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1. Introduction

The deep sea, defined as the waters and seabed areas below 200 m water depth, includes more than 95% of the global biosphere and represents the largest biome on Earth [1,2]. Contrary to what was believed in the past, the deep sea hosts high biodiversity [3–6] and sustains supporting, provisioning and regulating services that are crucial to human well-being [7,8]. However, with climate change, the expanding demand for deep-sea resources and the consequent increase in human impact threaten our chances of continuing to obtain these ecosystem services (ES) in the future [9–14].

The Mediterranean Sea covers an area of over 2.5 million square kilometres between Europe, Asia and Africa. It has an average depth of 1,500 m and a maximum depth that exceeds 5,000 m. It is also an evaporitic basin, characterised by high salinity, limited freshwater input, a microtidal regime, and high oxygen concentrations and oligotrophic conditions[5]. The deep-Mediterranean sea displays also high temperatures (ca 10°C higher than the Atlantic temperatures at the same depths). Although of relatively small dimension (in a world scenario), this semi-enclosed sea hosts a high proportion of endemic species and is considered a biodiversity hotspot [15,16].

Humans have used the resources of the Mediterranean for millennia, but only more recently have technological developments allowed the use of its deep-sea resources [17–19]. The anthropogenic activities that significantly impact the deep sea have changed from the disposal of residues and litter to active exploitation (mainly fishing). Moreover, climate change is predicted to represent likely the most dangerous threat to deep-sea ecosystems in the future [2]. Indeed, signs of a reduction in Mediterranean deep-sea biodiversity and ecosystem functioning in response to climate change are already evident, such as the changes in the trophic state of the deep-sea floor, altered carbon and nitrogen cycles, and reductions in the deep-sea bacteria, nematodes and benthic fauna [20–24]. Another growing phenomenon is the introduction of alien species into the Mediterranean basin [25,26], potentially negatively affecting the endemic fauna. Some studies have suggested that the loss of biodiversity is not only a moral wrong [27] but will also determine the decline of human well-being [11,28]. More efforts must be made to preserve the Mediterranean habitats and species, including the deep sea.

The benefits we gather from protecting biodiversity and the related ES exceed the costs of their conservation [12,29]. Although the interest in the deep sea is increasing, there are still many gaps in our scientific knowledge of the deep-sea environment and its ecosystem functioning [30,31].

Moreover, several methodological challenges greatly complicate the use of traditional valuation methods in terms of deep-sea ES [32,33]. Most of these ES are not traded on the market, which limits the use of market-based valuation methods. In general, the revealed preference methods that have

been considered have been hampered by the absence of any observable behaviour of people towards deep-sea ecosystems, even for indirect markets (e.g., tourism).

Methods such as discrete choice experiments (DCEs) are suitable for estimating preferences related to non-market goods and services, such as the deep-sea ES. This method can capture both use and non-use values, estimating people's preferences for hypothetical changes in the provision of the ES [28,34]. In addition, DCEs allow the researcher to convert the value of environmental goods or policies into an implicit value associated with particular attributes of these goods or policies. For this reason, DCEs have become popular for environmental evaluation over the last decade [35,36].

Unfortunately, deep-sea environmental goods and ES are unfamiliar to most people [37,38]. This lack of information and scientific gaps in our knowledge of deep-sea ecosystems [33] have contributed to the paucity of DCEs dedicated explicitly to the monetary estimation of deep-sea ES. Folkersen et al. [39] identified 65 studies (including both peer-reviewed papers and grey literature) investigating the relationships between deep-sea ES and economic value. Only 25 of these studies estimated any monetary value of one or more ES related to the deep sea, and only two used DCEs to estimate the individual willingness to pay (WTP).

In general, most economic valuations have been focused on marine biodiversity [40,41], particularly in the more "'charismatic' species, while the value of other important ES and more low-profile species have mainly been ignored [42]. For example, Scottish citizens revealed an overall WTP of between £70 and £77 per year per household to protect the national deep-sea biodiversity, which underlined the importance of its option and existence value [33]. In Norway, households were willing to pay between €274 and €287 annually to preserve the cold-water corals without disentangling the value attached to the corals as a habitat for fish from their existing value [43]. Other investigations have provided much lower estimates, with the WTP of the Irish people ranging from €0 and €10 per person to protect the corals of their country [44,45].

This study presents a Discrete Choice Experiment (DCE) used to explore the WTP of Italian households for some Mediterranean deep-sea ES, i.e. biodiversity (supporting), climate regulation (regulating), and scientific value (cultural). Given the lack of familiarity with the deep-sea environment among Italian households, we investigated their preferences for two exemplary deep-sea habitats, i.e. submarine canyons and cold-water corals. This allowed the possibility of reducing the cognitive distance from the deep sea and providing a plausible, understandable and meaningful decision context and valuation frame [46,47].

2. Materials and Methods

2.1. Discrete choice experiments

A DCE is a stated preference method in which consumers are asked to make a (hypothetical) choice among a set of alternatives, each of which is described by different levels of selected characteristics, known as attributes [48,49]. DCEs are used in environmental resource economics to estimate preferences for a technically divisible set of attributes of an environmental good. According to Lancaster's consumer theory, utilities for goods can be decomposed into separable utilities for their characteristics or attributes [50]. Additionally, random utility theory indicates that individuals acting rationally try to maximise their utility and hence would select the alternative that yields the highest utility to them.

The probability of an individual choosing an alternative from a choice set can be estimated using a multinomial logit (MNL) model. MNL models are well suited for behavioural modelling of polychotomous choice situations in which each choice among the alternatives is treated as a function of the characteristics of those alternatives, representing a starting point for most analyses of DCE data [49]. However, this relies on restrictive assumptions, such as the homogeneity of the preference structures and independence from irrelevant alternatives [51]. Thus, all population members are preference 'clones', which rarely holds in reality [48].

Random parameter mixed logit (RPL) models for panel observations obviate these limitations of preference homogeneity (i.e., that all respondents are preference clones), and allow for the more realistic hypothesis of taste variation across respondents [52]. These, thus, represent more flexible models that relax the assumptions used in MNL models. Moreover, respondent socio-economic characteristics can be incorporated into the RPL models to identify their effect on consumers' preferences.

2.2. Product and attributes selection

The number of attributes and levels were chosen to make the choice tasks less complex for the respondents [53,54] the values of the levels were defined to remain reasonable and scientifically acceptable. A complete list of the attributes, their definitions and their levels can be found in **Table 1**.

Table 1. Choice attributes.

Attribute	Description in the survey	Levels
Biodiversity	Percentage of deep-sea protected species: Many species live in the deep sea. Each species has particular characteristics and a functional role in the ecosystem. The extinction of deep-sea species would represent an irreplaceable loss.	• *Protect 5% of Deep-sea species* • Protect 10% of Deep-sea species • Protect 15% of Deep-sea species
Climate regulation	Increases in global temperatures: The deep sea contributes to limit temperature rises through carbon sequestration. The deep sea buffers the climate changes.	• *Limit the global temperature rise to 1°C* • Limit the global temperature rise to 0.5°C
Scientific value	Support for scientific research and diffusion of knowledge of the deep sea: Our knowledge of the deep sea is scarce. Increases in our awareness on the importance of the deep sea are needed	• *No research claim* • Support the scientific research and diffusion of knowledge of the deep sea
Donation (€)	Annual donation to an NGO to preserve the deep sea: Funds are necessary to cover the costs of environmental protection campaigns. Donations support NGOs in the protection of the deep-sea environment and biodiversity.	• Donate 10 euros • Donate 20 euros • Donate 30 euros • Donate 40 euros • Donate 50 euros • Donate 60 euros

* Baseline levels are in *italics*

The first selected attribute was biodiversity. Although biodiversity represents a supporting ES, and there are concerns regarding its valuation because of the problem of double-counting, it has already been successfully valued in other DCEs [33]. Moreover, as the deep-sea biodiversity is high [55] and is perceived as a conservation priority [56], it should be considered in conservation scenarios. In the present study, it was specified as the proportion rather than the number of protected species to facilitate respondent understanding. The attribute was modelled at three levels, each associated with different degrees of protection of deep-sea species, expressed as a percentage.

The second attribute refers to climate regulation. Regulating and cultural deep-sea ES sustain human well-being [57,58]. Nevertheless, their economic value is underestimated [59,60]. By absorbing atmospheric carbon dioxide, the oceans reduce the impact of global warming [61]. The deep sea constitutes a large portion of the ocean volume and contributes substantially to limiting increases in atmospheric temperature, also through the Carbon sequestration operated by deep-sea cacyfying organisms (e.g., deep-water corals [55]). For this attribute, two different levels of increase in global temperature were presented to respondents: 1°C and 0.5°C. Beyond being a source of inspiration, the deep sea provides discoveries of scientific, educational and entertainment value [57]. Public interest in deep-sea ecosystems is rising, partly due to the increasing number of documentaries on them [62]. Support for scientific research and diffusion of knowledge of this remote environment has been

included in only some scenarios. To the best of our knowledge, this is the first time that the deep sea's climate regulation and scientific value have been used as attributes in a DCE.

Concerning the cost attribute, Carson and Groves [63] indicated that to be incentive compatible, the payment vehicle used when valuing a public good must be compulsory. Theoretically, when the payment vehicle is voluntary (e.g., a donation), respondents have the incentive to exaggerate their willingness to pay (if they want the good at all) and then free-ride when payment is called [64,65]. However, studies have shown mixed results when comparing different payment vehicles. Ivehammar [64] reported that donations used as a payment vehicle result in lower (or the same) willingness to pay than mandatory payments (e.g., through taxes). In a study on renewable energy, Akcura [66] reported that UK households would prefer a voluntary payment scheme to support renewables. However, the respondents were less certain about paying their stated amount.

In the present study, the choice of using donations to environmental associations was based on the consideration that as such a payment vehicle is voluntary, this helped to make the valuation scenario more realistic than through taxes for highly unfamiliar public goods, such as deep-sea environments.

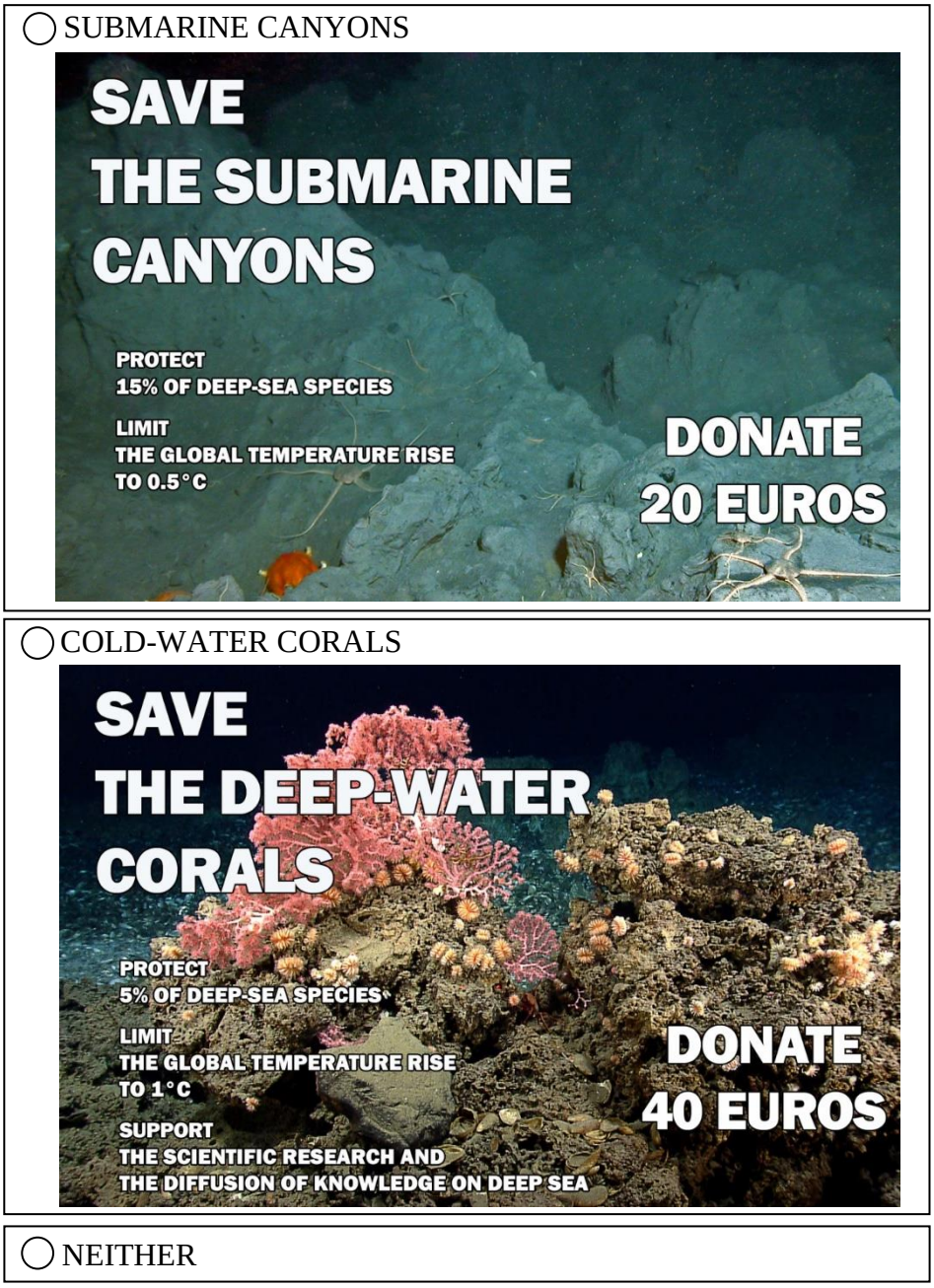
2.3. DCE design

Based on the priors obtained from a pilot study using the same survey instrument (26 respondents), a D-efficient choice set design with four blocks was developed. A total of 36 choice sets were obtained using the Ngene software [67]. Each respondent was randomly assigned to one block, composed of nine choice tasks. During the survey, those choice sets were further randomised within the blocks to prevent ordering effects [68].

Each choice task included three labelled alternatives. Two of these alternatives consisted of hypothetical campaign protection scenarios of the specific habitat that were aimed at increasing the conservation of the Mediterranean deep sea in return for an annual donation to a non-governmental organisation (NGO). A brief description of both was provided to the respondents. The first alternative was labelled as "Submarine canyons", and the second was labelled "Deep-water corals". Both were chosen because they represent two important environments in the Mediterranean deep sea [69–71], providing several ES to society [57,58]. The order in which these were presented to the respondents was also randomised [72].

For these submarine canyons and deep-water corals, the choice attributes were combined with images representing the two habitats (see **Figure 1**), making these scenarios more understandable to the respondents. These images were selected through a qualitative eye-tracking study [56], as they were those images that showed the highest attention to the attribute descriptions, therefore not distracting the respondents from the choice task.

Figure 1. Example one of the choice cards from the online survey.



The third option was "Neither", allowing the respondents to choose neither of the two hypothetical scenarios. The respondents were informed that, without new conservation strategies, the deep sea and the related ES would probably deteriorate in the near future.

The choice tasks were introduced by a 'neutral' talk on the consequences of their choices, noting that they could always choose the opt-out/ *status-quo* option. Instructions accompanied this on completing the questionnaire, reminding the respondents to account for budget constraints.

2.4. DCE estimation

The data were analysed using MNL and RPL models. The parameters of the RPL model related to the choice attributes were specified to be normally distributed, except for the cost coefficient. This was specified following a negative log-normal distribution. The model coefficients were estimated through simulation using 1,000 Halton draws from the mixing distribution [52]. The attribute coefficients indicated the change in the respondent utility of improving the deep-sea ES, starting from the baseline level.

A second RPL was estimated, including the respondents' sociodemographic characteristics (e.g. gender, age, education and income levels) as interactions with each attribute. Only the significant variables were kept in the final model. For this estimation, the age variable was categorised into under 30, 30-45 and above 45 years old. Also, the education variable was re-arranged into three categories: low (elementary and middle school), medium (high school) and high (bachelor, master or PhD). The income was recoded into three categories, based on the histogram and its distribution: low (less than €20,000 a year per family), medium (between €20,000 and €40,000) and high (more than €40,000). The reference categories were under 30, low education and low income. The Apollo code in the R [73] software was used to perform the models' estimations.

2.5. Data collection

Data were collected through an online survey of a panel of respondents recruited by Qualtrics. Stratified sampling was adopted to obtain a representative sample of the Italian population [74,75], taking into account age classes (18-30, 31-45, >45 years old), gender and geographic provenance (northern, central, southern Italy, and islands). The panel provided randomly collected 800 responses by selectively targeting the strata requested among the panel members, which together formed a large random sample representative of Italian households. Once a stratum was fulfilled, that stratum was not targeted anymore, and any further responses from that group were not collected. These strata thus acted as quotas, where any over-quota answers were not included in the analysis to ensure representativeness. Assuming there was no systematic pattern in the non-responses, such sampling can be referred to as sampling with probability proportional to the estimated strata size [76].

Respondents were introduced to the valuation's scope and framework, which provided them with key information regarding the deep sea in general and the Mediterranean deep sea in particular. Then, the participants were asked to rate how much of the information presented they felt they were already familiar with in a self-assessment question ranging from None to All. The respondents who stated that they had complete previous knowledge of the deep sea were excluded because they were considered not to be reliable or to represent a substantial deviation from the ordinary member of an Italian household. Experts views were ignored as they might generate bias and not truly reflect the general

population knowledge. Respondents with low knowledge on deep-see-related topics are likely to reflect the general population [77].

To further ensure the validity of the responses, attention filters were inserted in the survey instrument to control for respondent attention and to reduce strategic behaviours and decision heuristics. Here, these took the form of speed checks and attention checks, one of which was an extra choice task in which respondents were asked to select a predetermined alternative. Respondents who failed the attention checks or answered the survey in less than 150 seconds were excluded from the sample [78,79]. Respondents were also requested to provide additional sociodemographic data such as income and educational levels.

3. Results

3.1. Sample characteristics

In all, 800 respondents successfully completed the questionnaire. The sample was composed of 53% females and 48% males. 57% of participants were >45 years old. Almost half of respondents lived in northern Italy (46%). Overall, participants had a good level of instruction (graduates, 32%) and were employed (56%) with an annual family income between €10,000 and €40,000 (66%). On average, the households consisted of 2.6 (SD, 1.1) adults and 0.5 (SD, 0.9) children. Only a few respondents belonged to an environmental organisation (16%) or showed interest in diving (22%). Nevertheless, 47% of the respondents had previously donated money to NGOs, such as WWF, at least once. Overall, 78% of the donations ranged between €5 and €25 (

Table 2).

Table 2. *Socio-economic characteristics of the sample (N = 800)*

Characteristic group	Sub-characteristic	Proportion of survey sample (%)
Gender	Male	48
Age	18-30 years	17
	31-45 years	26
	>=46 years	57
Region	Northern Italy	46
	Central Italy	20
	Southern Italy and islands	34
Education	Primary school	1
	Middle school	12
	High school	53
	Bachelor degree	20
	Master degree	12
	PhD	2
Employment	Unemployed	13
	Student	6
	Part-time	13
	Full-time	43
	Retired	15
	Housewife	10
Family income	<€10,000	14
	€10,000-€20,000	23
	€20,000-€30,000	25
	€30,000-€40,000	18
	€40,000-€60,000	12
	>€60,000	8
Past donation[a]	Yes	47
	<€5	6
	€5-€10	40
	€10-€25	38
	€25-€50	12
	>€50	4
Information on deep sea	None	12
	Little	40
	Half	34
	Most	14
Knew of submarine canyons	Yes	62
Knew of cold-water corals	Yes	58

a Based on the 47% that had previously donated money to NGOs at least once.

Among the respondents, there was little knowledge of deep-sea ecosystems and biodiversity; almost half of the respondents had little or no information about the Mediterranean deep sea before the survey. Also, they had never heard about the submarine canyons and deep-water corals in 38% and 42% of cases, respectively. Documentaries were the first source of information on these habitats for most respondents

3.2. Model estimates and determinants of respondent preferences

Descriptive data shows that the opt-out alternative ("Neither") was selected in 45% of the respondents' choices. Among that 45%, the main reason for choosing the opt-out alternative was the

cost of the hypothetical scenarios (52%), followed by the idea that others should pay (40%), particularly the Italian state or those responsible for the environmental damage. Here, 16% of respondents thought the options proposed were not realistic. At the same time, a minority indicated that protection of the deep sea was not important (4%) or disagreed with additional restrictions on human activities in marine areas (3%). The other reasons (21%) included the financial difficulties caused by the economic crisis and the lack of trust regarding how the funds would be spent. The hypothetical scenarios for protecting the submarine canyons and deep-water corals were chosen in 21% and 34% of cases, respectively.

Three models were estimated: a MNL (homogeneous preferences), a RPL (heterogeneous preferences) and a RPL with sociodemographic interactions. Results of the model estimations are shown in

Table **3**. In general, the RPL specifications fit the data better and obviate the limitations of the standard MNL models by allowing for random taste variations and heterogeneity of respondent preferences [52,80]. The model fit improved from the MNL model to RPL and RPL with sociodemographic, as indicated by the decreasing log-likelihood and Bayesian information criterion and an increasing adjusted McFadden's ρ2. Including the socio-economic variables in RPL with sociodemographic variables did not appear to increase the predictive powers of the models.

Table 3. *Estimated coefficients for the MNL, RPL and RPL with sociodemographic variables models*

Coefficient	Multinomial logit model		Random parameter mixed logit model		Random parameter mixed logit model with sociodemographic variables	
	Coefficient	±SE	Coefficient	±SE	Coefficient	±SE
Asc_Canyon	-0.336***	0.083	1.824***	0.131	1.829***	0.136
Asc_Corals	0.198**	0.078	2.510***	0.129	2.515***	0.134
β Donation	-0.024***	0.002	-2.539***	0.121	-2.301***	0.084
β Biodiversity 10%	0.243***	0.050	0.328***	0.082	0.237***	0.083
β Biodiversity 15%	0.324***	0.048	0.408***	0.063	0.365***	0.066
β Climate Regulation	0.046	0.034	-0.005	0.045	-0.321**	0.144
β Scientific Value	0.193***	0.035	0.244***	0.045	0.211***	0.046
Donation (Sd)			2.415***	0.132	1.964***	0.117
Biodiversity 10% (Sd)			0.571***	0.184	0.441**	0.212
Biodiversity 15% (Sd)			0.778***	0.092	0.819***	0.089
Climate regulation (Sd)			0.514***	0.094	0.532***	0.094
Scientific value (Sd)			0.534***	0.086	0.539***	0.083
β Donation * Medium income					0.020***	0.004
β Donation * High income					0.022***	0.005
β Climate regulation * Medium education					0.299*	0.158
β Climate regulation * Higher education					0.450***	0.166
Log-likelihood	-7,317.76		-4,859.58		-4,834.37	
Adjusted ρ2	0.074		0.384		0.359	
Bayesian information criterion	14,697.69		9,825.73		9,810.84	

***, **, *Significance at 1%, 5% and 10% level, respecively; SD, standard deviation; SE, robust standard error

In all estimations, the alternative specific constants (ASCs) represent the variations in the preferences that are not explained by the choice attributes. As usual, one ASC (in our case, the "neither" alternative) was dropped to avoid perfect collinearity. As only differences in utility matter, the estimates obtained for each ASC parameter can be interpreted as the average effect of unincluded factors on the utility of each alternative relative to the baseline alternative ("neither") [52]. All ASCs were significant in all models. The utility of choosing submarine canyons or deep-water corals was significantly different from the utility of the opt-out alternative. Both alternatives showed higher baseline utility ($p < 0.001$) and were preferred over the "neither" option, except the MNL model, in which the canyon utility was negative. The coral alternative was always preferred in all model estimations.

The choice attributes regarding the deep-sea ES and the type of protected habitat were ranked mainly by respondents as important or extremely important factors for choosing either scenario. The donation amount was indicated as the least important factor in determining the choice of preserving submarine canyons and deep-water corals. Nevertheless, as theoretically expected, the parameter of the cost

attribute was negative ($p < 0.001$) for all specifications, indicating that the respondents were less likely to select the alternative if the associated cost (donation) was higher. However, estimations from the RPL with sociodemographic variables show that higher income levels were positively associated with less price sensitivity. This means that people with higher incomes might be more willing to pay for these attributes than people with lower income levels.

In all model specifications, increasing the protection of the deep-sea species (β *Biodiversity 10% and* β *Biodiversity 15%*) influences positively respondent choices. The attribute referring to the reduction in the rise of global temperature (β *Climate regulation*) was not significantly different from zero ($p > 0.1$), except in the RPL model with sociodemographic variables ($p < 0.05$). In this case, respondents with primary and middle school degrees had a negative preference for limiting the global temperature rise to 0.5 °C over 1 °C. Respondents with high school degrees presented a less negative preference towards limiting the global temperature rise ($p < 0.1$). In contrast, respondents with bachelor, master and Ph.D degrees had a favourable preference for the attribute ($p < 0.001$).

The utility parameter of scientific value was significant and positive for all model specifications. Respondents generally have a positive view of supporting scientific research and the diffusion of knowledge on the deep sea. However, all the random parameters' standard deviations were statistically significant for both RPL and RPL with sociodemographics variables ($p < 0.001$). This means that there is high heterogeneity among respondents' preferences. In fact, the RPL specification was preferred to the MNL model, as can also be seen by comparing the log-likelihoods.

Regarding all other sociodemographic variables, their interactions were not significant and did not appear to affect the choices or the marginal values. Overall, age and gender did not significantly affect any attribute. In contrast, income only affected the donation amount, and education affected the climate regulation attribute.

4. Discussion

The current work investigated Italian households' preferences for deep-sea ecosystem services through a discrete choice experiment. Although the estimates from the RPL models show high heterogeneity among respondents, interesting results arise. Many respondents selected neither of the hypothetical scenarios for protecting the Mediterranean deep sea. People's perception of the deep sea [56], the low public awareness of the importance of deep-sea ecosystems for human well-being [81] and the enduring economic crisis in Italy [82] might explain the large proportion of opt-outs. Indeed, the main reason for opting out was the donation cost. Respondents perceived the donation as too expensive or not affordable at the moment, as the levels of the cost attribute contributed to the determination of the people's budgetary restrictions [83,84].

In the present study, the minimum donation was €10 (maximum, €60). These values were set based on the average individual willingness to pay, defined by the reviewed literature. However, in many previous studies, the minimum payment was much lower [35,47]. This might be a limitation of the study, given that many respondents choose not to donate to any campaign. As a result, the interpretation of the remaining attributes is based only on those respondents that choose the submarine canyons or the deep-water corals. Moreover, deep-water corals emerged as the preferred habitat among the three alternatives in all model estimations. These might thus represent a "charismatic" deep-sea species for inclusion in future campaigns to promote public support for preserving part of the Mediterranean deep sea [85].

Regarding the attributes of both campaigns, respondents showed a favourable preference for protecting deep-sea biodiversity, which matches the previous literature [33,43–45]. In fact, it was the most preferred attribute, especially when protecting the 15% over only the 5% of deep-sea species. The reason might be the high visibility that marine biodiversity decline has compared to other attributes. There has been a significant increase in global initiatives in this area [6], such as the Census of Marine Life [86], the Ocean Assessments [87] and the UN Decade of Ocean Science for Sustainable Development [88]. Moreover, some conservation groups demand protection for at least 20-30% of each ocean habitat, far more than the 15% used in the discrete choice experiment [33,89].

An important finding is that the respondents revealed a null preference for limiting the global temperature rise due to carbon dioxide sequestration in the deep sea (climate regulation attribute). This implies that although the majority of people believe that human activity contributes to climate change (and global warming) [90,91], it does not mean that they are willing to bear the cost of climate change mitigation [92]. Layton and Brown [93] highlighted a substantial heterogeneity in references for mitigating global climate change impacts. People's preference for limiting the increase in global temperature remains controversial. It depends on several factors, among which there is the perception of global warming [94,95], environmentally friendly attitudes [96], the uncertainty regarding the mitigation policies [97,98] and the available information on climate change [99].

According to the RPL estimation with sociodemographic variables, information and knowledge generation availability seems to be the key for the deep sea. When the education level was considered in the estimation, respondents revealed a significant preference for limiting the global temperature. However, such preferences varied according to formal education levels. Respondents with a degree below high school had a negative preference for limiting the global temperature, while respondents with a bachelor's degree or above presented a favourable preference. Such difference highlights the critical role of education and knowledge generation in understanding the deep-see ES's role. As previous research has highlighted, there is a need to improve and share knowledge related to the environmental impacts caused by human beings on the resources of the deep-sea [14].

Many respondents might perceive low risks and dangers posed by global climate change [100]. Moreover, the scepticism for climate change mitigation policies might have also affected the respondent preferences [90]. Nevertheless, respondents had a significant and positive preference towards campaigns supporting research and diffusion of knowledge on the Mediterranean deep-sea ecosystems. Further research in this area should be encouraged, but not only. Results must be shared with the general public to build higher awareness of the role of scientific research and the importance of deep-sea ES for human beings [101,102].

The results suggest that in the short term, future campaigns to protect deep-sea biodiversity and to conduct scientific research on deep-sea ecosystems in the Mediterranean Sea should target higher-income individuals with a high awareness of the importance of natural resources for human well-being. Although formal education levels were only significant in limiting the global temperature, these individuals are likely to be those who have greater knowledge of the negative impact of human activities on our environment. As a longer-term strategy, education on the deterioration of the natural world and how human beans can reverse this trend should reach all corners of society. The key role of education is congruent with previous research [103,104]. Formal and non-formal educational programs incorporating environmental-related curricula could potentially provide effective tools to increase awareness and produce positive changes in behaviour towards the environment [105–107]. These initiatives should reach, in particular, the most disadvantaged individuals with limited access to knowledge and information. Moreover, such educational programs should be implemented at an early age, specifically in primary school, as previous research has established that this is the age at which environmental education will have a higher impact [108]

Other sociodemographic variables, such as age and gender, did not significantly interact with any of the attributes. This means there are no differences between respondents' preferences regarding age groups or gender. Regarding gender, previous studies present contradictory results. Dhenge et al. [107] found that while female respondents have a more favourable attitude towards eco-friendly agricultural development and organic food, male respondents have greater exposure to environmental issues and more positive attitudes towards environmental protection. On the other hand, previous studies have concluded that females are more pro-environmental than males [104,108,109]. However, some of these studies amainly focused on scholastic young populations [103,109], which might indicate a gender difference specific to age. Moreover, Arnocky and Stroink [110] suggested that gender differences are mediated by differences in emotional empathy. Several studies have found no significant differences between genders [111]. Such ambiguous results indicate the need for further research and analysis of the effect of gender on environmental awareness and attitudes.

In terms of age, young populations tend to be more enthusiastic and willing to accept changes. In fact, previous research shows that younger individuals present more positive attitudes towards the environment [107]. However, although environmental attitudes arise from individual characteristics,

they also depend on the interaction with other social groups [109], which makes them context-dependent. In the case of Italy, previous research on different environmental issues shows varied results. Prete et al. [112] concluded that younger individuals were more interested in implementing energy efficiency measures, while Aprile and Fiorillo [113] found that being older was a significant positive driver for water conservation behaviour. Given the diversity of results in terms of age, further research should explore this issue in specific contexts and diverse environment-related topics.

5. Conclusions

The deep sea represents the Earth's largest and least explored biome. The deep sea contains also huge resources (oil, gas, raw materials, biomass), which are being intensively exploited posing a serious threat to its conservation. This biome contains a large portion of the global biodiversity and provides essential ecosystem goods and services.However, the monetary value of these benefits has rarely been assessed. The present study analysed Italian households' preferences for deep-sea ecosystem services using a discrete choice experiment. Results show a wide heterogeneity of preferences among respondents. Many respondents declared that they would refuse to pay to support NGO initiatives aiming to conserve submarine canyons and deep-sea corals. The main reasons were linked to economic restrictions and the feeling that such investments are the responsibility of other individuals or organisations.

The deep-sea corals were the most attractive alternative among the respondents willing to support these initiatives. Respondents value biodiversity protection, followed by promoting scientific research on this remote and unfamiliar environment. Overall, global warming was of little concern. However, respondents with higher formal education were willing to support limiting the temperature increase. Such a result highlights the importance of awareness and knowledge in the general population.

Policymakers should promote campaigns focused on generating higher awareness and knowledge on the role of deep-sea ES for human beings to increase general population support for such initiatives. In order to have more successful results, these campaigns should be directed in particular to young children (primary school) and disadvantaged individuals with limited access to formal education. It is vital to make people aware of the importance of promoting and supporting further research in this area. Moreover, the collected donations should be managed transparently to increase people's trust in handling these funds.

Nevertheless, the current study presents some limitations. First, although stratified sampling was adopted, the data was collected using an online questionnaire. While online questionnaires allow reaching a variety of respondents, marginal groups without access to the web might have been

excluded. Moreover, quantitative methods such as questionnaires do not allow an in-depth view of the reasons behind the respondents' choices. Future research should also implement qualitative methodologies such as in-depth interviews, which can reach different points of view of society and provide more detail on individuals' points of view.

Second, the present study implements a hypothetical discrete choice experiment, which means that respondents might exhibit preferences that differ from those under real circumstances. As a result, the current willingness to pay estimations might be overestimated. Future studies should include also stated preferences data to get more reliable estimates.

Third, the current work focuses only on Italian respondents. Although Italy has a strategic position in the Mediterranean sea, the point of view of consumers from other Mediterranean bordering countries should also be studied. Additional research could also include psychographic variables related to lifestyle and motivations. Moreover, respondents' segmentations based on preferences (e.g. latent classes) or psychographic variables could enrich future research.

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