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"Please let me visit": Management options for marine ecosystems in a Mediterranean Marine Protected Area

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ABSTRACT

Designation of Marine Protected Areas (MPAs) as a means to support conservation of marine ecosystems is expected to depend on local communities and stakeholder' participation and support. This paper presents the preferences of residents of Malta for measures intended to protect *Posidonia oceanica* seagrasses and coralligenous formations from threats from the anchoring and mooring of vessels in an offshore MPA area. The results indicate that only the most modest of restrictions increase the economic welfare of residents as participants are, overall, against further restrictions to enter the MPA. Survey participants wish to see an increase in provisioning ecosystem services such as fish caught and increases in carbon sequestration and are willing to pay to secure such benefits. Respondents also appear to have individualistic and use-driven values as a result of interacting with the MPA while past experiences play an important role in preferences, with frequent visitors strongly objecting to further restrictions to entry. The good current condition of the seagrass beds might explain the rejection of stringent restrictions but fails to account for threats from climate change and projected increase in tourism vessels' visits. Such findings make co-operation and appropriate communication of threats and policies for management of marine resources through MPAs to the public more imperative.

1. Introduction

The Mediterranean Sea has been described as a marine biodiversity hotspot as approximately 17,000 species are endemic there (Coll et al., 2010). Several anthropogenic activities have placed significant pressures on marine ecosystems and the biodiversity they support (Mazaris et al., 2019). Introducing Marine Protected Areas (MPAs) in the Mediterranean area has long been viewed as a means to mitigate pressures on marine and coastal ecosystems (Magris et al., 2018) and increase human welfare through increases in fish catches as a result of fish nursery abundance within the MPA (Pomeroy et al., 2005), especially for local communities (Bennett and Dearden, 2014). Designation of MPAs has also been integrated in the Natura 2000 European network of protected areas. Despite the designation of these areas, threats still exist, mainly due to human activities such as outdoor recreational activities and fishing (Mazaris et al., 2019). Effective MPA management has been linked to the alignment of stakeholders' goals with management authorities and the ability to enforce restrictions (Batista and Cabral, 2016). Ecosystem Services (ES) provided by marine and coastal ecosystems have been streamlined in the past 20 years through the Millennium Ecosystem Assessment (MEA, 2005) and the proceedings of The Economics of Ecosystems and Biodiversity (TEEB, 2010). As definitions and classifications of ES in different frameworks are sometimes leading to double count benefits from ecosystem services, different countries have operationalised the definitions of ES using combinations of widely accepted definitions, such as the UK's National Ecosystem Assessment – Follow-on (UKNEA-FO, 2014). As human activities impact the delivery of ES, understanding the trade-offs between levels of human welfare and the quality and quantity of ES is required (Hattam et al., 2015) and ideally through synergistic interaction between management decisions and ES trade-offs (Côté et al., 2016). Environmental valuation methods provide information on these trade-offs by showing the economic value people place on changes between levels of ES quality and quantity (Fisher and Turner, 2008; Fisher et al., 2009). Such methods refer to the Contingent Valuation Method and the Choice Experiment method and have been used extensively in the context of marine and coastal ecosystems (Tonin, 2018a,b).

In order to achieve better conservation of marine ecosystems, the EU introduced in 2010 the Marine Strategy Framework Directive (2008/56/EC) that had as an overarching target achieving or maintaining good environmental status by the year 2020 through an ecosystem-based approach. *Posidonia oceanica* is the only habitat that is considered a

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priority habitat under the Habitats Directive (Personnic et al., 2014) and the Mediterranean marine environment contains highly endemic seagrass meadows, with *Posidonia oceanica* meadows in particular being described both as unique and endangered in the region (Coll et al., 2010). They provide several ecosystem services such as protection from coastal erosion and carbon sequestration (Liquete et al., 2013; Duarte et al., 2013), providing habitats for fish nursery (Nordlund et al., 2017) and nutrient cycling (Constanza et al., 2014). Posidonia meadows' extent has been in decline and can be traced up to pre-1900 coastal development and sediment loading (Gibson et al., 2007). Posidonia meadows up to today are primarily threatened by human activities (Metafalcone et al., 2007) and are reduced by 7% per year, globally (Waycott et al., 2009). Posidonia meadows are known for their longevity as well as their slow recovery and recolonisation rates, which increase their vulnerability (Marbà et al., 2002; Giakoumi et al., 2013). The main threats to seagrass beds are anthropogenic pressures such as trawling and dredging (Marbà et al., 2014) and plastic pollution (Bonanno and Orlando-Bonaca, 2020). In particular, anchoring in seagrass meadows has been found to have detrimental effects as it dislodges plant rhizomes or leaves, even if the anchors are small in size (Milazzo et al., 2004; La Manna et al., 2015).

Coralligenous formations are the most common benthic habitat in the Mediterranean region, after Posidonia meadows (Boudouresque, 2004; Coll et al., 2010) and can be found usually in steep cliffs with low irradiance levels, between 20 m and 120 m deep (Giakoumi et al., 2013) but their depth is dependant on location (de Ville d'Avray et al., 2019). Coralligenous formations are protected under the Habitats Directive (92/43/EEC) of the European Union and the MSFD, although a widely accepted definition is not yet established. In this paper we use the definition of coralligenous formations provided by Giakoumi et al (2013). Protection of such formations is required given their generally slow growth rate that renders them more vulnerable to disturbances (Bo et al., 2014). Coralligenous habitats support ecological functions by providing nursery and foraging habitats for high-value species, as well as protection from erosion (de Ville d'Avray et al., 2019), carbon sequestration (de Ville d'Avray et al., 2019) and are an attraction to divers for recreational purposes and to commercial fishing and diving (Ballesteros, 2006; de Ville d'Avray et al., 2019). Nevertheless, coralligenous formations are threatened by human activities such as fishing, with fishing gear left behind or lost damaging the sensitive and slow growing coralligenous formations (de Ville d'Avray et al., 2019), invasive species (Martin et al., 2013), diving (Giakoumi et al., 2013; Linares et al., 2010), pollution (Martin et al., 2014) and ocean acidification (Zunino et al., 2017).

As little, but growing evidence on the views and perceptions of local communities and stakeholders regarding MPA success exists (Dehens and Fanning, 2018), this paper investigates the preferences of a local community for the provisioning of ecosystem services from marine ecosystems. I focus on two of these ecosystems, the seagrass species of *Posidonia oceanica* (also known as Neptune's seagrass) and coralligenous assemblages found both in the case study area, the North-East (Żona fil-Baħar bejn il-Ponta ta' San Dimitri (Għawdex) u Il-Qaliet) MPA in Malta (see Fig. 1), as part of the work conducted in 5 different Mediterranean MPAs in the Interreg project AMARe[1]. I hypothesise that effective MPA management requires the support both from stakeholders and the general public, in line with Batista and Cabral (2016), and analyse the levels of public support for different types of MPA management. We examine how additional restrictions to entry in the MPA can be perceived by locals and how heterogeneity in preferences to support monetarily better management of the MPA is driven by environmental beliefs and norms, socio-demographic characteristics and past experiences through the use of the Choice Experiment (CE) method. We also provide economic estimates of the changes in human welfare from different management options and how these can inform policy-making. The structure of the paper is as follows: first, the description of the case study and the use of MPAs to enhance delivery of ES is presented (Section 2). Section 3 presents the case study, the data collection and methods used, Section 4 presents the results and Sections 5 and 6 include the discussion and policy recommendations.

2. Case study description

The Żona fil-Baħar bejn il-Ponta ta' San Dimitri (Għawdex) u Il-Qaliet North East Marine Protected Area (from now one referred to simply as MPA) has been classified as a Site of Community Importance (SCI) which is part of the Natura 2000 designation. The Maltese MPA hosts a large variety of Posidonia sub-types and is home to approximately 80% of the country's *Posidonia oceanica* meadows (4.9 thousand hectares) and 45 ha of reefs (Environment and Resources Authority, 2019). This MPA has the unique feature of multiple activities operating within its limits, with recreational boating and fishing as well as cargo and oil ships operating and mooring. The existence of several wrecks and Blue Flag beaches are also a large tourist attraction and simultaneously a source of pressure to seagrass meadows and coralligenous formations within the MPA. The combination of fishing activities using nets and trawlers and recreational tourism creates disturbances in the marine and coastal ecosystems. Marine traffic, destruction of benthic habitats due to trawling, entanglement of marine mammals to fishing gear and human-induced pollution from "ghost" fishing gear, recreational boats and land-sourced pollution are threatening foraging habitats for fish and marine mammals. Finally, potential threats from oil spills and ship-borne pollution exist from cargo and oil tankers that birth or pass through the areas of the MPA (AMARe, 2019). Coralligenous formations are common in the Mediterranean region, particular in the Northwestern areas (de Ville d'Avray et al., 2019). The Maltese MPA is also home to the Mediterranean coral (Cladocora caespitosa).

MPAs have long been promoted as a means of conservation of biodiversity and restoring and assisting the growth of fish populations (Harmelin-Vivien et al., 2008). Protected marine areas have been found to increase extent density in *Posidonia* meadows (Ferrari et al., 2008) and species diversity and health through coral reef protection (McLanahan et al., 2006). Larger MPAs have been found to be more effective in effectively protecting ecologically important fish populations (Di Franko et al., 2018) but smaller MPAs are better managed and restrictions are more efficiently imposed (Giakoumi et al., 2017). This relationship is complicated as restrictions to fishing have been documented to increase fish populations inside of MPAs (e.g., Marbà et al., 2002) and in neighbouring areas (Claudet et al., 2008) but there might be adverse effects in seagrass meadows extent and health due to the increase of foraging of the abundant fish population (Ferrari et al., 2008). Nevertheless, restrictions to fishing in Mediterranean MPAs have been well-documented to increase biomass, fish size and abundance (see Harmelin-Vivien et al., 2008 for a review). Protected status of marine areas while allowing visitations for tourist and recreation purposes in the Mediterranean has resulted in an increase of scarring of *Posidonia* meadows during the tourist period, despite the introduction of restrictions to mooring (La Manna et al., 2015). High numbers of diving visits have been found to be positively related to increases in mass mortality rates of the sensitive red gorgonian populations (a type of coralligenous assemblage) in a Mediterranean MPA (Linares et al., 2010). Instead, regulated diving visits and in a reduced number are expected to not impact coral reefs (Linares et al., 2010). Restrictions to certain activities in MPAs can also lead to increases in carbon sequestration in seagrass beds (Potts et al., 2014).

Several studies have examined preferences for management of coastal and marine ecosystems in MPAs through the CE method. Past studies have focused on increasing recreational benefits for general visitors (Paltriguera et al., 2018;), divers and anglers (e.g., Jobstvogt et al., 2014; Rodrigues et al., 2016), tourists (Christie et al., 2015),.

[1] https://amare.interreg-med.eu/.

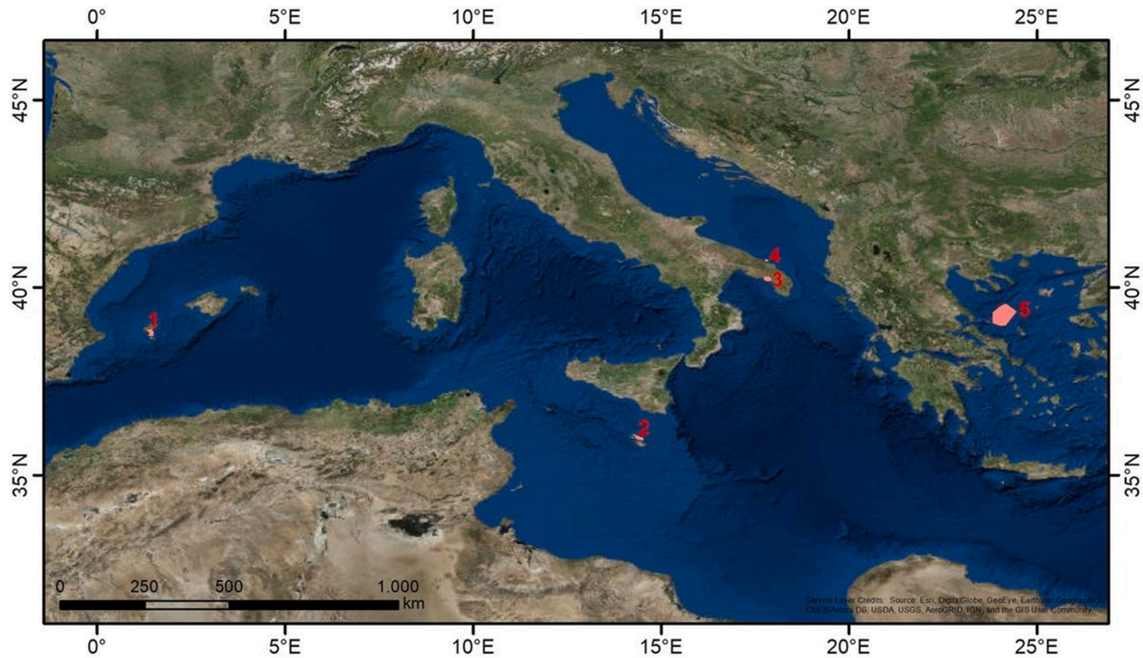

Fig. 1. The full list of the MPAs considered under the AMARe project, number 2 is the The North-East Marine Protected Area in Malta.

Benefits examined refer to increasing fish catches within the MPA (e.g., Wallmo and Kosaka, 2011), protection of species diversity and of threatened species (Wattage et al., 2011; Börger et al., 2014; Remoundou et al., 2015) and increases in biodiversity (e.g., McVittie and Moran, 2010; Remoundou et al., 2015). Only one previous study exists investigating the economic value of ES provided by coralligenous formations in MPA areas in Italy (Tonin, 2018b).

The use of the CE method to measure the economic value of ecosystem services provided by MPAs has demonstrated that individuals do understand trade-offs (e.g., increases in provisioning of ES have a higher cost, in terms of restrictions to activities which also translates to economic costs to enforce such restrictions or to compensate the people affected by such closures) between different management approaches (Brouwer et al., 2016) and are willing to contribute monetarily for their implementation (Tonin, 2018a). Nevertheless, CEs cannot always account for heterogeneity between the preferences of respondents, especially when it comes to valuing environmental goods and services (Hess and Beharry-Borg, 2012). Heterogenous preferences have been attributed to differences in respondents' strong environmental and ecological beliefs (e.g., Boxall and Adamowicz, 2002), socio-demographic characteristics (Shao et al., 2018) and past experiences (ranging from strong, personal experiences to no experiences at all) with the environmental good or service they are asked to value (Whitehead, 2006), among other factors. Latent class choice models have been applied to account for such heterogeneity which varies due to factors unobserved to the analyst, by allowing segmentation of a sample based on both observed and unobserved characteristics of the sample. Such models have been previously employed in various aspects of marine and coastal ecosystems management such as in the restoration of wetlands (Stainback et al., 2020), offshore MPAs in trade-offs between MPAs and offshore wind farms (Karlõševa et al., 2016), coastal water quality improvements (Hess and Beharry-Borg, 2012) and determine the value of ES provided by benthic ecosystems (Ruiz-Frau et al., 2019).

3. Methods and data

In order to identify the understanding of local populations and stakeholders of *Posidonia oceanica* and coralligenous formations, focus groups were organised in Malta in June 2019, with approximately 80 representatives of local stakeholder groups involved in fishing, diving tourism, boating and yachting and recreational tourism. The purpose of the meeting was to identify means of achieving conservation of ES and reasons for conflicts between different MPA-related stakeholder groups. Additionally, the following conflicts stemming from the use of the MPA were identified: the existence of aquaculture farms and mooring and anchoring of oil tankers inside the MPA, impacting ecosystem health (AMARE, 2019). From the focus groups' recommendations the following final ecosystem services were identified as important for the analysis: 1) the final provisioning ES of fish/food caught (such as fish and shellfish, wild and in captivity supported by seagrass beds and coralligenous formations), 2) the regulating service of climate regulation (such as carbon capture and sequestration by coastal and marine ecosystems such as seagrass meadows) and 3) the cultural services of aesthetic value/information and recreation (realised through visits to marine and coastal ecosystems through walking, swimming, snorkelling, diving, boating etc.), following the MEA (2005) definition. The presentation of different levels for these three final ES was also examined, resulting in the attributes and levels. The different levels of changes in ES of fish/food caught were informed by the study of Claudet et al. (2008) while the levels of regulating and cultural ES were hypothetical and chosen based on stakeholder views during this survey consultation phase. See Section 3.1 below for the full list of changes to provisioning, regulating and cultural ecosystem services examined. According to the findings of the workshop, the following intervention scenario was proposed: protecting *Posidonia oceanica* meadows and coralligenous formations by creating a zonation plan that includes the following two areas: a) a core area, where all exploitation is prohibited but regulated tourism and scientific research are permitted and b) regulated fishing areas with a prohibition of certain type of fishing methods (trawling) and a limitation of the numbers of fishermen through a system of authorization after a (free) permit is obtained. Such options on restrictions are similar with the study of McVittie and Moran (2010).

3.1. Questionnaire structure

The questionnaire included 4 sections. The first section included questions to identify the levels of engagement and personal experience participants had with the MPA and its ecosystems. The second section included the CE part. There, respondents were presented with a description of the current situation of the MPA and with a hypothetical scenario that was aiming at improving the quality of ES provided by *Posidonia oceanica* and coralligenous formations through the introduction of various restrictions to entry. The hypothetical scenario presented that this change in management of the MPA would be achieved by a voluntary donation to a new biodiversity fund. The following section included questions aiming at identifying the ecological orientation of participants as well as types of final ecosystem services participants believe they receive from the MPA. In this section, 12 statements were used from a previous study regarding ES provided by marine and coastal ecosystems (Gkadolou et al., 2018). The final section of the questionnaire included questions on sociodemographic characteristics such as age, education and income.

Given the delicate balance that MPAs need to have between restrictions to enter and natural resource use and attract visitors, the payment vehicle selected was a voluntary donation to a hypothetical organisation tasked with the enforcement of the suggested policies, which was considered the most feasible option given that no entrance fees are considered for the Maltese MPA. Voluntary donations are used in the literature of valuation in the marine environment (e.g., Stithou and Scarpa, 2012) and were deemed more appropriate than landing fees as no such measures exist in the majority of the Mediterranean MPAs. Additionally, information in the CE part of the questionnaire was provided about how each of the attributes can have a direct economic impact on their lives was offered (for example, carbon sequestration was introduced as "*one square kilometre of Posidonia seagrass meadows can capture 10–150 times the carbon that is emitted to produce electricity for the average European citizen, in a year*") in order to facilitate choice-making from respondents in terms of utility, expanding the narrative from Carlsson et al. (2010) that attributes need to be easy to understand to respondents and the objectives concrete. As the consultation on introducing new MPA areas and designating existing MPAs as Special Areas of Conservation (SAC) and SCI as required by the EU Habitats (19 92/43/EEC) and Birds (2009/147/EC) Directives, remaining in the current situation for the MPA was considered to be still implementing some restriction to access and yield some ecosystem services benefits. As such, respondents were offered the opportunity to choose the status quo as an indication of continuing existing restrictions and not as a "no-change" scenario, following Mariel et al. (2021).

3.2. Statistical design and model

The CE method follows the random utility theory (RUT) (McFadden, 1974) and assumes that participants know the impact on their welfare (approximated by the concept of utility) that the MPA and its ecosystem has, as well as the individual impact on welfare that changes in the quality and quantity of ES provided by seagrass beds and coralligenous formations. The utility U is only known to the individual and unobserved by the researcher. The utility an individual j obtains for choosing choice alternative (alternative levels of ES provision through changes in MPA management) i is comprised of an observable part V_{ni} and an unobserved part e_{ni} which it assumed it follows an IID type I extreme value distribution:.

$$U_{ji} = V_{ji} + e_{ji} \tag{1}$$

The specification of a latent-class conditional logit (LCL) model is similar of that of the mixed logit model that accounts for preference heterogeneity, assuming that individual parameters are clustered in classes, while following a discrete mixing distribution (Greene and Heshner, 2003). The conditional probability of individual j to be in class c and to choose alternative i in a mixed logit model specification is:

$$P_{ji|c} = \frac{e^{r'_{j|c}\beta x_{ji}}}{\sum_{n=1}^{N} e^{r'_{j|c}\beta x_{jn}}} \tag{2}$$

This assumes that the (conditional) probability of belonging to class c is a factor of individual-specific covariates r_j, such as socio-economic variables and variables measuring experience of the respondent concerning an MPA. The latter cannot be inserted directly into the model as they are likely to be correlated with other unobserved variables (Hess and Beharry-Borg, 2012) and instead are inserted as explanatory variables through a series of structural equations linking attitudinal questions to measurement equations (see Boxall and Adamowicz (2002) for a more detailed explanation).

The LCL model assumes that individuals within the same class share similar, observable characteristics. The class C that contains any particular individual is unknown to the researcher. The ratio of each of the CE attributes with the cost (entrance fee) coefficient with a negative sign also produces the marginal WTP for each of these attributes as.

$$WTP_z = \frac{-\beta_{attribute}}{\beta_{price}} \tag{3}$$

The information collected from the focus groups allowed for collecting priors for the statistical design of the CE via a Bayesian d-efficient design (Rose and Bliemer, 2009) in the Ngene1.1.2 software with two blocks of 12 choice sets, evenly and randomly distributed across the two blocks, resulting in 6 choices being presented to each participant of the survey.

The provisioning ES through increase in fish caught within the MPA was included (*FISH*), as well as the provisioning ecosystem services of carbon sequestration (*CARBON*). Cultural ES were captured through increase in aesthetic beauty of the two ecosystems in question (*AESTH*) while the changes in MPA management where included (*RESTRICT*) as well as the cost of financing such changes (PRICE). For the full list of attributes see Table 1 below. Given the current policy recommendations regarding the management practices and current status of ES delivery from the ecosystems present in the area (AMARe, 2019), the attributes appearing in bold in Table 1 are the base level, in other words, the expected ES delivery as a result of the current management levels. Fig. 2 shows an example of a choice card. An initial statistical design with effects coding (the base level of attributes coded as −1 instead of 0 as in dummy-coding of variables) to account for non-linearities between changes in the attribute and utility was used to carry out a pilot survey among stakeholders (responses not included in the final dataset) with a D-error of 0.2352, following Johnston et al. (2017). Several restrictions were placed on the original design after this consultation to allow for plausible options to be presented to participants. Following Bliemer and Collins (2016) a Bayesian D-efficient design based on a pilot on 25 participants in 2019 resulted in a final design with a D-error of 0.072.

The latent class model was estimated in Stata 15.1 with the *lclogit2* command from Yoo (2020) which allows for a mixed logit model specification, following Hole's (2007) *mixlogit* command. In the mixed model we assumed that all variables apart from price were following a random distribution and were homogenous across classes. WTP was estimated with the postestimation command *lclogitwtp* from Yoo (2020), a wrapper

Table 1
List of attributes and levels, the status quo levels are presented in bold.

Attributes	Levels	No.
Fish catches [FISH]	**5%**, 10%, 20%, 40%	4
Aesthetic and recreational benefits [AEST]	**More visible healthy and biodiverse ecosystems for 25% of the MPA**, More visibly healthy and biodiverse ecosystems for the 50% of the MPA	2
Carbon sequestration [CARBON]	Increase in carbon sequestration and storage by **5%**, 10%, 15%, 25%	4
Restrictions to entry [RESTRICT]	**Ban trawling within the MPA**; Ban trawling within the MPA, restrict mooring for recreational boats; Ban trawling within the MPA, restrict mooring for recreational boats and passage of oil and cargo ships	3
Entrance Fee [PRICE]	Per year: 5 Euros, 10 Euros, 25 Euros, 40 Euros	4

	Option A	Option B	Option C
Fish stocks	10% increase	20% increase	No changes in the management of protected seagrass meadows and coralligenous formations protected
Aesthetic beauty and recreation	More visibly healthy and biodiverse ecosystems for the 50% of the MPA	More visible healthy and biodiverse ecosystems for 25% of the MPA,	
Carbon sequestration	15% increase	5% increase	
Limits to entry	No entry for oil tankers and cargo vessels	No entry for recreational boats and oil tankers and cargo vessels	
Donation to biodiversity fund	10 Euros per year	25 Euros per year	
WHICH OPTION DO YOU CHOOSE ?	○	○	○

Fig. 2. Example of a choice card.

for Stata's *nlcom* command.

3.3. Data collection

The final questionnaire (available in the Supplementary Material) was disseminated via face-to-face interviews from several trained interviewers in several locations across the island of Malta (targeting members of the public, fishermen and divers). All questionnaires were translated from English to Maltese and made available to respondents while interviewers were native speakers of the two languages. Data collection took place between May and July 2019, resulting in 118 complete questionnaires after accounting for incomplete questionnaires and protest responses (people who stated their WTP but also stated they were against paying any amount to protect the environment, per questions in Section C7 of the questionnaire), out of 180 total interviews. An example of a choice card can be seen below:

4. Results

The descriptive statistics of the sample are presented in Table 2 below. The face-to-face sampling closely resembles the age and gender distribution according to the 2011 Census (latest available during time of study, National Statistics Office, 2012) and can be considered as representative of the population. For a full description of sociodemographic characteristics and attitudinal statements see the Supplementary Material 33% of the sample had at least a Master's degree (HIGH_EDUC), while 21% was making more than 24 k Euros per year and was classified as high income earners (HIGH_INC). Also 33% of the sample stated that they were aware of the two ecosystems that restrictions in the MPA were meant to protect (seagrasses and coralligenous formations, EXPERIENCE) while 51% of sample stated they had visited the MPA more than 10 times in a year and were considered to have personal knowledge and familiarity with its current management practices (VISITOR).

Table 2
Summary of key socio-demographic characteristics.

Age Gender	18–24	25–34	35–44	45–54	55–64	65+
Male	−1%	−3%	−1%	−6%	0%	0%
Female	−3%	−3%	−1%	1%	1%	3%
Differences between 2011 Census and sample						
HIGH_EDUC	33.05					
HIGH_INC	21.19					
EXPERIENCE	33.05					
VISITOR	50.85					

Frequencies of selected socio-economic and experience-related characteristics.

4.1. Principal Component analysis

The statements in summary form that participants were asked to state how much they agree or disagree with are presented in Table 3. From a scale from 1 to 5, respondents scored highly in statements about the importance of the MPA in shaping and creating experiences. Relaxation (lf_nature), creating new experiences (lf_feel), increase cultural heritage (lf_culture), knowledge and ocean literacy (lf_knowledge) were the statements the respondents identified most. Human interaction within the MPA was the least agreed argument (lf_connect) while respondents agreed less with the statement that the MPA was contributing to the uniqueness of the scenery due to the good environmental state of the coastal and marine areas (lf_scenery). The statements respondents

Table 3
Statements and mean values of attitudinal statements.

Name	Description	Mean	St. Dev
lf_nature	*These places make me feel more connected with nature*	4.305	0.742
lf_feel	*These places make me feel free/healthy and allow me to relax*	4.314	0.733
lf_connect	*These places allow me to make connections with other people*	3.237	1.047
lf_bigger	*These places make me feel as if I am part of something bigger than myself*	3.847	1.031
lf_create	*In these places I create many unforgettable experiences*	4.000	0.912
lf_belong	*These places are part of my personal identity and I feel like I "belong"*	3.720	0.999
	The MT0000105 - Żona fil-Baħar bejn il-Ponta ta' San Dimitri (Għawdex) u Il-Qaliet MPA contributes		
lf_scenery	*... to the unique scenery due to the traditional character of the fishing grounds*	3.492	0.900
lf_unique	*... to the uniqueness of the scenery due to the good environmental state of the coastal and marine areas*	3.771	0.887
lf_culture	*... to the cultural heritage and identity of the local communities*	3.949	0.891
lf_research	*... to promote research and new tecnologies*	3.695	0.988
lf_art	*... to inspire art*	3.873	0.926
lf_knowledge	*... to promote new knowledge and educate people to become Ocean literate*	4.025	0.775
Observations		118	

agreed more with referred more to individual than shared use of the MPA and focused on personal experiences and uses of MPA and its ecosystems.

A Principal Component Analysis (PCA) with a varimax rotation was carried out to determine any meaningful ways of statements' grouping. Initial results showed that from the 12 statements included lf_scenery had low construct validity and was removed from further analysis. The remaining 11 statements were grouped into three components and are presented in Table 4. Component 1 included 3 statements (lf_nature, lf_feel and lf_create) that broadly describe personal connections and activities as a result of visiting the MPA. Component 2 included 4 statements (lf_bigger, lf_belong, lf_research and lf_knowledge) that broadly cover sense of place, emotions and knowledge increase as a result of visiting the MPA. Finally, Component 3 included 4 statements (lf_connect, lf_unique, lf_culture and lf_art) that reflect increase in cultural and life-shaping experiences as a result of visiting the MPA. The Keiser-Meyer-Olkin measure of sampling (KMO) showed a good overall score of 0.82 that indicates good construct validity and that the statements can be appropriately analysed in a PCA, with loadings being similar to other studies employing the same technique (e.g., Grilli et al., 2021).

4.2. Latent class and willingness to pay

In order to determine whether there is heterogeneity in the preferences for different management practices in the MPA a mixed logit model was estimated as it is more flexible as it allows its parameters to be randomly distributed using Eq. (2), in other words, for preferences to vary across respondents (Hole, 2007). As can be seen from the relative size of the standard deviation in Table 6 compared to the coefficients, with several variables standard deviations are much larger than the coefficients, pointing towards preference heterogeneity. Several variables are significant, including PRICE which has a negative sign as expected and allows for the calculation of marginal WTP. Respondents also show strong preferences to not introduce restrictions in the MPA, as evident from the large negative size of STATUS_QUO. To account for heterogenous preferences, a latent class conditional logit model was used which allows for a discrete distribution of the parameters between different classes (Yoo, 2020). Preferences are allowed to vary between but not within classes. These preferences were assumed to be influenced by both the results of the PCA and of key-sociodemographic characteristics (Grilli et al., 2021; Notaro et al., 2019). To determine the optimum number of classes the Akaike's information criterion (AIC) and Bayesian information (BIC) were used. As can be seen in Table 5below, the AIC and log-likelihood are minimised in the 3-class solution. The BIC is expected to be minimized between the 3-and-4 class solution so the 3-class solution was preferred. The mixed logit model is also equivalent with the 1-class latent class logit model and is also presented in Table 5[2].

The results of Mixed Logit and LCL models are presented in Table 6

Table 4
Principal Component Analysis loadings with a varimax rotation.

Variable	COMP1	COMP2	COMP3
lf_nature	0.537		
lf_feel	0.618		
lf_connect			0.502
lf_bigger		0.381	
lf_create	0.387		
lf_belong		0.379	
lf_unique			0.369
lf_culture			0.490
lf_research		0.395	
lf_art			0.569
lf_knowledge		0.634	

Table 5
Goodness-of-fit indices for different latent class conditional logit model specifications.

Model	Obs	ll(model)	Parameters	AIC	BIC
1-class	2,124	−649.215	21	1340.429	1459.311
2-class	2,124	−551.332	30	1162.664	1245.785
3-class	2,124	−468.543	49	1035.087	1170.85
4-class	2,124	−449.424	68	1034.848	1223.255
5-class	2,124	−429.394	87	1032.787	1273.837

Table 6
Changes in marginal utility in mixed logit and latent class conditional logit modes, ***,**,* indicating statistical significance at the 1%,5% and 10% level, respectively.

	Mixed Logit (s.d. in parentheses)	Class 1 (st. error in parentheses)	Class 2 (st. error in parentheses)	Class 3 (st. error in parentheses)
PRICE	−0.027** s.e.(0.013)	−0.103*** (0.035)	0.089*** (0.027)	−0.401*** (0.106)
FISH_10	−0.962***s.d.(−0.128)	−0.499 (0.756)	−0.912 (0.758)	4.237** (1.767)
FISH_20	−0.337 s.d.: (0.471)	−0.891 (0.600)	0.251 (0.788)	6.710*** (2.367)
FISH_40	−2.929***s.d.:(−0.872*)	−1.904 (1.45)	−4.499*** (1.672)	7.414* (3.933)
AEST_50	1.631**s.d.: (0.135***)	2.619* (1.37)	1.025 (1.219)	−1.902 (2.025)
CARBON_10	1.318***s.d.: (0.063)	−2.165** (0.916)	4.371*** (1.175)	4.838** (2.258)
CARBON_15	0.577 s.d.: (0.084)	−2.575** (1.05)	3.024*** (0.960)	4.584*** (1.514)
CARBON_25	3.208***s.d.: (−0.135)	−3.275** (1.60)	7.743*** (1.879)	6.932*** (2.518)
RESTRICT_3	−0.546 s.d.: (−0.009)	1.543 (1.04)	−2.953*** (0.867)	−2.633** (1.345)
RESTRICT_4	−2.002*** s.d.:(−0.076)	−0.891 (1.54)	−4.474*** (1.324)	0.783 (1.789)
STATUS_QUO	−5.245*** s.d.:(4.094***)	−1.475*** (0.56)	−2.327*** (0.787)	−6.624*** (1.287)
COMP1	–	0.097 (0.215)	0.297 (0.233)	–
COMP2	–	−0.009 (0.247)	0.419** (0.211)	–
COMP3	–	−0.365 (0.240)	−0.340 (0.227)	–
HIGH_EDUC	–	−0.929 (0.890)	1.176** (0.590)	–
HIGH_INC	–	−0.794 (0.781)	−0.720 (0.709)	–
EXPERIENCE	–	−0.081 (0.647)	−0.933 (0.657)	–
VISITOR	–	0.643 (0.679)	−0.611 (0.529)	–
CONSTANT	–	−0.819 (0.527)	0.538 (0.376)	–
Class share (in %)	–	0.178	0.360	0.462
R-squared	10.1%	LR chi-squared (10) = 223.901		
Observations	118	21	43	55

[2] The goodness-of-fit indices for a model accounting for homogenous preferences (multinomial logit) where: ll(model): −1222.14; Parameters:12; AIC: 2468.28 and BIC 2536.213, showing clearly an approach accounting for preference heterogeneity is preferred.

below. The PRICE coefficient is statistically significant in all classes and negative, as expected, in classes 1 and 3. Respondents also show a preference for the current situation as the STATUS_QUO coefficient is large and negative. The change of most of the coefficients' sign between the mixed model and the latent classes demonstrates the variability in preferences regarding management of the Maltese MPA and ecosystem services' provisioning. Based on the class composition, Class 1 members who are the fewest in the sample, can be classified as casual visitors with low income who don't interact with the marine ecosystems in the MPA, as evident from the low or negative coefficients in the three components. Class 2 and 3 are the biggest in the sample, containing 36% and 46% of the sample, respectively. Class 2 participants are highly educated but not regular visitors of the MPA and with very limited personal knowledge of the ecosystems. Nevertheless, Class 2 participants are the ones experiencing sense of place and identity from the marine ecosystems (see COMP1 and COMP2′ large positive loadings). Therefore, it is no surprise this class has a positive PRICE coefficient, indicating an objection to support management measures of an area where they have little use values of.

Class 3 participants have the strongest use values and sense of place and identity from all the sample with respect to the MPA and can be described as regular users that prefer minimum disruptions to access to the MPA while enjoying its benefits to the fullest. Class 3 participants have strong preferences for all levels of increases in fish catches as a result of new MPA restrictions while having the strongest preference to remain in the status quo (where the fewest possible restrictions enforced). Class 2 participants did not prefer big increases in fish catches in the MPA and instead showed higher preferences for increases in carbon sequestration. Only Class 1 participants are interested in paying for increases in aesthetic benefits (AESTH_50), the only attribute increasing the satisfaction for these participants. Increases in carbon sequestration (CARBON) from healthier seagrass meadows had the biggest positive impact in the utility of Class 2 and 3 participants, with estimates being higher as assumed benefits increase. As expected, further closures in the MPA, either in the form of preventing boating and berthing of large cargo ships within the MPA were not preferred by any class, especially Class 3 participants. Only Class 3 participants appear to prefer restrictions in cargo ships and oil tankers to anchor in the MPA but this attribute (RESTRICT_4) was not statistically significant than the base level. Scoring higher in statements referring to sense of place emotions and knowledge decreases the likelihood a participant belongs in Class 2 (statistically significant at the 5% level) 2, as well as being highly educated, compared to the base level class (Class 2).

The WTP for each attribute for the Mixed Logit and LC models was calculated with Eq. (3) and estimated with the *delta* method and is presented in Table 7 below. The results show the large variation in the WTP estimates with all negative estimates having confidence intervals that straddle the zero value showing that responses are not well-formed. The highest WTP estimates for Class one is 25.5€, per person per year to secure increases by 50% in fish catches within the MPA (AESTH_50). Class 2 participants had robust, positive and significant WTP estimates and are willing to pay, on average, 50.6€ per person, per year for increases in fish catches by 40% (FISH_40), 33.2€ for moderate restrictions to access to the MPA (RESTRICT_3) and 50.4€ for the toughest restrictions to entry (RESTRIC_4). These estimates are also significant and their values do not straddle 0, showing well-formed preferences. Class 3 respondents were willing to pay between 10.5€ and 18.5€ per year for different levels of increases in fish catches as a result of new management practices in the MPA. WTP levels for Class 3 participants' values for increases in carbon sequestration were also similar with those for increases in fish catches with estimates ranging between 11.4€ and 17.3€ per person, per year. Only Class 2 participants had a positive WTP to depart from the status quo and apply further restrictions to entry in the MPA and were willing to pay 26.2€ per year to support such actions. The Mixed logit and Class 1 and 3 estimates were negative, significant and robust (not over the zero value).

4.3. Welfare change results

In order to measure the potential social magnitude of such a potential policy change in the management of the MPA, the Compensating Variation (CV) was estimated with the *logsum* method from the Mixed logit model, following Train (2009). This measure estimates the maximum amount of compensation required to be paid to residents of Malta to forego the benefits from enhancement of ecosystem services provided by the potential changes in the management of the Maltese MPA. The estimates are then projected over the whole population of the island of Malta (385 k inhabitants according to the 2011 Census) given the island's small overall extent, who are expected to be affected by potential changes in the management of the MPA. The results, presented in Table 8, show some combinations of potential changes management policies of the MPA. The first, second and third level correspond to the sequence of levels of Table 1 (e.g., first levels refer to FISH_10, AEST_50, CARBON_10 and RESTRICT_3, and so on). Results show that any improvement over the baseline (the current management practices that are expected to produce some increases in fish catches, aesthetic benefits and carbon sequestration while enforcing some restrictions to anchoring) offers similar increases in the welfare of Malta's population, at approximately € 570 k. More stringent management measures do not increase welfare more than that of the most moderate interventions. For example, the "most realistic" mix of management measures in terms of enforcing restrictions and the ecosystems responding to them (assuming a 10% increase in fish catches and the lowest possible increase in carbon sequestration and aesthetic benefits) is still generating lower increase of

Table 8
Compensating Variation for changes in MPA management over the baseline, for the whole sample.

Policy changes	Changes in welfare
Baseline to 1st level	€ 578,232
Baseline to 2nd level	€ 570,831
Baseline to 3rd level	€ 569,522
Baseline to most realistic	€ 571,734

Table 7
Willingness to Pay, per person, per year in Euros.

	Mixed logit	Conf. Interv.	Class1	Conf. Interv.	Class2	Conf. Interv.	Class3	Conf.Interv.
FISH_10	−35.461	[−82.2–11.3	−4.857	[−21.3–11.6]	10.277	[−5.1–25.6]	10.574***	[5.9–15.2]
FISH_20	−12.412	[−43.9–19.1]	−8.669	[−23.1–5.7]	−2.826	[−20.9–15.2]	16.747***	[11.4–22.1]
FISH_40	−107.901 *	[−226.2–10.2]	−18.528	[−45.1–8.0]	50.651**	[7.9–93.4]	18.503**	[0.7–36.4]
AEST_50	60.139*	[−4.0–124.2]	25.495*	[−1.9–52.8]	−11.539	[−36.9–13.8]	−4.746	[−15.3–5.8]
CARBON_10	48.583*	[−3.9–101.1]	−21.073*	[−43.5–1.3]	−49.208**	[−95.3 – −3.1]	12.07***	[3.7–20.4]
CARBON_15	21.282	[−18.7–61.2]	−25.067 **	[−44.4––5.7]	−34.044*	[−69.5–1.4]	11.439***	[5.5–17.3]
CARBON_25	118.269*	[−4.9–241.4]	−31.873*	[−68.1–4.4]	−87.176**	[−164.4–63.9]	17.301***	[6.8–27.8]
RESTRICT_3	−20.121	[−52.6–12.4]	15.022*	[−2.8–32.9]	33.241**	[2.6–63.9]	−6.571**	[−12.7 – −0.5]
RESTRICT_4	−73.820*	[−153.5–5.8]	−8.669	[−39.9–22.5]	50.370***	[15.2–85.5]	1.953	[−7.0–10.9]
STATUS_QUO	−193.943 **	[−373.7––13.0]	−14.358 **	[−25.8––2.9]	26.203***	[6.6–45.8]	−16.532 ***	[−21.7––11.3]

welfare than the most moderate one ("Baseline to 1st level").

5. Discussion

The results offer an interesting view on preferences for management for an offshore MPA in Malta. Respondents appeared to have understood their personal interaction with ecosystems within the MPA through a more individual perspective MPA instead of a shared one. Respondents agreed more with statements focusing on creating and enjoying personal recreational experiences and uses of MPA and its ecosystems (such as relaxation and creating unique experiences, see Table 3). This can be related to the fact that the seagrass beds and coralligenous formations are not visible to beach users and that the location of the MPA requires transport by boat to reach it. Past studies have found that social and aesthetic values in ecosystems in MPAs tend to be higher closer to the coastline or infrastructure (Johnson et al., 2019). Overall, respondents' high scoring in experiential and utilitarian as well as their high standard deviations is common in the literature employing such questions to understand respondents' engagement (e.g., Zha et al., 2020) and it is possibly explained by the strong influence personal experiences with marine ecosystems exert on humans (Elrick-Barr et al., 2022).

Overall, respondents demonstrate strong use values and are generally opposed to further restrictions to enter the Maltese MPA and engage in recreational activities (see Table 6). There are divergent findings in the literature with some studies finding stronger use than non-use values of coastal and marine ecosystems (e.g., McVittie and Moran, 2010; Tyllianakis et al., 2019) while other studies report the opposite (e.g., Oleson et al., 2015; Hynes et al., 2021). The strong preferences against restrictions though are also accompanied with strong preferences for more abundant fish catches and increases in carbon sequestration (see Table 6). Such results are similar with those of other surveys on preferences for marine and coastal ecosystem management where restrictions are generally rejected while respondents still want to enjoy higher quality, if provisioning and cultural ES (e.g., Jobstvogt et al., 2014; Grilli et al., 2021). As expected, since the MPA provides extensive fishing opportunities, WTP was higher for increases in fish catches, as a result of better management. Strong preferences for increase in fish catches have also been previously reported in several studies (Christie et al., 2015; Andrews et al., 2021). The strong preferences for increase in fish catches while disliking any extra restrictions to anchoring of vessels makes achieving such increases in fish catches difficult. Although the increase in fish biomass as a result of introducing MPAs in the Mediterranean has been proven (Harmelin-Vivien et al., 2008), survey respondents appear to have strong, short-term use values, preferring enjoying increased fish catches in the present (as a result of the abundance of *Posidonia* meadows acting as foraging grounds) over interventions that could provide long-term benefits.

With regards to preferences on increases in aesthetic benefits, the negative WTP sign (see Table 7) might appear counter-intuitive at first. The sign can be partly explained by the relatively moderate levels of agreement respondents had to the statement (lf_scenery) which was also the lowest out of all 12 statements in Table 3. The combination of these two findings might indicate that participants do not consider as aesthetic improvements any improvements in the health and extent of marine ecosystems. Past studies have found that visible and "eye-catching" ecosystems such as sandy beaches (Grilli et al., 2021) and rock formations (Jobstvogt et al., 2014) that exist in the MPA are what respondents consider as "attractive" and therefore underwater ecosystems visible only to divers and anglers do not create similar increases in utility. Seagrass meadows are also known to not be considered "attractive" and therefore receive less attention when it comes to prioritise their conservation over other more appealing ecosystems such as coral reefs (Duarte et al., 2008). As the number of divers and anglers was low in the sample this did not allow for any split sample analysis to further validate this assumption. Nevertheless, the mixed logit and Class 1 estimates showed positive values, consistent with economic theory. Interpreting these results should be done cautiously, as the sample size (although representative of the population of Malta) is small, further segmented in the LCL model.

Participants were also strongly against restrictions, as is evident from the negative sign of the coefficients in both the mixed logit and the latent class conditional logit models in Table 6. This finding is similar to those of Jobstvogt et al. (2014), Wallmo and Kosaka (2017) and Paltriguera et al. (2018). In particular, Walmo and Kosaka found that utility increased in moderate closures but decreased when more stringent measures were implemented while Remoundou et al. (2015) found the opposite, with utility increasing as closures increase. In this case study, strong preferences against such restrictions can be partly explained by the high density, connectivity and overall health of the seagrass beds in the MPA (Environment and Resources Authority, 2019). In particular, the conservation status of the Posidonia meadows has been described as "good", indicating good overall condition of the ecosystems. As respondents, some of them being divers and anglers, have good (stated) knowledge of the MPA they might seem less willing to enforce higher restrictions to protect and ecosystem that currently appears to be in good health despite the anchoring of various vessels within the MPA. This finding is further supported by the moderate levels of agreement to the statement "*The MPA contributes to the uniqueness of the scenery due to the good environmental state of the coastal and marine areas*" (see Table 3). Despite the good condition that Posidonia meadows appear to be in general MPA area, in some areas anthropogenic activities have resulted in decreased seagrass density (Environment and Resources Authority, 2019) and even the most moderate restrictions (as those indicated by the results of Table 6) to boats anchoring can prevent further damages. Health ecosystem status has been previously found to be correctly identified by well-informed members of the public in freshwater bodies (Skuras and Tyllianakis, 2018). Such findings however have not been documented for marine ecosystems and therefore no assumptions can be made whether changes in the status of marine ecosystems can be correctly and readily identified by members of the public (and not just by those with personal experience of the ecosystems such as anglers and divers).

Latent class formation, accounting for preference heterogeneity, points to strong preferences towards management of MPAs in Malta as they pertain to use and non-use values of the survey participants, most of them being familiar and frequent visitors of the MPA. As use-values were more prevalent in the sample and especially in classes 1 and 3, statements captured in the PCA reflecting aspects of cultural ES also defined class composition, with those in Class 2 being more likely to state that they agree that the MPA provides such ES (see results for COMP2 in Table 6). Visiting the MPA requires boat access and past studies amongst divers and anglers have shown that such groups prefer easy access to MPAs (e.g., Jobstvogt et al., 2014) and being able to keep their catches (Andrews et al., 2021). Class 1 participants appeared against any extra measures in the MPA. Class 2 participants appear to be protesting in any types of restrictions while wanting increases in carbon sequestration provisioning, as well as assigning monetary value to ES while acknowledging that the MPA provides several cultural ES. This can be related to the concept of incommensurability, where services provided by public goods such as ES provided by marine ecosystems cannot be approximated with goods and services sold in private markets (Aldred, 2002). Additionally, Nyborg (2000) finds that in surveys on the topic of the environment participants assume various roles, sometimes focusing on their own personal interest (as a consumer) and sometimes answering with the interests of society in mind (acting as an engaged citizen) which can explain these conflicting preferences. Only those with limited personal experiences of the MPA and its ecosystems were willing to pay to increase restrictions to entry, but these responses could be interpreted as indicators of intentions as the PRICE coefficient in Table 3 for Class 2 was positive, possibly indicating a rejection of the notion of paying for improvements in ES (Spash et al., 2009). Nevertheless, the introduction of an entry fee to access a resource previously enjoyed freely can also explain strong disagreement, something common with introducing fees (Cho, 2005; Suziana, 2017) as evident from the positive sign of PRICE for Class 3 in Table 6. Such economic interventions also need to be informed by accounting for preference heterogeneity (Zabala et al., 2022).

Regarding WTP estimates, Class 2 estimates were statistically significant and with varied signs (see Table 7). The estimates for increases in fish catches are lower than those from Jobstvogt et al. (2014) and Andrews et al. (2021), as expected since their samples included explicitly divers and anglers and anglers, respectively, that tend to pay more to secure such benefits. The author is not aware of other studies having estimated the value of increased carbon sequestration from marine ecosystems to compare the mean WTP estimates of CARBON with. The overlapping of the confidence intervals for carbon sequestration (see Table 7) might indicate some insensitivity to scope, which is common in stated preference surveys (e.g., Goldberg and Roosen, 2007) and in studies valuing ecosystem services of marine ecosystems (e.g., Remoundou et al., 2015; Jobstvogt et al., 2014). Contrary to Jobstvogt et al. (2015) that found scope sensitivity of participants to the type of ecosystem services provided by marine ecosystems and of features present within an MPA, insensitivity in the present study might be the result of the presentation of the attributes as percentage increases. Although this representation was supported by focus groups during survey development, these groups included fishers and local stakeholders and not members of the public as were the majority of the survey participants.

The impact on participants welfare from introducing extra restrictions to the Maltese MPA amounted to half a million Euros for all interventions examined (see Table 8). Welfare changes were positive, indicating that the public does experience higher welfare but would prefer such restrictions to be minimum so that access (both for recreational and commercial activities) is as little obstructed as possible. Given the large familiarity and the important role that such activities play in the life of respondents, such results are expected. These estimates appear very small when comparing them with the country's Gross Domestic Product (GDP) in 2019 (0.003% of GDP) but estimates derived from non-market valuation methods are also considered to express the low-end of the total economic value of marine ecosystems (Schaafsma and Turner, 2015).

6. Conclusions

To achieve improvements in the quality of ecosystem services provided by marine ecosystems marine protected area designations have been used for decades. Signatory countries of the Convention of Biological Diversity have agreed to increase protected areas in the water to reach 10% of their water territories by 2020, and on this front Mediterranean MPAs are behind, covering around 6% of the total Mediterranean area (Claudet et al., 2020). Although restrictions to fishing and recreational activities are not always enforced or achieved, marine planning and management is nevertheless expected to be more effective with ensuring public support behind management measures. The present study presents the results of a public survey amongst the Maltese population with respect to the North-East Marine Protected Area in Malta that contains seagrass meadows and coralligenous formations that are threatened by anchoring and mooring activities currently taking place.

Results show that frequent visitors strongly object to introduction of restrictions to enter the MPA while also preferring the increase in provisioning ecosystem services such as fish caught and increases in carbon sequestration. These findings are partly explained by a potential utilitarian view that respondents might have regarding the MPA and the general good and abundant current condition *Posidonia oceanica* meadows are in. A deviation from such a use-centric view of ecosystems can be achieved by allowing members of the public to support decision-making through "citizen science" activities (e.g., Kleitou et al., 2021; Hermoso et al., 2022) which increases knowledge and engagement. Despite such preferences against restrictions, minimum new restrictions to entry such as banning of trawling within the Maltese MPA increase human welfare the most. Such policy-relevant findings are at odds with ecological studies' findings that advocate for the highest possible levels of restrictions to achieve biological conservation of marine ecosystems (e.g., Claudet et al., 2020). This divergence is confirmed in this study that finds an apparent divergence of preferences between suggested MPA management actions between the public and stakeholders from the fishing and tourism sector. Better co-governance between managing authorities and stakeholders as well as information sharing between MPAs has been recently advocated as means of achieving integrated biological conservation (Hermoso et al., 2022). If biodiversity conservation is to be prioritised, further management decisions regarding the NE MPA in Malta should consider better communication of current threats to ecosystems and means of improving their quality so that public support for stricter restrictions to enter the MPA are accepted.

Declaration of Competing Interest

The author 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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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jnc.2022.126174.

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