanni et al. 2024; Karamanlidis et al. 2020). During our study, fishers mentioned they receive compensation through EU funding for loss of profit resulting from interactions with dolphins. However, the latest EU regulations allow claims for loss of profit *and* damage to equipment, machinery and property caused by protected animals (European Union 2023). As Croatia classifies MMS as a strictly protected species (Official Gazette of the Republic of Croatia 2006), fishers should be assured that in the event of re-colonisation, they would be entitled to compensation. Another mechanism could be to provide financial support to develop and test new technologies to reduce the occurrence of MMS-fisher conflict, and if successful, support for fishers to invest in technologies (Papageorgiou et al. 2023). Educational workshops and awareness raising campaigns could also be used to engage fishers and showcase the positive attributes of re-colonisation (e.g., role in cultural heritage and as indicators of ecosystem health; Panou et al. 2023), particularly in the southern parts of Croatia, where we found lower levels of support for MMS return. Working closely with fishers on a management plan for the seals could lower the potential of future conflict (Konrad et al. 2024). If conflict does occur, deterrents may also be needed, such as observer programmes, GPS logging of boats and camera monitoring.

4.2 | Overfishing

Overfishing is considered the leading cause of depletion in fish populations in the Mediterranean (Karamanlidis et al. 2020). This not only negatively impacts marine mammals through accidental bycatch and decreased prey availability (Farella et al. 2020; Karamanlidis et al. 2020), but also those who are economically dependent on fishing (Li Veli et al. 2023). More than 60% of fishers engaged in our study believed there is less fish in the sea compared to when they first started fishing. Further,

some respondents felt that their catchment levels have remained the same only due to the use of new technologies and tools, and despite a decrease in total fish stocks. The results showed no significant differences between fishers' perceptions on changes in fish stocks between the two islands, indicating fishers in both north and south areas perceive overfishing as an issue. In addition to lowering fish stock levels, fishing practices in the Mediterranean and the Adriatic are resulting in severe degradation of the marine environment and present a further threat to marine wildlife (Bastari et al. 2016). For example, trawling is widely used within large-scale fishing operations, and its unselective nature poses a serious threat to marine life (Farella et al. 2020). Proportionally, the highest levels of trawling in the Mediterranean have been recorded in the Adriatic Sea (Russo et al. 2019). During our study, 18 fishers (7 in Mali Lošinj and 11 in Vis) volunteered their support for no-take zones as a solution to overfishing unprompted. A marine spatial planning approach would therefore be valuable to optimise the use of the sea space for the needs of people, wildlife and ecosystems (Frazão Santos et al. 2019).

Development of no-take zones, where fishing is prohibited, could help protect marine mammals, such as MMS, through a reduction in bycatch levels, an increase in prey availability, and by limiting boat traffic, while simultaneously increasing fish stocks in fishing areas through the spill-over effect (Bastari et al. 2016; Karamanlidis et al. 2020). Examples from Greece, Turkey, and Italy show that well-managed no-take zones can positively impact fishers' livelihoods and protect marine megafauna, such as MMS (Karamanlidis et al. 2020; Saydam and Güçlüsoy 2023; Bastari et al. 2016). No-take zones or protected marine areas could enable better control over destructive fishing practices (Bastari et al. 2016) and could also be used to regulate the activities of small-scale fisheries (SSFs), which are an often underestimated threat. Estimates show that more than 90% of the world's fishing vessels belong in this category (Grati et al. 2022). While studies have shown that fishers across the Mediterranean are mostly in favour of no-take zones (Karamanlidis et al. 2020), it is recognised that SSFs may be reluctant to accept restrictions, particularly when facing socio-economic challenges (Li Veli et al. 2023). As no-take zones could impact SSFs' short-term financial profits, incentives and subsidies could be used to improve acceptance rates, and investments in new technologies for fishers could improve fishing yields outside of no-take zones (Papageorgiou et al. 2023). Enforcement of no-take zones can be challenging (Saydam and Güçlüsoy 2023), and fishers in this study also identified this as a barrier. Enforcement could be achieved in different ways. For example, Sea Shepherd has run joint operations with Italian and Greek authorities to ensure the cessation of illegal fishing in protected areas (Sea Shepherd 2024). Alternatively, including fishers in the planning and management of no-take zones could result in a system of self-policing. In Turkey, a voluntary marine ranger system has been organised to support the coast guard (Saydam and Güçlüsoy 2023). Management of no-take zones could also greatly benefit from fishers' traditional ecological knowledge (TEK), as this can be an invaluable tool for monitoring species and ecological changes in marine environments (Grati et al. 2022; Papageorgiou et al. 2023). As the Croatian part of the Adriatic has been found to have high levels of species richness, working with fishers towards successful implementation of monitoring systems could be key to returning this area to its historical state with an abundance of MMS and other marine mammals (Ferretti et al. 2013; Bastari et al. 2016; Manea et al. 2022).

4.3 | Impacts of Tourism

Increasing levels of under-regulated tourism have been shown to have severe negative impacts on the marine environment and its wildlife (Panou et al. 2023; Johnson and Lavigne 1999). We investigated whether tourism could generate funding for conservation in coastal areas of Croatia through payment of conservation fees. The results showed near universal acceptance of conservation fees, with more than 95% of visitors prepared to pay. There was a preference (63.9%) for one-off fees on arrival compared with per-activity fees. A general one-off fee often generates more revenue, as every visitor contributes to the funding (Schuhmann et al. 2019). Our results suggest that a one-off fee on arrival could be a viable mechanism to generate funding for conservation activities such as habitat improvements and mitigation of negative anthropogenic pressures, which would benefit the MMS. Growing tourism and increased visitor numbers across their range have displaced MMS from open beaches—critical areas for MMS for resting and pupping (Dendrinos et al. 2022). In 2014, a tourist was fined and subsequently expelled from Croatia after punching a seal that was resting on a beach (RTE News 2014). As pressure on open beaches has increased, MMS have sought out caves and underwater entrances as alternative habitats (Johnson and Lavigne 1999). While some suitable caves provide better protection, many can still be accessed by boats and/or scuba divers (Karamanlidis 2024). For example, the famous Blue Cave on Biševo (Croatia), which was frequently visited by MMS prior to their extirpation, was first visited by tourists as early as 1848 (Johnson and Lavigne 1999) and remains a popular attraction today. The increased boating activity in the Mediterranean has led to unsustainable levels of noise pollution (Rako et al. 2013; Charrier et al. 2023), as well as chemical pollution (Capanni et al. 2024). MMS depend on communication with other individuals and the continuous increase in boating traffic is impeding their ability to do so (Charrier et al. 2023). Indeed, three of the fishers we interviewed mentioned the need to regulate tourism and associated boat traffic. In addition, the coastal development of hotels and resorts on top of, or near, suitable caves has been the lead cause of population declines due to the pollution and habitat destruction (Panou et al. 2023; Johnson and Lavigne 1999).

The 'Polluter Pays Principle' economic theory suggests that, as large levels of tourism can degrade and pollute natural environments, visitors should be obligated to pay conservation fees to mitigate this impact (Schuhmann et al. 2019). Similarly, the 'Beneficiary Pays Principle' suggests that visitors choose coastal destinations for the benefits they receive from natural marine environments, and as such, should pay for those benefits (Schuhmann et al. 2019). Studies have shown that visitors are increasingly willing to pay conservation fees (Getzner et al. 2017), especially when visiting countries such as Croatia, where the health of the marine environment is a key influencer in choosing their destination (Bastari et al. 2016). However, conservation fees as a source of funding remain extremely

underutilised (Aseres and Sira 2020). Our results indicate that Croatia could implement a one-off fee on arrival. This fee type is preferable for countries where visitors can gain environmental benefits across the whole national coastline (Schuhmann et al. 2019). Potential infrastructure for fee collection already exists (e.g., airports, ferry ports); however, a committee of management would be required to decide how such fees would be spent, ideally run by a collection of NGOs instead of government bodies as visitors have been shown to have higher levels of trust towards NGOs (Getzner et al. 2017). To ensure the long-term viability and effectiveness of a conservation fee system, investment in physical infrastructure and payment systems should be accompanied by appropriate legal and administrative frameworks as well as regulation and enforcement of tourism numbers and boat traffic. Awareness raising campaigns could be beneficial as educational tools for visitors and could be delivered at the point of fee collection to improve buy-in and to give transparency on how the fees will be used (Johnson & Lavigne, 199, Schuhmann et al. 2019). Most respondents (75%) stated that they would visit again if MMS were to return to the area, suggesting that MMS could be used as a flagship species. This could improve visitors' acceptance of any temporary restrictions to ecologically important areas (Getzner et al. 2017), such as closure of suitable caves during the MMS pupping season (Karamanlidis et al. 2020). The funds generated from fees could be invested into various initiatives—for example, habitat improvement through the provision of artificial ledges which have proven successful for supporting MMS resting and pupping (Saydam et al. 2023). Fees could also help support protected area management, governance and enforcement systems.

4.4 | Future of MMS in Croatia

Recent positive trends in MMS population size and range, and the re-colonisation of Albania (Bundone et al. 2022; Panou et al. 2023) and potentially Montenegro (Varda 2024) and southern Italy (Fioravanti et al. 2020; Bundone et al. 2023) suggest that other countries in the native range could experience a return of MMS in the near future (Bundone et al. 2019; Karamanlidis et al. 2023). As Croatia offers suitable habitats (Antolović et al. 2005; Bundone et al. 2013; Monk Seal Alliance 2024), it could be a leading candidate for future re-colonisation. However, to support an MMS re-colonisation and protect marine wildlife, governments of historic MMS range countries will need to consider whether current management options are suitable. We suggest working closely with fishers, demarking new no-take zones, establishing financial mechanisms for compensation and subsidies for fishers, developing awareness raising campaigns, and implementing one-off marine conservation fees for all visitors. The Croatian government should also consider expanding their marine protected area (MPA) network, currently at 5158 km^2 (9.34% coverage) (UNEP-WCMC 2025). This could benefit MMS through the protection of important areas and creation of corridors between key habitats (Panou et al. 2023). MPAs could impose fishing quotas (including through no-take zones), regulation of visitor numbers and boating traffic, and establish protocols for monitoring the health of the marine ecosystem (Manea et al. 2022; Panou et al. 2023). As many MPAs lack funding (Coad et al. 2019), if Croatia were to implement conservation fees on arrival, this could be used to support the management and enforcement of MPAs. This would help Croatia meet its goal of conserving 30% of its land, waters and seas, a key target set by the Kunming-Montreal Global Biodiversity Framework, which is reinforced by the EU's Marine Strategy Framework Directive (MSFD, CE/2008/58) (Bearzi et al. 2024; Farella et al. 2020).

Further research could inform and support implementation of management. Given that data on the MMS is sparse and challenging to collect, citizen/community science approaches could be used to improve data availability and inform conservation actions (Kelly et al. 2020; Adamantopoulou et al. 2023). The WTP element of this study was limited due to a small sample size and the short time period over which it was conducted (Schuhmann et al. 2019). Our study found that demographics did not affect WTP, whereas findings from the Lastovo Archipelago Marine Park in Croatia show that demographics can affect fee levels (Getzner et al. 2017). Further research could engage fishers in discussions about the viability and suitability of no-take zones, ensuring local TEK is captured. Studies on boat density, noise pollution from tourist activities, and their impact on MMS will also be needed to inform appropriate management and mitigation activities such as the development and regulation of MPAs (Charrier et al. 2023). It is clear that the Croatian government needs to be proactive in preparing for a possible MMS return. Further research will be needed to enable a thorough evaluation of the different management options considered in this study following input from two key stakeholder groups—fishers and visitors. These stakeholder groups have previously presented threats to MMS; however, this study shows that they could be constructive and valuable partners in supporting a future MMS return. Learnings may also be applied to other contexts where conservation goals may be at conflict with other economic and development interests. With MMS facing similar threats across their native range (Karamanlidis 2024), the management options considered in this study could be implemented across the Mediterranean in countries with potential for MMS re-colonisation. This would encourage the positive trends in MMS population size and range to continue, contributing towards the long-term viability of the species.

Author Contributions

Marty Terzic: conceptualization, investigation, funding acquisition, writing – original draft, methodology, validation, visualization, formal analysis, project administration, data curation. **Daniel J. Ingram:** conceptualization, funding acquisition, writing – review and editing, methodology, validation, visualization, formal analysis, project administration, supervision.

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Ethics Statement

The University of Kent Ethics Committee (ID: 20241712057482638) approved the research involving human subjects. Only individuals aged 18 or over were asked to participate in the study and all gave free, prior informed consent. Prior to taking part, participants were informed about the study's objectives, were informed that they would remain anonymous, and that their data would be protected. Participants were told that they could remove themselves from the study at any time without providing a reason why. Following this process, the participants were asked to provide oral consent to take part, which was marked down on the questionnaire. No permits were needed for this research.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data is not made publicly available to protect the fishers' identities given the studies were conducted on small islands with small fishing communities. Data may be made available upon reasonable request.

Use of Artificial Intelligence

AI was not used in the preparation of this manuscript.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Data S1:** Supplementary information.