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Valuing public preferences by eliciting ecosystem services trade-offs for the extension and management of marine protected areas in Italy

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ABSTRACT

Marine Protected Areas are central to Marine Spatial Planning strategies aimed at protecting biodiversity and sustaining ecosystem services, but their effectiveness ultimately depends on public support. This study investigates Italian citizens' preferences for Marine Protected Areas expansion through a Discrete Choice Experiment conducted across three coastal zones, the Northern Adriatic Sea, the Northern Tyrrhenian Sea, and the Strait of Sicily, selected for their distinct ecological and socio-economic profiles. Data were collected from 1961 valid respondents via an online survey stratified by age, gender, and income. The choice tasks presented respondents with policy alternatives defined by three attributes, Marine Protected Areas coverage, restriction levels, and an annual eco-tax. Responses were analysed using a mixed logit model to capture random preference heterogeneity and derive willingness to pay estimates. Findings provide novel quantitative evidence by linking household preferences to ecosystem service attributes and by examining regional differences. Results show that citizens strongly favour moderate restrictions over minimal or complete bans, with willingness to pay values up to €10.07 per household annually, and express positive but more modest support for expanding protected areas to 5–10 % coverage (willingness to pay up to €7.08). Regional heterogeneity emerged, with stronger support in northern zones compared to the more fisheries-dependent south, and pro-environmental attitudes were positively associated with preferences for stricter and larger Marine Protected Areas. Overall, the results offer quantitative economic evidence to support the design of socially acceptable conservation policies that align biodiversity targets with public priorities within the framework of sustainable Marine Spatial Planning.

1. Introduction

Rising human demand continues to expand maritime and upstream activities, intensifying anthropogenic pressures and contributing to the progressive degradation of ocean health (Borja et al., 2024). As a result, marine ecosystems are experiencing biodiversity loss and resource depletion, which weaken their ecological resilience and exacerbate the impacts of global stressors such as climate change and ocean acidification, ultimately affecting human well-being. Such socio-ecological interaction is captured by the concept of ecosystem services (ESs), which refers to the goods and benefits that ecosystems provide to people (Pascual et al., 2022; MEA, 2005). ESs arise from ecosystem structures, functions, and processes, and sustain human life by supplying resources, maintaining a habitable environment, and fulfilling a range of cultural and non-material needs (Bennett et al., 2015). Healthy and functioning marine ecosystems therefore underpin key human activities, whose performance depends on the continued provision of ESs (Gacutan et al., 2019).

These challenges have prompted the development of policy frameworks grounded in area-based management tools to reconcile conservation objectives with the socio-economic uses (Borja et al., 2024; Nash et al., 2020). Marine Spatial Planning (MSP) provides a structured framework for analysing interactions among maritime activities and promoting sustainable economic development, ecosystem protection and responsible marine resource use (Galparsoro et al., 2021; Ehler and Douvere, 2009). This is operationalized through the coordination of overlapping uses under multi-layered governance ranging from international conventions to local laws (Galparsoro et al., 2025; Frazão Santos et al., 2019).

Within this framework, Marine Protected Areas (MPAs) represent a spatial management tool to regulate human activities and protect ecosystem integrity. MPAs are typically organized into zoning systems that differentiate between no-take areas, partially restricted zones, and lightly regulated zones applied to selected activities and uses

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(Aminian-Biquet et al., 2024; Hall et al., 2023).

Evidence shows that MPAs generate positive outcomes, including increases in biodiversity, biomass and associated ESs (Potts et al., 2014; Spanier, 2024). Provisioning services are enhanced through biomass recovery in no-take zones, supporting spillover into adjacent areas and sustaining fisheries yields while preventing habitat degradation and fostering the recovery of habitat-forming species (Lester et al., 2009; Marcos et al., 2021; Stephenson et al., 2019). Regulating services include carbon sequestration, coastal erosion mitigation, storm buffering, and improved ecological resilience (Di Lorenzo et al., 2020; Sala et al., 2018). Cultural services are supported through eco-tourism, diving, and educational opportunities promoted by MPAs (Pacifico et al., 2025; Leenhardt et al., 2015). The ecological effectiveness of MPAs, and their capacity to deliver ESs, is shaped by multiple factors, including their age, size, zoning and permissible uses (Zupan et al., 2018; Leenhardt et al., 2015; Edgar et al., 2014; Potts et al., 2014).

Currently, MPAs cover around 12 % of EU marine waters and are designated under national law, EU directives (i.e., Habitats and Birds Directives, Natura 2000), and regional sea conventions such as Barcelona, OSPAR, and HELCOM (EEA, 2022). At the global level, the Kunming–Montreal Global Biodiversity Framework set the "30 by 30" target, calling for the protection of at least 30 % of terrestrial and marine areas by 2030 (CBD, 2022).

Within the European Union (EU), this commitment is reflected in the Biodiversity Strategy for 2030 (COM/2020/380), which requires 30 % of land and sea to be protected, including 10 % under strict protection. For member states such as Italy, meeting these targets necessitates both the expansion and more effective management of existing MPAs. The implementation of the EU Maritime Spatial Planning Directive (2014/89/EU) has further contributed to the designation and expansion of MPAs, advancing their planning by informing their designation and adaptation (Frazão Santos et al., 2025; van den Burg et al., 2023; Trouillet and Jay, 2021).

Effective MPA design and management require identifying the ecological and socio-economic benefits provided by marine ecosystems (Van Schoubroeck et al., 2024).

Beyond ecological considerations, effectiveness also depends on social acceptance and stakeholder involvement (Cadoret and Jones, 2024). Public support is increasingly recognized as a prerequisite for ensuring that MPA policies are both ecologically effective and socially legitimate (Raabe et al., 2024). Acknowledging these dual ecological and socio-economic dimensions is fundamental to evaluating trade-offs in MPA expansion and to integrating stakeholder preferences into conservation and planning strategies (Roncin et al., 2008; Voyer et al., 2012).

Assessing such support is particularly relevant, given the central role of MPAs in MSP strategies that seek to balance ecological protection with socio-economic uses of the sea while fostering participatory marine governance (Di Franco et al., 2020).

While stated preference methods have increasingly been used to investigate public support for MPAs (Soliño, 2023; Ruiz-Frau et al., 2019; Wallmo and Kosaka, 2017), quantitative evidence for Italy remains limited. Existing research has mainly examined perceptions and attitudes (Intonti et al., 2024; Floris et al., 2020), without providing estimates of residents' preferences for specific policy alternatives. Moreover, potential regional variation across Italy's different coastal zones and the role of individual attitudes remains underexplored.

In this regard, the objective of this study is to investigate Italian citizens' preferences for the expansion and management of MPAs across three different coastal zones which were selected for their distinct ecological and socio-economic profiles. A Discrete Choice Experiment (DCE) is employed to estimate willingness to pay (WTP) for different levels of restrictions and spatial coverage, linking stated preferences to ES attributes and examining differences across regions and environmental attitudes. The research relies on the design of an eco-tax, with the aim of identifying the amount that citizens would be willing to contribute to a financing scheme dedicated to supporting the expansion of MPAs. Accordingly, the main research questions of this study are as follows: (1) What are the most valued features of MPAs according to Italian coastal residents, and how do these preferences vary across zones? (2) How much are residents willing to pay annually to support different levels of protection and coverage in MPAs? (3) To what extent do regional context and individual environmental attitudes influence the likelihood of supporting more restrictive or expansive MPA policies? By addressing these questions through a structured approach, the study aims to inform the design of socially acceptable and effective MPA policies that align biodiversity conservation goals with public priorities.

2. Materials and methods

2.1. Study areas

The study was conducted across three distinct socio-ecological systems in Italy. The three areas include the Northern Adriatic Sea (NAS), encompassing the coastal regions of Veneto, Friuli Venezia Giulia, Emilia-Romagna and Marche; the Northern Tyrrhenian Sea (NTS), including Liguria and Toscana; and the Strait of Sicily (SOS), corresponding to the island of Sicily (Fig. 1). Together, these areas capture the social and ecological heterogeneity of Italy's northern and southern coastal territories, ranging from highly exploited to ecologically rich yet socio-economically vulnerable systems. This gradient provides a representative framework for analysing public preferences for the expansion and management of MPAs.

The NAS includes one of Italy's most urbanized and industrialized marine regions, characterized by soft-bottom habitats, lagoons, estuaries and deltas, as well as *tegnùe* bio-concretions acting as biodiversity hotspots. The area experiences eutrophication and marine litter accumulation (Solidoro et al., 2009) and hosts major ports (Venice, Trieste, Ravenna, Ancona), tourism, and intensive fisheries and aquaculture, particularly mussel and clam farming. Main conservation measures include the Po Delta and Conero Regional Parks (Marangon et al., 2008). In addition, the area hosts the Miramare MPA, which extends over 30 ha (ISPRA, 2024).

The NTS features rocky seabeds, *Posidonia oceanica* meadows, deep-sea corals, and submarine canyons. It hosts the western portion of the Pelagos Sanctuary for cetaceans. Socio-economically, the coast is densely populated, with major ports (Genoa, La Spezia, Livorno), artisanal fisheries, aquaculture, and a strong nautical and cultural tourism sector. Conservation efforts include the Tuscan Archipelago National Park, the Pelagos Sanctuary, and four MPAs, namely Cinque Terre, Portofino, Porto Venere, and Secche della Meloria. Together, these MPAs cover 14,524 ha, while the Pelagos Sanctuary for the protection of marine mammals in the Mediterranean extends over 8,750,000 ha (ISPRA, 2024).

The SOS is a biodiversity hotspot and a transition area between the western and eastern Mediterranean, with Posidonia meadows, coral banks, and seamounts sustaining fish, cetaceans, turtles, and seabirds (Consoli et al., 2021). Socio-economically, the SOS is highly dependent on fisheries, with Mazara del Vallo as Italy's main deep-sea fishing port. Tourism is expanding, supported by rich underwater cultural heritage. Key challenges include industrial pollution, coastal erosion, and climate change impacts. Main conservation measures include seven established MPAs (i.e., Isola di Ustica, Isole Ciclopi, Isole Pelagie, Capo Gallo–Isola delle Femmine, Plemmirio, Isole Egadi, and Capo Milazzo) extending approximately 78,000 ha and the Pantelleria National Park (ISPRA, 2024).

Under the Italian MSP framework, national legislation has identified several sites proposed for future inclusion in the MPA network. Two prospective MPAs have been designated for the NAS, three for the NTS, and eight for the SOS, reflecting national priorities for expanding spatial protection across these basins (MASE, 2025).

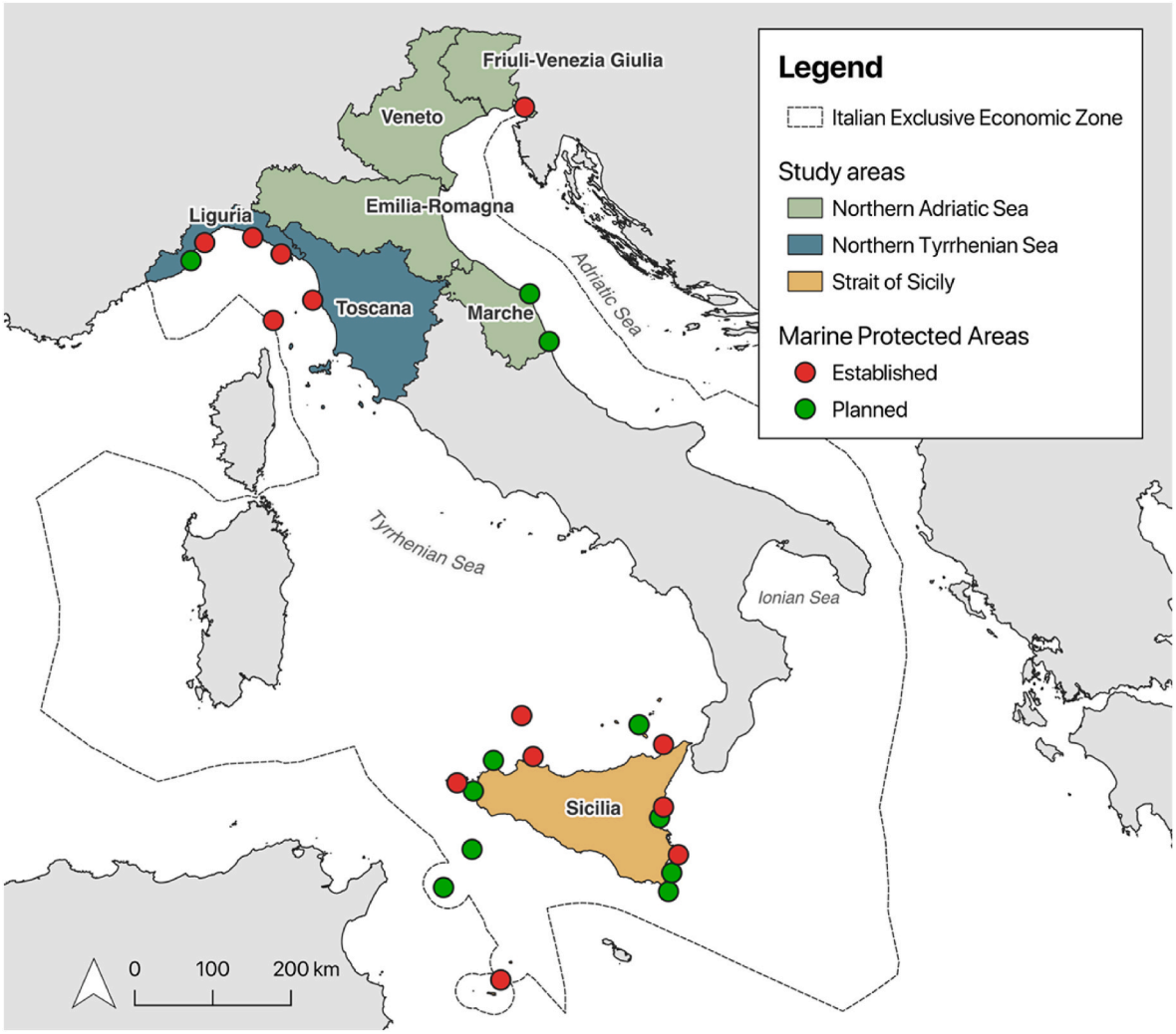

Fig. 1. Study areas included in the Discrete Choice Experiment (DCE): the Northern Adriatic Sea (NAS), encompassing the coastal regions of Veneto, Friuli Venezia Giulia, Emilia-Romagna and Marche; the Northern Tyrrhenian Sea (NTS), covering Liguria and Toscana; and the Strait of Sicily (SOS), corresponding to the island of Sicily. The map also shows the established and planned Marine Protected Areas (MPAs) across the three study areas.

2.2. Discrete Choice Experiment design and sampling

A DCE is a stated preference method that elicits individuals' preferences by presenting a set of mutually exclusive policy alternatives. The approach enables the systematic assessment of how different attributes of policy and management interventions are valued, making it particularly suitable for analysing public preferences in the context of conservation and natural resource management (Enthoven et al., 2025; Pacifico et al., 2025; Hanley et al., 2001).

A structured online questionnaire was developed within the "National Biodiversity Future Center – NBFC" (Spoke 2) project. A focus group involving 10 participants, including researchers, MPAs managers, policymakers from regional governments and representatives of environmental organizations, was conducted to organize the questionnaire and conceptualise hypothetical yet feasible policy scenarios. The questionnaire consisted of four sections. Section 1 collected geographical and socio-experiential information, including the respondent's region of residence, previous direct or indirect experience with MPAs (e.g., having visited an MPA), and the level of personal engagement in environmental activities. Section 2 assessed respondents' awareness of marine conservation policies and included questions capturing their interest in marine protection issues and their support for government intervention in coastal and marine management. Section 3 introduced the main part of the survey, presenting the scenario used for the DCE. Respondents were informed that the government was considering implementing new measures to protect marine areas in their region through the extension and management of the MPA network. A total of 8 choice tasks designed to simulated three hypothetical policy scenarios and a status quo option were generated and split into two blocks to reduce participant burden and maintain response quality. The status quo option was presented as a no-cost option and indicated that no action would be taken and that the existing coverage and management of the established MPAs would remain unchanged. The hypothetical scenarios were defined by three key attributes, namely MPA coverage, restriction level and a payment vehicle represented by an annual eco-tax per household used to finance MPA extension and management. The attributes and related levels, whose description are detailed in Table 1, were formulated to reflect variations in the provision of ESs. Specifically, provisioning services were linked to limitations on commercial fishing, regulating services were reflected in the degree of ecosystem protection, and cultural services were associated to access for recreational activities including boating, snorkelling, and recreational fishing. Supporting services were represented by the role of biodiversity in sustaining ecological functions and long-term ecosystem resilience. By linking attributes to these different categories of ESs, the design captured both use values, derived from direct interactions with marine resources, such as fishing or recreation, and non-use values, which relate to the benefits individuals derive from the existence, preservation or bequest of ecosystems (Van

Table 1
Attributes and levels used in the discrete choice experiment design.

Attributes	Levels	Description	Variables
Restriction level	Minimum Restriction	There are no significant prohibitions. Recreational activities are allowed under management and monitoring rules. Professional fishing is permitted with authorization. Ecosystem protection is minimal.	BASE
	Moderate Restriction	Access is regulated for high-impact recreational activities. Local fishers may operate in selected areas with low-impact gear. Ecosystem protection is moderate.	MOD_RESTR
	Complete Restriction	Access is highly restricted or entirely prohibited, with most activities harmful to flora and fauna banned. At this level, ecosystem protection is maximized.	COMP_RESTR
MPA coverage	1 %	1 % of the regional marine surface is protected, ensuring limited biodiversity protection.	BASE
	5 %	5 % of the regional marine surface is protected, providing moderate biodiversity protection.	MPA5 %
	10 %	10 % of the regional marine surface is protected, ensuring maximum biodiversity protection.	MPA10 %
Annual Eco-Tax per family	€6	Low contribution per household.	ECO-TAX
	€12	Medium contribution per household.	
	€24	High contribution per household.	

Schoubroeck et al., 2024). In doing so, it provides insights into trade-offs by revealing the economic value people assign to changes in the quality and quantity of ESs (Tyllianakis, 2022)

Finally, Section 4 asked participants to reflect on which attributes influenced their choices and included questions on sociodemographic information including age, gender, education, household composition, and income.

Prior to the final survey, the questionnaire was tested through an online pilot involving 100 participants. It was subsequently refined to improve the clarity of the questions and the scenario, improve the attribute descriptions, enhance the visual presentation, and simplify the language. Visual aids and examples were incorporated to clarify differences between attribute levels and support respondents in making informed decisions (Fig. 2).

Once finalised, the survey was administered online by a professional survey company (Demetra Opinioni.net) between May and June 2025. Sampling was stratified by age, gender and income to achieve a balanced distribution of responses across the study areas, thereby ensuring population representativeness and enabling comparative analyses of individual preferences in each area. To ensure data quality, a time-based screening criterion was applied. Respondents completing the full questionnaire in less than 3 min were excluded from the sample, as such completion times were considered insufficient to properly engage with the choice tasks and questions. An attention check was also embedded in the questionnaire to assess response consistency, and respondents who failed this test were removed the sample. Based on these criteria, 229 respondents were excluded, resulting in a final sample of 1961 valid responses. The sample included 623 respondents from the NAS, 755 from the NTS, and 583 from the SOS. The demographic profile of respondents across the three study areas is summarized in Table 2.

2.3. Data analysis

The experimental design was created using Ngene 1.4.0 software. An orthogonal design structure was preserved to ensure minimal correlation among attribute levels across alternatives and tasks. The priors used were normally distributed for the non-monetary attributes and constrained (negative) for the cost attribute, reflecting prior expectations from theory and previous studies (Street et al., 2005). The design ensured both efficiency and orthogonality, meeting core criteria for statistical robustness and interpretability. All attributes were dummy-coded during analysis, using the lowest levels as the base

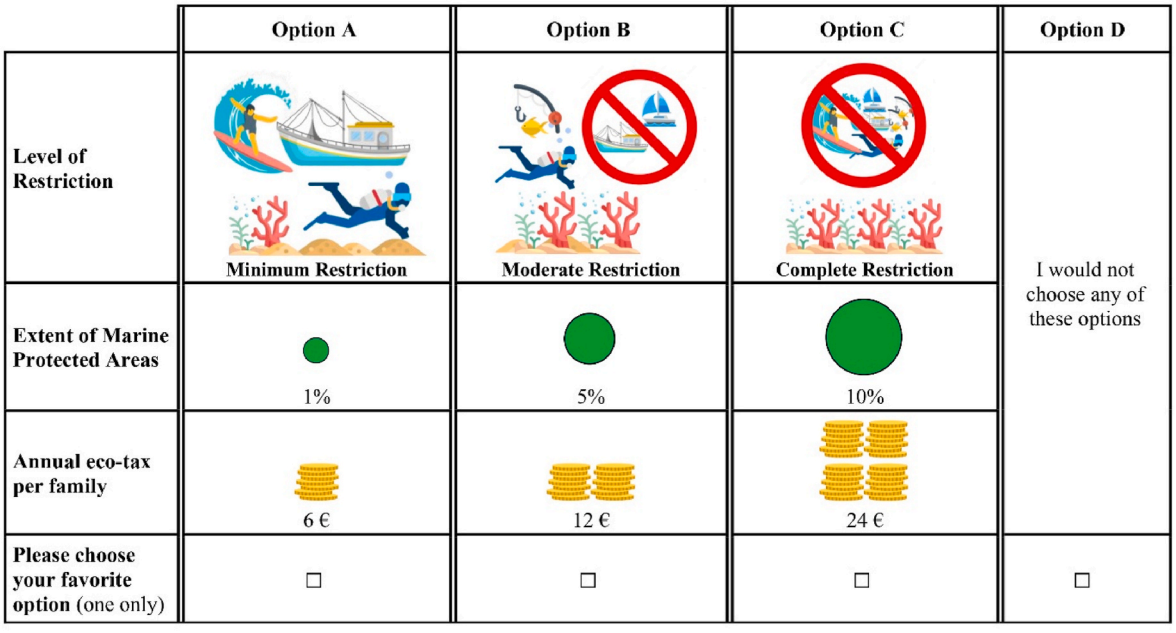

Fig. 2. Example of a choice card showing three policy scenarios with varying attribute levels (MPA coverage, restriction level, annual eco-tax), plus a no-cost status quo option where no action is taken and current MPA coverage and management remain unchanged.

Table 2
Demographic profile of the survey sample for the Northern Adriatic Sea (NAS), the Northern Tyrrhenian Sea (NTS), and the Strait of Sicily (SOS).

Variable	Category	NAS	NTS	SOS
Gender	% Women	53 %	51 %	51 %
Age	Mean	49.88	49.70	48.24
	Median	51	51	49
	Std. Deviation	13.97	13.32	14.30
Income	0–26,000 €	49 %	53 %	67 %
	26,000–55,000 €	40 %	29 %	28 %
	55,000–75,000 €	7 %	11 %	3 %
	>75,000 €	4 %	7 %	2 %
Education	University	33 %	40 %	31 %
	High school	56 %	48 %	54 %

categories.

R 3.5.1 was used to analyse the data for this study. The analysis of stated preferences in this study is grounded in the Random Utility Theory (RUT), which posits that individuals derive utility from attributes of alternatives and make choices that maximize their utility (Lancaster, 1966). According to RUT, the utility U_{ijt} that individual i associates with alternative j in choice task t can be expressed as (McFadden, 1974) (Eq. (1)).

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} \quad (1)$$

Where V_{ijt} is the deterministic component of utility, explained by observable attributes of the alternatives, and ε_{ijt} is the random error term capturing unobserved influences. Following the specification in McFadden's framework and as applied in recent environmental economics literature, the deterministic component V_{ijt} was modelled as a linear combination of choice attributes.

In this study, a Mixed Logit (MXL) model was estimated. The MXL model accommodates repeated choices and accounts for random preference heterogeneity by allowing coefficients to vary across individuals (Train, 2009). The dataset was transformed into long format, with each row representing an alternative within a specific choice situation. Dummy variables were created for the categorical attributes (restriction level and MPA coverage), while the eco-tax attribute was treated as continuous. The utility function was specified as follows:

$$U_{ijt} = \alpha\ .ASC + \beta_1 V_{1ijt} + \beta_2 V_{2ijt} + \beta_3 V_{3ijt} + \beta_4 V_{4ijt} + \beta_5 P_{ijt} + \varepsilon_{ijt} \quad (2)$$

In Equation (2), U_{ijt} is the utility that individual i derives from alternative j in choice situation t. α is the coefficient for the alternative-specific constant (ASC) representing the opt-out option, which is coded as 1 when the status quo option is chosen and 0 for all other alternatives. V_{1ijt} and V_{2ijt} denote the dummy variables for restriction levels (i.e., moderate, complete; base: minimal), while V_{3ijt} and V_{4ijt} represent the dummy variables for MPA coverage (i.e., 5 %, 10 %; base: 1 %). P_{ijt} is the annual eco-tax (continuous). Each β coefficient represents the marginal utility associated with the corresponding attribute, while ε_{ijt} is the stochastic error term.

To capture preference heterogeneity, all non-monetary attribute coefficients were modelled as normally distributed, while the cost coefficient was constrained to be negative, following either a triangular or log-normal distribution.

WTP for each attribute was derived in preference space as the marginal rate of substitution between the attribute and the cost coefficient (Eq. (3)):

$$WTP_k = -\frac{\beta_k}{\beta_p} \quad (3)$$

3. Results

3.1. Respondents' environmental behaviour and policy awareness

Across the three study areas, respondents exhibited notable variation in environmental engagement, familiarity with MPAs and awareness of policy frameworks. Participation in environmental initiatives was generally low, with most individuals reporting that they engaged either rarely or only occasionally. Regular participation remained limited, ranged from 7 % in the NAS to 12 % in the SOS, highlighting consistently low involvement in structured environmental activities across regions.

Self-reported experience with MPAs showed comparable variability. Between 16 % and 20 % of respondents in each area stated that they had never visited an MPA, while a substantial proportion, particularly in the NAS (23 %) and NTS (28 %), reported being unsure whether they had ever visited one. This pattern indicates limited recognition of existing MPAs and low awareness of their geographic boundaries or designation status.

Policy awareness was limited in all areas. Between 48 % of respondents in the SOS and 62 % in the NTS reported they had no knowledge of current policies governing MPA development. The SOS was the only area in which more than half of the respondents reported at least minimal awareness, suggesting greater exposure to policy processes in this region compared with the northern basins.

Across all study areas, respondents' self-reported determinants of their choices indicated a consistent hierarchy of attribute relevance. Biodiversity protection was most frequently identified as the primary factor influencing decisions, while the importance attached to recreational opportunities was highest in the SOS. Professional fishing activities were also reported as particularly relevant in the SOS and NAS, reflecting the socio-economic importance of extractive activities in these basins. These patterns suggest that respondents considered both ecological benefits and socio-economic implications when evaluating policy alternatives, supporting the interpretation of their stated preferences as reflecting ESs trade-offs across different regional contexts.

3.2. Valued features of MPAs

The MXL results reveal consistent patterns in how Italian coastal residents evaluate different features of MPA expansion. Across all three zones, the coefficients for moderate restrictions were strongly positive and highly significant (NAS: $\beta = 1.52$, $p < 0.001$; NTS: $\beta = 1.43$, $p < 0.001$; SOS: $\beta = 1.19$, $p < 0.001$) (Table 3). This indicates that respondents clearly favoured policies introducing moderate levels of restriction compared to minimal restrictions, suggesting that citizens generally support policies that balance conservation with continued access to marine resources. The consistently large coefficient values also highlight that moderate restrictions are perceived as both effective and acceptable, representing a policy compromise that can reconcile ecological goals with socio-economic activities.

By contrast, complete restrictions were also positively valued, but their effect sizes were much smaller and statistically weaker (NAS: $\beta = 0.63$, $p < 0.001$; NTS: $\beta = 0.58$, $p < 0.001$; SOS: $\beta = 0.43$, $p < 0.01$). While this indicates that some degree of support exists for fully protected areas, the lower coefficients suggest that respondents are more cautious toward policies that entirely prohibit extractive and recreational uses.

With respect to MPA coverage, both the 5 % and 10 % levels were positively valued in all three zones. Larger coverage consistently attracted stronger support, particularly in the NTS, where both 5 % ($\beta = 0.89$, $p < 0.001$) and 10 % ($\beta = 1.10$, $p < 0.001$) coefficients were among the highest observed. These findings suggest that respondents are receptive to the idea of scaling up protected areas if restrictions remain moderate rather than absolute. The SOS displayed weaker coefficients ($\beta = 0.49$ for 5 % and $\beta = 0.65$ for 10 %), reflecting more cautious preferences, possibly linked to the stronger dependence of local economies on fisheries and other resource-intensive activities.

Table 3
Mixed Logit (MXL) models estimation results. Northern Adriatic Sea (NAS), the Northern Tyrrhenian Sea (NTS), and the Strait of Sicily (SOS).

Variable name	NAS		NTS		SOS	
	Coeff.	Std. Error	Coeff.	Std. Error	Coeff.	Std. Error
ASC	−6.0408***	0.6227	−7.1111***	0.7238	−7.270***	0.8269
MOD_RESTR	1.5219***	0.1081	1.4272***	0.1025	1.1942***	0.1154
COM_RESTR	0.6265***	0.1311	0.5755***	0.1261	0.4276***	0.1290
MPA5 %	0.7173***	0.0915	0.8905***	0.0860	0.4868***	0.0908
MPA10 %	1.0705***	0.0976	1.1022***	0.0955	0.6450***	0.0898
ECO-TAX	−0.1512***	0.0108	−0.1579***	0.0103	−0.1275***	0.0099
Standard deviation coefficient						
ASC	5.3620***	0.5444	6.2423***	0.5802	8.0448***	0.9249
MOD_RESTR	1.1879***	0.1554	1.2278***	0.1478	1.4598***	0.1442
COMP_RESTR	2.2010***	0.1782	2.4164***	0.1668	2.0918***	0.1714
MPA5 %	0.0133	0.1521	0.0647	0.1836	0.0472	0.1830
MPA10 %	0.9245***	0.1553	1.1544***	0.1414	0.4798*	0.2110
ECO-TAX	0.1337***	0.0109	0.1494***	0.0107	0.1253***	0.0106
Log Likelihood	−2423.1		−2885.7		−2298.1	
McFadden's R^2	0.299		0.311		0.290	

Note: * denotes significance at 10 %, ** at 5 %, *** at 1 %.

The eco-tax attribute was consistently negative and highly significant across all zones (NAS: $\beta = -0.15$, NTS: $\beta = -0.16$, SOS: $\beta = -0.13$; all $p < 0.001$). This confirms that higher financial contributions reduce the likelihood of selecting a policy scenario, as expected, and validates the internal consistency of the model. The magnitude of the eco-tax coefficients also indicates that, while respondents value MPA features positively, they remain cost-sensitive, underscoring the importance of carefully calibrating financing mechanisms.

3.3. Willingness to pay for MPA policies

The WTP estimates provide a quantification of how much households are prepared to contribute annually for alternative MPA features (Table 4). Across all zones, the highest WTP values were recorded for moderate restrictions, ranging from €9.04 in the NTS to €10.07 in the NAS. These values are substantially higher than those for complete restrictions, which ranged from €3.35 in the SOS to €4.14 in the NAS. This discrepancy underscores that while citizens are willing to financially support protection measures, they strongly prefer approaches that maintain some flexibility in marine use.

With respect to MPA coverage, WTP values followed a clear gradient. At the 5 % coverage level, residents were willing to pay between €3.82 (SOS) and €5.64 (NTS), while at the 10 % coverage level, contributions increased to between €5.06 (SOS) and €7.08 (NAS). This progression indicates that citizens recognize the added ecological and societal value of larger protected areas and are willing to support their expansion, although at lower levels than for restrictions. Importantly, the relatively higher WTP for 10 % coverage in the NAS and NTS suggests that northern regions are more supportive of ambitious spatial expansion, while southern respondents remain more cost-sensitive and cautious.

3.4. Regional and attitudinal differences

The comparative analysis across zones highlights notable regional variations in preferences and WTP. Respondents in the NAS consistently expressed the strongest support, with the highest WTP values for both restrictions (€10.07 for moderate) and coverage expansion (€7.08 for 10 %). This finding may reflect greater public awareness of marine degradation in this heavily industrialized and urbanized region, where pollution, eutrophication, and habitat loss are widely documented.

In the NTS, preferences were slightly different: while WTP for restrictions was lower than in the NAS (€9.04 for moderate restrictions), support for coverage expansion was relatively high, with €6.98 for 10 % coverage. This pattern suggests that residents in this zone, characterized by strong tourism and cultural values, may place more emphasis on the spatial extent of protection and its potential for sustaining eco-tourism and recreation.

By contrast, respondents in the SOS were the least supportive overall, with the lowest WTP values across attributes (€9.37 for moderate restrictions and €5.06 for 10 % coverage). These results point to greater scepticism toward restrictive measures in southern regions, where dependence on fisheries and economic vulnerability may increase resistance to policies perceived as limiting resource access.

The random parameter estimates reported in Table 3 further confirm substantial preference heterogeneity within each zone. The standard deviations for restrictions and opt-out options were consistently large and significant, indicating that while many respondents favour stricter protection, others remain opposed or indifferent. This variability is particularly relevant for complete restrictions, where high heterogeneity suggests polarized views between strong environmental advocates and more sceptical or economically constrained groups.

Finally, when linked with the attitudinal data collected in the survey, the results suggest that individual environmental attitudes strongly condition preferences. Respondents with higher pro-environmental orientations and stronger agreement with the effectiveness of MPAs were more likely to support larger coverage and stricter restrictions and expressed higher WTP. Conversely, respondents reporting lower concern for biodiversity were more inclined to select the opt-out option. These findings underscore that both regional socio-ecological context and individual attitudes play crucial roles in shaping support for MPA policies.

Table 4
Mean willingness to pay (WTP) estimates for the Northern Adriatic Sea (NAS), the Northern Tyrrhenian Sea (NTS), and the Strait of Sicily (SOS).

Attribute	NAS	NTS	SOS
Moderate restriction	€10.07	€9.04	€9.37
Complete restriction	€4.14	€3.64	€3.35
5 % MPA coverage	€4.75	€5.64	€3.82
10 % MPA coverage	€7.08	€6.98	€5.06

4. Discussion

This study provides new evidence on public preferences for the expansion of MPAs in Italy by linking restriction levels and spatial extent to WTP. Through the proposed approach, the analysis advances the application of pluralistic valuation methods, which may enhance social justice by reducing asymmetries in the access and use of overlapping areas and resources among different stakeholders (Villasante et al., 2023). Three key findings emerge. Citizens prefer moderate restrictions over complete bans, they support gradual spatial expansion, and their preferences vary significantly across regions and according to

environmental attitudes.

The study's novelty lies in providing the first multi-regional estimates of WTP in Italy, with the DCE incorporating ES-related attributes to directly link citizens' preferences to the ecological functions and socio-economic benefits of MPAs. This approach also provides insights into trade-offs by revealing the economic value people assign to changes in the quality and quantity of ecosystem services (Tyllianakis, 2022). Findings reveals a stronger preference for use-related values (i.e., maintaining access to resources) compared to non-use values (coverage expansion) consistent with previous evidence in literature (Tyllianakis et al., 2019; McVittie and Moran, 2010).

Respondents expressed a strong and consistent preference for moderate restrictions, which received the highest WTP values across all three zones. This confirms earlier findings that policies combining ecological protection with some degree of continued access are more socially acceptable (Ruiz-Frau et al., 2019). By contrast, complete restrictions were valued positively but less strongly, reflecting cautious support for fully no-take zones. This aligns with previous studies indicating that while citizens recognize the ecological effectiveness of strict protection, acceptance depends on how restrictions interact with local livelihoods and access rights (Horta e Costa et al., 2022; Edgar et al., 2014).

With respect to spatial extent, respondents favoured both 5 % and 10 % coverage levels relative to 1 %, with stronger preferences in the NTS and NAS. These results suggest that citizens are receptive to scaling up MPAs, provided restrictions remain moderate. The finding resonates with broader research demonstrating public willingness to endorse ambitious conservation goals when they are framed as compatible with socio-economic uses (Voyer et al., 2012).

The consistently negative and significant eco-tax coefficients indicate that while citizens value the ecological and social benefits of MPAs, they remain cost sensitive. This highlights the importance of designing financing instruments that are perceived as fair, transparent, and proportional to expected benefits. Previous studies have shown that acceptance of environmental levies depends on trust in how revenues are used (Hakam et al., 2024). Importantly, the inclusion of attitudinal measures shows that pro-environmental orientations amplify support for both stricter restrictions and larger coverage, indicating that individuals with stronger environmental attitudes are more willing to accept higher associated costs (Kaiser et al., 2023). This underscores the value of incorporating social-psychological dimensions into policy design, as attitudes can strongly mediate acceptance of conservation measures.

Furthermore, by comparing three distinct marine basins, the study highlights regional heterogeneity that has been largely overlooked in the literature. Significant standard deviations for restriction levels and opt-out options further revealed preference variations within each region, indicating that some citizens strongly support stricter protection while others remain sceptical. This heterogeneity mirrors findings in other Mediterranean contexts, where perceptions of fairness and trust in governance shape acceptance of marine policies (Cadoret and Jones, 2024). Regional patterns can be further interpreted in light of the existing MPA regime, planned designations and the socio-economic profiles of respondents in each study area. Residents of the NAS display the highest WTP, possibly reflecting greater awareness of ecological degradation in an industrialized basin. Here, where only the small Miramare MPA currently exists, WTP for moderate restrictions and for 10 % coverage is highest, potentially due to perceived urgency for enhanced protection and relatively favourable socio-economic characteristics, in terms of income and education. The two prospective MPAs identified under the national MSP framework appear broadly aligned with this willingness to scale up protection. In the NTS, WTP for moderate restrictions and spatial expansion remains high despite the presence of an existing network of four MPAs and the Pelagos Sanctuary. This suggests that respondents may perceive current protection as insufficient or may associate MPAs with co-benefits for tourism, cultural services, and small-scale fisheries, consistent with evidence from the Tuscan Archipelago, where a proactive segment of artisanal fishers sees MPAs as a tool for long-term sectoral sustainability (Di Cintio et al., 2026). The higher proportion of university-educated respondents and intermediate-to-high income classes facilitate greater support. By contrast, in the SOS, where seven MPAs already cover approximately 78, 000 ha and further sites are planned, respondents show lower WTP for additional coverage, although WTP for moderate restrictions remains substantial. Here, marginal gains from further expansion may be perceived as limited, while opportunity costs for fisheries-dependent communities are comparatively higher. The higher prevalence of low-income households on average may also constrain the willingness to bear additional costs. Together, these results suggest that Italy's uneven MPA distribution and the ongoing expansion under MSP interact with local socio-economic conditions to shape both public acceptance and perceived affordability. This interpretation is consistent with recent findings showing that MSP tends to align more closely with multiple-use MPAs, while exhibiting negative correlations with stricter MPAs that prioritise conservation over socio-economic criteria (Pegorelli et al., 2026). Taken together, these patterns underscore the need for tailored policy approaches that explicitly account for local socio-economic contexts when designing and implementing MPAs.

Stakeholder-specific perspectives, particularly those of fishers, may differ from the aggregate citizens preferences observed in this study. Fishers often experience MPAs more directly through changes in access, spatial limitations, and resource use. Those operating in legally designated MPAs are expected to show greater acceptability when they recognize the ecological, social, and economic benefits of effective management (Marzo et al., 2023). Recent research shows that fishers hold heterogeneous views on MPAs, with some seeing them as an opportunity for co-management, others acknowledging their usefulness but opposing restrictions in traditional fishing grounds, and a third group remaining sceptical and preferring stricter enforcement of existing rules over new spatial limits (Di Cintio et al., 2026). Enthoven et al. (2025) find that fishers in low-income coastal communities prioritise conflict-resolution mechanisms, boundary visibility and the socio-economic impacts of restrictions. Even where public support for moderate restrictions is strong, segments of the fishing sector may resist further spatial constraints unless measures are co-designed, perceived as fair and linked to visible benefits (Di Cintio et al., 2024; Horta e Costa et al., 2022). This highlights that social acceptance is closely tied to the perceived balance between ecological gains and livelihood outcomes. When MPAs are supported by comprehensive governance, effective management, and adequate development inputs, they are generally expected to deliver improved ecological outcomes and, in turn, contribute to increased income from fishing, harvesting or tourism-related activities (Enthoven, 2025).

The findings of this study offer several governance-relevant insights for the ongoing reform and implementation of marine resource management in Italy. The present results reinforce this message by demonstrating that WTP is substantial but not unlimited, suggesting that eco-tax schemes should be carefully calibrated to balance social acceptance while ensuring long-term viability and ecological ambition (Hakam et al., 2024). By quantifying WTP for protection levels and spatial extensions, the study provides monetary benchmarks for designing sustainable financing mechanisms (Ison et al., 2018). Strengthening financial sustainability is a central governance priority highlighted in assessments of MPAs (Bohorquez et al., 2023). The heterogeneity across regions underscores the need for place-based governance, in line with MSP strategies that expect distinct basins to contribute differently to national targets. Regions with stronger resource dependence may require more effective participatory and compensatory mechanisms to address the opportunity costs in terms of economic development that arise after the designation of MPAs (Zhang et al., 2024). Furthermore, the widespread preference for moderate restrictions has direct implications for zoning design in future MPAs. The results indicate that social legitimacy increases when strict protection is

combined with regulated access. This supports the development of multi-zone MPAs featuring core no-take areas surrounded by low-impact use zones, consistent with guidelines emphasising adaptive and context-specific management. Future research could investigate how WTP evolves in response to policy developments, communication strategies, and observable changes in ecosystem condition. Tracking these dynamics over time would improve the decision relevance of valuation studies and strengthen their contribution to adaptive and context-specific MPA governance.

5. Conclusion

This study investigated Italian citizens' preferences for the expansion and management of MPAs, linking policy attributes to the provision of ESs. The results reveal that citizens attribute the greatest value to moderate restrictions, confirming that policies combining ecological protection with continued and regulated access to marine resources are perceived as the most acceptable.

Nevertheless, some limitations should be acknowledged. First, the design of the DCE relied on simplified scenarios that may not fully capture the complexity of real-world MPA governance, including enforcement capacity and stakeholder conflicts. Second, the integration of ESs was indirect, based on proxies including restriction levels and spatial coverage, rather than on detailed socio-ecological indicators. Third, while the survey covered three ecologically and socio-economically distinct basins, it did not explicitly include stakeholder groups such as fishers or tourism operators, whose preferences may differ from those of the citizens. Finally, the cross-sectional nature of the data prevents us from capturing how preferences may evolve over time in response to changing ecological conditions, policies, or public awareness.

Despite these constraints, the study provides valuable empirical insights with relevance for policy and management design. The findings demonstrate that regional context significantly influences public support. Respondents from the NAS and the NTS, which are among the most exploited and ecologically degraded marine areas in Italy, showed a higher WTP for stricter protection and MPA expansion. By contrast, respondents from the SOS, where degradation is less immediately perceived, expressed lower WTP, suggesting that the urgency of protection is not equally recognized across regions. This underscores the need for context-sensitive communication and policy design that make ecological threats more tangible in regions where environmental decline is less visible.

WTP for spatial expansion follows a positive gradient but remains consistently lower than for moderate restrictions, indicating that how MPAs are managed matters more to the public than their spatial extent alone. The high WTP for both regulated access and expansion suggests that citizens support protection while still valuing opportunities to benefit from marine areas. In this regard, the eco-tax serves as both an indicator of public support and a potential financing mechanism for effective MPA governance, which requires sustained resources for enforcement, monitoring and research.

Overall, the contribution of this study lies in providing the first multi-regional assessment of public preferences for MPA expansion in Italy, offering timely evidence to support national efforts in meeting marine conservation and restoration objectives. By quantifying citizens' WTP for different degrees of protection and spatial extension, the study offers an evidence base for designing socially acceptable, regionally tailored and financially sustainable pathways for expanding Italy's MPA network. These insights can support national institutions in implementing biodiversity objectives through management models that balance ecological ambition with public preferences, thereby enhancing both legitimacy and long-term effectiveness.

CRediT authorship contribution statement

Andrea Mattia Pacifico: Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Sina Ahmadi Kaliji:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Luca Mulazzani:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization. **Giulio Malorgio:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization.

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Declaration of competing interest

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

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Data availability

Data will be made available on request.

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