Investigating societal attitudes towards marine ecosystem restoration

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Abstract

Globally, direct and indirect human impacts have led to the widespread degradation of marine ecosystems. The resulting loss of habitat and marine biodiversity has led to the increased impetus for marine ecosystem restoration at a policy level. The success of such programs relies on an understanding of the nature of public support for marine restoration. This paper examines such support through a survey of the attitudes of the general public in Norway and Italy. The results show that amongst both populations, there is broad support for restoration despite a lack of awareness of marine restoration activity. Differences in responses to the attitudinal questions across countries were tested using standard statistical independence tests and Multi-Group Confirmatory Factor Analysis. Results show significant differences between samples in attitudes toward the completion of restoration and attitudes toward how restoration should be funded. Examining within-group variation, for both samples, regression analysis indicates that a mixture of socio-economic and context-specific variables are significant predictors of awareness and attitudes toward restoration, while environmental awareness is a positive and significant indicator of attitude toward restoration.

Key Words: Marine Ecosystem Restoration, Stakeholder, Public attitudes, Sustainability

Implications for Practice

- High levels of support despite low levels of awareness suggest societal acceptance of marine ecosystem restoration policy and projects.
- Survey results further indicate that there are potential gains in support possible from campaigns to increase awareness of marine restoration activity.
- Survey results demonstrate heterogeneity in preferences both across and within Italy and Norway for how restoration should be completed and financed.
- Therefore, in ensuring public support in the implementation of restoration projects it is important for policy makers to be aware and adapt programs to take into account the preferences of the public in their respective jurisdictions.

Introduction

Ecological restoration of degraded ecosystems is currently embedded in many important global and EU environmental and climate policies. The UN has launched a new initiative entitled the "Decade on Ecosystem Restoration (2021-2030)" that aims to halt further degradation and to accelerate existing restoration efforts for land, aquatic and marine ecosystems (United Nations 2020). The need for restoration has also been stressed in several pieces of EU marine environmental legislation such as the Marine Strategy Framework Directive, the Birds and Habitats Directive, the Maritime Spatial Planning Directive, the Water Framework Directive, the Invasive Species Regulation and Bathing Water Quality Directive and the Common Fisheries Policy (Long 2019). Ecological restoration of marine ecosystems is also highlighted in several multilateral and regional treaties such as the United Nations Convention on the Law of the Sea, the Convention on Biological Diversity, the OSPAR Convention, the HELCOM Convention, and the Mediterranean Sea Barcelona Convention (Long 2019). Ecological restoration has demonstrated good conservation outcomes (Possingham et al. 2015) and is regarded as an important management tool to reverse the degradation of many marine ecosystems (Mitsch 2014).

Following the Society of Ecological Restoration (SER), ecological restoration is defined as *"the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed"* (SER 2004). A further distinction can be made between unassisted or spontaneous regeneration and active restoration. The former is associated with ecosystem management approaches that regulate and/or stop human activities that cause degrading pressures and the latter refers to human interventions to assist in ecosystem recovery (McDonald et al. 2016; Ounanian et al. 2019). While both forms of restoration are not mutually exclusive this study is in the main, concerned with active restoration (hereby referred to as restoration).

Restoration in the marine environment is relatively new compared to restoration in the terrestrial and freshwater environment (Ounanian et al. 2019; Waltham et al. 2020). Stakeholder involvement in the terrestrial case has been found to lead to greater uptake of restoration measures, to reduce conflicts as well as improving the quality of decision (Reed 2008; Sultana & Abeyasekera 2007; Beierle 2002). Social responses have also been found crucial for the introduction and implementation of new technologies and infrastructures (Bell et al. 2013; Haggett 2011). The need to engage wider society in a marine conservation context has been recognised as an important step in changing negative societal behaviour and has been shown to potentially affect the results of conservation interventions including restoration (Jefferson 2015). Effective public participation has also been found to be important for marine conservation and planning; for example, for large scale MPAs (e.g. Day 2017) and Marine Protected Area (MPA) network planning (Gleason et al. 2010).

Marine restoration may involve ecosystem engineering, often requires large upfront investments, and can face high uncertainty in terms of restoration outcomes (Bayraktarov et al.

2016; Waltham et al. 2020). While there are several potential financing mechanisms available, public funding appears to be the most feasible in the short term. Private financing mechanisms are however desirable for the sustainable development of restoration projects. Such mechanisms rely on projects having demonstratable and attractive financial returns, which is likely to be challenging for many marine restoration projects given existing funding options due to uncertainties in quantifying returns (Waltham et al. 2020). Considerable innovation in existing financing mechanisms is thus likely necessary to make funding options attractive to private investors (Thiele & Gerber 2017; Vanderklift et al. 2019; Claudet et al. 2020; Waltham et al. 2020). Financing based on the polluter pay principle is also highly attractive due to its equitability. It however relies on the identification of specific polluters which is not always feasible. Therefore, for the immediate future, financing of marine restoration for a sizeable portion of restoration projects is likely to rely on some degree of public funding. For example, in a review of 42 recent marine restoration projects in Europe, Papadopoulou et al. (2018) found that 32 projects were entirely funded through public means with one additional study funded through a joint public-private funding mechanism.

As taxpayers are likely to fund much of the needed restoration, effective public participation and public support will be key success factors for marine restoration projects. Implementing effective public participation and garnishing public support for ecosystem restoration first requires an understanding of the public's attitude toward the need for restoration and their knowledge of the multiple anthropogenic stressors on the marine environment (Crain et al. 2008; Claudet & Fraschetti 2010). Several previous studies have examined public attitudes towards the marine environment (Potts et al. 2011; Hynes et al. 2014; Jacobs et al. 2015; Loetze

et al. 2018; Ware & Calloway 2019; Ankamah-Yeboah et al. 2020). Others have examined public attitudes to marine industrial activity and in particular to different forms of aquaculture and their perceived impacts on the marine environment (Whitmarsh & Palmieri 2009; Alexander et al. 2016; Hynes et al. 2019). In one of the few studies to have examined attitudes to marine ecosystem restoration, Papadopoulou et al. (2019) looked at the attitudes of specific groups such as government officials (local and central), conservation-oriented environmental NGOs, MPA managers, marine researchers and marine users (professional and recreational). No previous work has examined the attitudes of the general public toward marine restoration.

This paper contributes to the above literature through a comprehensive survey of the Norwegian and Italian public's knowledgeability and attitude toward marine restoration activity in their country's respective waters. Norway and Italy both have large marine territories, publicised instances of human-related degradation of marine ecosystems, and the presence of on-going marine restoration projects in their territorial waters (Papadopolou et al. 2018). Further, Norway (Northern Europe) and Italy (Southern Europe) belong to distinct cultural and economic regions. The results of the survey thus provide insight into attitudes toward restoration in countries affected by current and future European policy program on restoration. The comparison of results provides insight into regional variation in public attitudes toward marine restoration.

The distribution of responses across samples was tested for independence, and Multi-Group Confirmatory Factor Analysis (M-GCFA) was employed to analyse survey responses. The advantage of the latter being that it allows for measurement error and tests for the presence of measurement invariance (i.e. that the survey instrument elicits equivalent patterns of response

across both groups) (Brown 2015). Regression techniques were also used to explore the relationship between respondent's socio-demographic characteristics and awareness of and attitudes toward issues surrounding marine restoration. The study, therefore, represents the first in-depth empirical examination of attitudes toward marine restoration amongst the general public. By developing a better understanding of the attitudes of the public towards marine ecosystem restoration, policymakers can be better informed as to how future policy interventions in this regard should be designed.

Methods

Survey design and administration

Data for the study was collected via online surveys. These surveys were conducted in Norway and Italy with the twin objectives of examining public attitudes to marine restoration and estimating the public good benefit value of restoration of a specific marine ecosystem (kelp forests in Norway and a deep sea canyon in Italy). In designing the survey instruments, focus groups were carried out in both countries to ensure that the questions were presented in a manner that was understood by the general public. Three focus groups were carried out for the Norwegian survey while two subsequent focus groups were carried out in the Italian case to make sure that no unique issues were present for the Italian population not already highlighted in the Norwegian focus groups.

Extensive discussions with kelp ecologists and deep sea scientists involved in the EU Horizon 2020 project MERCES also assisted in question formation. The survey was then piloted to

ensure its effectiveness before the final survey instrument was implemented. The pilot testing was conducted with 90 randomly selected panel members in the case of Norway and 60 in the case of Italy. A key issue with online surveys is the low level of assistance that can be given to interviewees which potentially can affect the quality of answers. To control for this the recommendations of Alexander et al. (2016) were followed by avoiding open ended questions and ensured the questions were clearly worded and limited scales used to binary and Likert formats.

The survey was administrated by two specialist market research companies, Istituto Piepoli in the Italian case and NOSTAT in the Norwegian case. Each company collected the data using their established online panels of the general public. Active sampling approaches were used to ensure that the final samples in each case were representative of the population by age, gender and region. Respondents had also to be at least 18 years of age in each case.

The final survey instrument contained four sections. The preliminary section outlined the aim of the survey and detailed the wider Marine Ecosystem Restoration in Changing European Seas (MERCES) project of which this study is a part. Respondents were also informed of the voluntary nature of participation. Section A surveyed respondents' prior awareness of marine restoration and related issues in their national seas, perceptions of the quality of their respective marine environments and general attitudes toward marine restoration activity. Attitudes were surveyed through asking respondents to indicate their level of agreement with statements regarding the appropriateness of restoring marine ecosystems following degradation due to human pressures and agreement with statements regarding payment for marine restoration. Section B included stated preference valuation approaches to estimate the public-good benefit

value of the specified marine environment. Finally, section C collected socio-economic descriptive data regarding the individuals surveyed. Section A and C are the relevant sections of interest for this study with the results of Section B examined elsewhere. An overview of Section A is available in Supplement S1 and a copy of the full survey instrument is provided in Supplement S2.

Data Analysis

A number of techniques were employed to analyse the generated survey data. Firstly, the answers derived from section A were compiled into figures to visually compare answers across the Norwegian and Italian samples. Secondly, standard statistical tests were employed to test for independence in the distribution of responses to individual questions across samples. Given the categorical nature of the response variables, Fisher's exact test of independence of distributions was employed. Where applicable, odds ratio tests were used to quantify differences between responses.

The third approach employed tested for structural differences in responses to questions regarding attitudes toward the appropriateness of restoring damaged ecosystems and paying to support ecosystem restoration through MG-CFA. MG-CFA is commonly used in social science studies to test for measurement invariance (equivalence) of a factorial model to explain variability in survey responses between distinct cultural groupings of individuals (Brown et al. 2017). Factorial models explain variability between observable variables in terms of a lesser number of unobserved latent variables. Measurement invariance occurs when differences in the pattern of responses of a survey as explained by a common factorial model are small enough

to be statistically equivalent (i.e. explained by random chance rather than group characteristics) (Brown et al. 2015). Relative to comparing the distribution of single responses at a time, MG-CFA involves analysing the covariance and mean structure of all responses together to compare the pattern of responses across the samples.

A preliminary step in the analysis, was to define and fit a factorial model to be tested. A correlated two-factor model was proposed as represented in Figure 1 (this model was found to fit the data better than a single factor model in preliminary analysis). The two factors are *"Agreeability with restoring damaged ecosystems"* and "*Agreeability with paying to restore damaged ecosystems"* as consistent with the design of the survey. Measurement invariance across groups was then tested by estimating and comparing the fit between four variants of the CFA model sequentially to establish four hierarchical levels of invariance; configural; threshold; metric and scalar (Wu & Estabrook 2016; Lemos et al. 2019).

The Satorra-Bentler Chi-squared test statistic supplemented with two indices of model fit; the Root Mean Square Error Approximation (RMSEA) and Comparative Fit Index (CFI)), were used to establish configural invariance. The standard Hu & Bentler (1999) cut-off values for an acceptable fit of 0.95 for the CFI and 0.06 for the RMSEA were used to establish significance of the fit indices. As chi-squared difference tests are sensitive to sample size and data non-normality in establishing measurement invariance, changes in fit of the RMSEA and CFI indices of the restricted model relative to the nesting model were used to indicate threshold, metric and scalar invariance (Chen 2007). Standard cut-off thresholds of $\Delta CFI \geq -0.01$ and $\Delta RMSEA \leq 0.015$ were employed to establish invariance at the various levels (Chen 2007).

Finally, regression analysis was used to examine for potential variation across sub-groups within each population and responses to survey questions.

Insert Figure 1.

Socio-economic status has been found in the past to be a predictor of knowledgeability and awareness of the marine environment (Steel et al. 2005; Heck et al. 2018). There is also likely to be a relationship between an individual's engagement with the marine environment and environment issues generally and their awareness/willingness to support marine restoration (Steel et al. 2005; Perry et al. 2014; Aanesen et al. 2018; Heck et al. 2018). Engagement with the marine environment and environmentalism were measured through the aforementioned questions regarding an individual's use of coastal amenities and membership of an environmental organisation.

The relationship between respondents' characteristics and prior awareness of issues related to the marine environment was examined through the use of logistic regressions. Two regressions per sample were run. The dependent variable in the first regression was a binary variable indicating awareness of restoration activity and/or MPA's in their respective waters. The dependent variable for the second regression is a binary variable indicating prior awareness of the presence of invasive and/or endangered species in their respective waters.

The relationship between survey respondents' characteristics and attitudes toward restoration was examined by regressing the common factors identified through the CFA model on predictor variables. This type of model is typically called a CFA with covariates or Multiple Indicator Multiple Causes (MIMIC) model (Brown et al. 2015). In addition to socio-economic

and use of the marine environment indicators, prior awareness of either MPAs or marine ecosystem restoration in the respondents' respective countries was used as an additional predictor in the MIMIC model. Increasing support amongst the general public is known to be a key motivating factor for public awareness campaigns aimed at boosting knowledge of environmental programmes (Latinopoulos et al. 2018). The relationship between awareness and support is thus important from a policy perspective.

Several software packages were used to generate results. Excel was used to create compiled figures. Stata was used to complete descriptive statistics and tests of independence across samples. The R packages *Lavaan* and *SemTools* were used to complete the CFA, MG-CFA and MIMIC models. Further deataills regarding estimation of the CFA models and the MG-CFA procedure are provided in Supplement S3.

Results

In total 1,102 valid responses were received from the Norwegian study and 1,060 valid responses from the Italian case. Summary statistics for the Norwegian and Italian samples are presented in Table 1. There are significant differences observed across both countries for several variables. Firstly, the Norwegian sample is older than the Italian sample *(47 Norway vs 41 Italy, t-test =26.68, p<0.001).* This is also reflected in the employment statistics with a higher percentage of Norwegians retired *(19% Norway vs 2% Italy, Fishers exact test, p<0.001).* Similarly, there is a higher percentage of Italians employed relative in the Norwegian sample *(64% Italy vs 56% Norway, Fishers exact test, p<0.001).* Conversely, the percentage of the

Norwegian sample who are unemployed is significantly lower than the Italian sample *(2% Norway versus 13% Italy, Fishers exact test, p<0.001)*. Median personal income per year amongst respondents in the Norwegian sample is also considerably higher than in the Italian *sample (€50,667 Norway versus €25,628 Italy, t-test = -29.66, p<0.001)*. Finally, the percentage of Norwegians and Italians currently enrolled in education is statistically equivalent *(11% Norway versus 9% Italy, Fishers exact test, p =0.065)*. There is however a higher percentage of the Norwegian sample who have already obtained third level education (*64% Norway vs 36% Italy Fishers exact test, p<0.001)*.

A number of additional variables related to the respondents' use of coastal amenities are reported in Table 1. Italian respondents had a higher rate of usage of coastal amenities relative to Norwegian respondents. Italians were statistically more likely to have visited the seaside in the previous 12 months *(80% Italy vs 63% Norway, Odds Ratio (OR) = 3.04, p<0.001)* and have partaken in water-based activities at least once every three months *(48% Italy vs 37% Norway, Odds Ratio (OR) = 1.61, p<0.001)*. The percentages of respondents who are, or have somebody in their family a member of an environmental organisation are statistically equivalent across both samples (11% Italy vs 13% Norway, *Odds Ratio (OR) = 0*.837, *p = 0.174).*

Insert Table 1.

Awareness of Marine environment and coastal waters

Responses to questions regarding awareness of the marine environment are presented in Figure 2. Italian respondents reported significantly higher levels of awareness of both restoration

activity (32% Italy versus 9% in Norway, Odds Ratio (OR) = 5.001, $p<0.001$) and MPAs (79% Italy versus 29% Norway, OR = 9.138, $p<0.001$). Respondents in Italy also reported higher levels of prior awareness of endangered species compared to Norwegians (63% Italy versus 55% Norway, OR= 1.284, p =0.004). In contrast, however, Italian respondents reported a lower awareness of invasive species relative to Norwegian counterparts (38% Italy versus 44% Norway, OR= 0.708, $p<0.001$). Notably, respondents reported significantly higher levels of awareness of MPA's relative to marine restoration activity in their national seas for both the Italian (OR = 7.815, $p<0.001$) and Norwegian cases (OR =4.280, $p<0.001$).

Insert Figure 2.

Estimates and associated levels of statistical significance of parameters of the binary logistic regression of prior levels of awareness on socio-economic characteristics are reported in Table S1. For the Norwegian sample, being female is a negative and significant (at the 5% level) predictor of prior awareness of MPAs/restoration and the presence of endangered/invasive species. Having obtained third level education, partaking in water-based activities, and having a member of your family, a member of an environmental organization are positive and significant (at the 1% level) predictors of prior awareness of MPAs/restoration and the presence of endangered/invasive species. For the Italian sample, age is a positive and significant predictor (at the 5% level) of prior awareness of the presence of MPAs/restoration activity but does not have a significant effect on prior awareness of invasive/endangered species. Partaking in water-based activities is a positive and significant (at the 1% level) predictor of both prior awareness of MPAs/restoration and the presence of endangered/invasive species. Finally having a member of your family, a member of an environmental organization is a positive and

significant (at the 5% level) indicator for awareness of the presence of endangered/invasive species. It is however not a significant predictor of prior awareness of marine MPA's/restoration activity in the Italian case.

Perceptions of quality of marine environment

Responses to questions regarding quality of the marine environment in the respective marine waters of respondents are displayed in Figure 3. Regarding the perceived quality of coastal waters, significant differences were observed between the Italian and Norwegian samples (*Fishers exact test, $p<0.001$*) with 42% of Italians were either satisfied or very satisfied with Italian coastal waters compared to 29% of Norwegians perceptions with respect to Norwegian coastal waters. Similar proportions of respondents were either dissatisfied or very dissatisfied with the quality of marine coastal water bodies at 22% in Italy and 24% in Norway. There were also significant differences in responses across samples in relation to satisfaction with the quality of the deep-sea environment (*Fishers exact test, $p<0.001$*). A higher proportion of Italians were satisfied or very satisfied (46%) relative to Norwegians (27%) with a near equivalent proportion of respondents dissatisfied at 15% in the Italian case and 16% in the Norwegian case. A different pattern emerges in respect to perceptions regarding fjords in Norway and estuaries in Italy. Proportionally there is near equivalence with approximately 30% satisfied/very satisfied, 25% unsatisfied/very unsatisfied and 45% answering either neither satisfied or dissatisfied or don't know. In this case the null hypothesis of independence between samples is rejected at the 5% significance level (*Fishers exact test, $p = 0.056$*).

Insert Figure 3.

Attitudes toward and willingness to support marine restoration

Levels of agreement with statements regarding the appropriateness of restoring marine ecosystems following degradation due to human pressures are displayed in Figure 4. Across both samples, there was a high level of agreement with the statement that a part of marine ecosystems should be restored; 73% of Norwegian agreed or strongly agreed relative to 76% of Italians, with the overall distribution of responses found to be statistically equivalent (*Fishers exact test, p* = 0.340). There was however significant variance in agreement with the statements that the complete marine ecosystems should be restored in situ (*Fishers exact test, p<0.001*) and a marine ecosystem restored elsewhere that is considered of equal value would also be OK (*Fishers exact test, p<0.001*).

For the Norwegian sample, respondents were significantly more likely to agree with part restoration relative to complete restoration in situ (73% part restoration versus 48% complete restoration, OR= 3.00, p<0.001). For the Italian sample the proportion of respondents who agreed with both statements is statistically equivalent (76% part restoration versus 76% complete restoration, OR= 1.010, p=0.919). For both the Norwegian (73% part restoration versus 31% restoration elsewhere, OR= 6.189, p<0.001) and Italian (76% part restoration versus 48% restoration elsewhere, OR= 3.369, *p<0.001*) samples there is a significant drop in respondents who agreed with the need for part restoration relative to a marine ecosystem restored elsewhere that is considered of equal value.

Insert Figure 4.

Reported levels of agreement with statements regarding payment for marine restoration are displayed in Figure 5. In total, 42% of Norwegians agreed that they would pay to support a targeted local marine ecosystem project relative to 53% of Italians, with significant variation in the distribution of responses across both samples (*Fishers exact test, $p<0.001$*). Likewise, the distribution of responses to statements two (*Fishers exact test, $p<0.001$*) and three (*Fishers exact test, $p<0.001$*) were also statistically different. Norwegian respondents were significantly more likely to agree that they would pay to support a national ecosystem restoration fund financed by increased tax relative to participating in a crowdfunding campaign (42% increased tax vs 30% crowdfunding, OR= 1.743, *$p<0.001$*). In contrast, Italian respondents displayed a preference for participating in a crowdfunding campaign over a national ecosystem restoration fund financed by increased tax (60% crowdfunding vs 43% increased tax, OR= 1.994, *$p<0.001$*). Lastly 61% of the Italian respondents indicated they would pay to support a local marine restoration project using their x5000 tax contribution option.

The relative decline in those numbers who agree that restoration should take place to those who are willing to pay for restoration is also informative. Of those respondents who agree with the need for partial restoration, 49% of Norwegian and 38% of Italian respondents don't agree that they should pay for a targeted local restoration. This indicates that there is a statistically significant proportion of the respondents who believe that there is a need to restore damaged marine ecosystems but don't agree to pay themselves for the restoration work required.

Insert Figure 5.

The above results indicate significant variation in attitudes toward restoration across samples. This is further examined through testing responses for factorial equivalence. Before examining the results from the Multi-Group Confirmatory Factorial Analysis, results from fitting the Confirmatory Factor Analysis (CFA) model to each sample is reported in Table S2. Two models were fitted per sample. For model 1, observed response variables were set to load on respective factors as per the survey design. While all factor loadings are significant (at the 1% level) in model 1, for both samples, the factor loadings for the statement *"A marine ecosystem restored elsewhere that is considered of equal value would also be OK*" on the common factor, Factor 2 - *"Agreeability with paying to restore marine ecosystems"* is relatively low in both cases. This indicates that the shared variance between the observed variable and latent factor is low (in tests the observed variable was also found not to load significantly on Factor 1). For this reason, response to *"A marine ecosystem restored elsewhere that is considered of equal value would also be OK*" is excluded as a measurement variable in model 2. While there is little change in the fit of the model in the Norwegian case, there is a significant improvement in the fit of the model in the Italian case as indicated by improvement in the CFI (0.992 (model 2) $\geq$ 0.976 (model 1)) and RMSEA (0.052 (model 2) $\leq$ 0.086 (model 1)). Model 2 is therefore used for testing measurement invariance in the MG-CFA analysis.

To formally test for equivalence across groups, the MG-CFA procedure outlined in section 2 is applied with results reported in Table S3. Firstly configural invariance is established based on the significance of the chi-squared statistic (χ2, df=8, $p<0.001$) and fit indices (*CFI=0.997*

$\geq$ *0.995*, RMSEA=0.043 $\leq$ 0.06). This indicates that the common factorial model adequately explains the observed variance in the response pattern for both models. Threshold (Δ *CFI*=-0.004 $\geq$ *-0.01*, Δ RMSEA =0.002 $\leq$ 0.015) and metric (Δ *CFI*=0.00 $\geq$ *-0.01*, Δ RMSEA =-0.004 $\leq$ 0.015) invariance are also established as changes in the fit indices are above/below cut off values. Changes in fit indices from the metric to the scalar model (Δ *CFI*=-0.055 $\leq$ *-0.01*, Δ RMSEA = 0.119 $\geq$ 0.015) are however above/below the acceptable cut off values. Based on this result it possible to reject the hypothesis of measurement invariance across groups at the scalar level.

Regression coefficients and associated significance levels generated through regressing the common factors identified through the CFA model on predictor variables are reported in Table S4. Across both samples, partaking in water-based activities is a positive and significant (at the 1% level) predictor of Factor 2 ("*Agreeability with paying to restore damaged ecosystems"*). Having a family member affiliated to an environmental organisation is also a positive and significant predictor (Norway at the 1% level, Italy at the 5% level) of Factor 2. For the Norwegian sample having a family member affiliated to an environmental organisation is similarly a positive and significant (at the 1% level) predictor of Factor 1 ("*Agreeability with restoring damaged ecosystems"*), while partaking in water-based activities is, however, an insignificant predictor of Factor 1. For the Italian sample in contrast partaking in water-based activates is a positive and significant predictor (at the 5% level) of Factor 1, while having a family member affiliated to an environmental organisation is an insignificant predictor.

Across both samples, prior awareness of MPAs/ Restoration Activity in the respondents' respective waters was a positive and significant (at the 1%) predictor of both Factor 1 and 2. Age is a positive and significant (at the 5% level) predictor of Factor 1 for the Norwegian sample and a significant but negative (at the 5% level) predictor for Factor 1 amongst the Italian sample. For the Italian sample age (negative) income (positive) and being retired (positive) are significant (at the 5% level) predictors of Factor 2. No other indicators of socio-economic status are significant predictors across either sample.

Discussion and Conclusions

Public support has been found to be a critical factor in the success of active restoration programmes in the terrestrial sphere (Reed 2008; Sultana & Abeyasekera 2007; Beierle 2002). Perhaps reflective of the fact that the science of marine restoration is still in the formative stage there is little evidence available as to public support for marine restoration programmes. This paper thus provides valuable insight into public support of marine restoration through a survey of awareness and attitudes toward marine restoration amongst the Norwegian and Italian populations.

Across both countries' prior awareness of marine restoration activity was lower than awareness of other issues related to the marine environment including the establishment of MPAs in their respective waters. This is consistent with Papadopolou (2018) who found that amongst European stakeholder groups awareness of marine restoration activity is relatively lower than other issues related to marine ecosystem management. The fact that awareness of marine

restoration is lower than for MPAs is not surprising given that the creation of MPAs is more established than active marine restoration and has received greater publicity (Papadopolou 2018). This is also likely to be true of the presence of invasive and/or endangered species; issues that tend to receive more media attention (Didham et al. 2005). The result suggests the need to disseminate further information related to what is involved in marine restoration should there be an increase in such restoration activity, as is being indicated by current policy proposals in Europe and elsewhere.

Considering awareness of issues related to marine ecosystem restoration and conservation interventions more broadly results from the logistic regression analysis indicate that use of the marine environment and membership of an environmental organisation are particularly strong predictors of awareness of marine restoration/MPA's and the presence of endangered/invasive species in the national seas of the survey respondents. While gender (Italy and Norway), age (Italy), and attending third level education (Italy) were significant across both samples employment status and income were insignificant predictors of awareness. As discussed by Steel (2005) if knowledge is largely determined by socio-economic variables then the scope for changing public knowledgeability may be limited as socio-economic variables tend to be static. The significance of both socio-economic and context related explanatory variables points to a potential positive return in awareness raising programmes that encourage engagement with the marine environment (Steel 2005; Heck et al. 2018).

Despite relatively low awareness, there were high levels of support for restoration with 73% of Norwegians and 76% of Italians agreeing that once damaged at least a part of the ecosystem should be restored. While no direct comparisons are forthcoming from the literature these levels

of support compare favourably with studies that survey key stakeholder support for restoration and support amongst the general public for related marine conservation efforts (Ware & Calloway 2019; Ankamah-Yeboah et al. 2020). Papadopolou (2019) found 54% of Greek and 81% of European stakeholders support marine restoration. Ware and Callaway (2019) found 91% of respondents supported the creation of artificial floating islands for habitat creation amongst a survey of the UK public and Loetze et al. (2018) found in a large scale survey of the general public across 21 countries that 73% of respondents support MPAs areas in their region.

In this study, a significant portion of respondents agreed that part of a marine ecosystem should be restored but did not agree with they themselves paying for restoration. Furthermore, while there was a positive correlation between factors in the two factor CFA model (0.6 approximately for both samples), the correlation coefficient was well below 0.85, the threshold generally employed in factor analysis to signal that two factors are sufficiently correlated to suggest that they should be combined (Brown 2015). The results thus indicate that a positive attitude toward the undertaking of restoration does not automatically imply individuals will have a positive attitude toward paying to support marine restoration.

Results from testing the distribution of responses for equivalence across samples and the MG-CFA indicate significant differences in attitudes across both samples. Examining individual responses, results suggest a variation in preferences for payment vehicles. Respondents from the Norwegian sample showed higher levels of agreement (and lower levels of disagreement) for the tax-based payment vehicles relative to the voluntary based crowdfunding approach. The opposite was true in the Italian case with higher levels of agreement for a crowd funding-based approach and the x5000 tax contribution option relative to a mandatory tax. This result suggests

heterogeneity across the jurisdictions in preferences for how respondents would like to pay to support restoration.

Reasons posited to explain alternate preferences for different payment vehicles include the danger of free riding and objection to payment of more tax when it comes to mandatory taxation systems (Wiser 2007; O'Neill & Yadav 2016). Harring (2016) points toward the perceived quality of government or trust in government as an important factor amongst populations in determining preferences for forms of policy intervention. Using survey methods, the author finds that in countries with a high perceived quality of government, including Norway, there is a higher preference for taxation (Harring 2016). Trust in government to use increased taxation appropriately could thus also be a significant explanatory factor in explaining the difference in preferences for payment vehicles between Norway and Italy. For policymakers, the results point toward the importance of considering alternative preferences in designing financing mechanisms.

There was also variation in agreement across both samples regarding the appropriateness of completing the full in-situ restoration once an ecosystem was damaged, with Italians more likely to agree relative to Norwegians. In both samples however there was significantly lower agreement with the statement that a *"A marine ecosystem restored elsewhere that is considered of equal value would also be OK"* relative to the agreement that a marine ecosystem should be restored once damaged. Furthermore, after fitting the two-factor CFA model, the obsevered response variable had a lower association with the factor "*Agreeability with restoring damaged ecosystems*" relative to the two other associated observed variables. This indicates that public

support for offsetting the benefits lost from a damaged ecosystem by restoring an ecosystem elsewhere is significantly lower than on-site restoration.

This latter result is consistent with the idea of a mitigation hierarchy common in many modern planning regimes, which dictates that given the potential loss of biodiversity due to a specific project, action should first be taken to firstly to avoid or minimize negative impacts, secondly to undertake on-site restoration, and lastly to offset biodiversity loss to ensure that there is no net-loss (Jacob et al. 2018). Potential sources of aversion to mitigating losses through equivalent restoration elsewhere include a non-substitutable socio-cultural value associated with an ecosystem in a particular location (Gardner et al. 2013; Abdo et al. 2019), aversion to inequality given that restoration elsewhere may not compensate individuals who lose out on ecosystem services lost in a given location (Jacob et al. 2016; Abdo et al. 2019) and aversion due to the perceived commodification of natural capital (Vaissière et al. 2017). It is important to note that it is not clear from the survey results as to whether the public would support offsetting practices should it not be possible to restore a damaged site in-situ and future research is necessary to ascertain under what conditions the public is likely to support off-setting bio-diversity loss in the marine sphere.

The MGCFA failed to demonstrate measurement invariance in the two factor CFA model across the samples. Measurement non-invariance implies that comparisons of scores of the latent variables from the CFA model are subject to measurement bias due to both samples representing different populations with different response mechanisms (Brown et al. 2015; Brown et al. 2017). In the current case, this implies that differences in the observed scale of attitudes are not necessarily reflective of a genuine divergence in scale of the underlying latent

variable (i.e. it's not possible to deduce that Italians have a more positive (negative) attitude toward marine restoration than Norwegians using the measurement model). Results thus suggest that caution should be employed when comparing differences in attitudinal levels toward marine restoration across countries using survey methods as observed scores are likely to be sensitive to measurement bias due to substantive differences across groups (Brown et al. 2017; Marsh et al. 2018).

Within-population variation in attitudes was also examined through regressing individual characteristics on the latent attitudinal factors derived through the CFA. As with awareness, a combination of variables indicating an individual socioeconomic status and usage of the marine environment and environmental leaning were found to positively and significantly affect attitudes. This result indicates that personal experience and context, in addition to socio-economic status, is likely to be an influencing factor on individuals' attitudes toward restoration across both populations. Awareness of either MPAs/restoration activity in the respective waters of the respondents has a positive effect on both factors. Once again, this suggests that raising public awareness is likely to have a positive effect on generating support for marine restoration. This result is further supported by prior research that shows that increasing awareness of environmental programmes can positively increase willingness to support environmental programmes (Ford et al., 2009; Latinopoulos et al. 2018; Liski et al. 2019). Based on the influence of contact with the marine environment on awreness, policies aimed at exposing the public to the sea, either physically or virtually could also increase awareness and support for marine ecosystem restoration efforts

To conclude, with initiatives such as the UN's "Decade on Ecosystem Restoration (2021-2030)", the need for marine restoration is increasingly gaining importance on the public policy agenda. The success of marine restoration however is subject to overcoming a variety of technical, scientific, financial, and governance challenges (Waltham et al. 2020). As has been the case for the restoration of terrestrial ecosystems, public awareness and support are likely to be key factors in overcoming these challenges and achieving success in the restoration of marine ecosystems. While the results in this study suggest high levels of support for marine restoration action there was also considerable heterogeneity in attitudes across both countries towards how restoration should be completed and financed. Therefore, in ensuring public support in the implementation of marine restoration projects policymakers need to account for the preferences of the public as well as other relevant stakeholders.

As pointed out by Ankamah-Yeboah et al. (2020) examining public environmental perceptions, and in this case attitudes twords marine ecosystem restoration, is a critical socio-economic assessment tool for the success of any marine management program. Recognising the public's current level of knowledge with regard to marine ecosystems and restoration can also assist in the development of educational tools and effective management policy that might influence behaviour and in turn reduce future damages to marine ecosystems. Ultimately, building public support for marine habitat restoration begins with understanding peoples current knowledge and environmental preferences and in fostering a personal responsibility for protecting our seas and ocean ecosystems.

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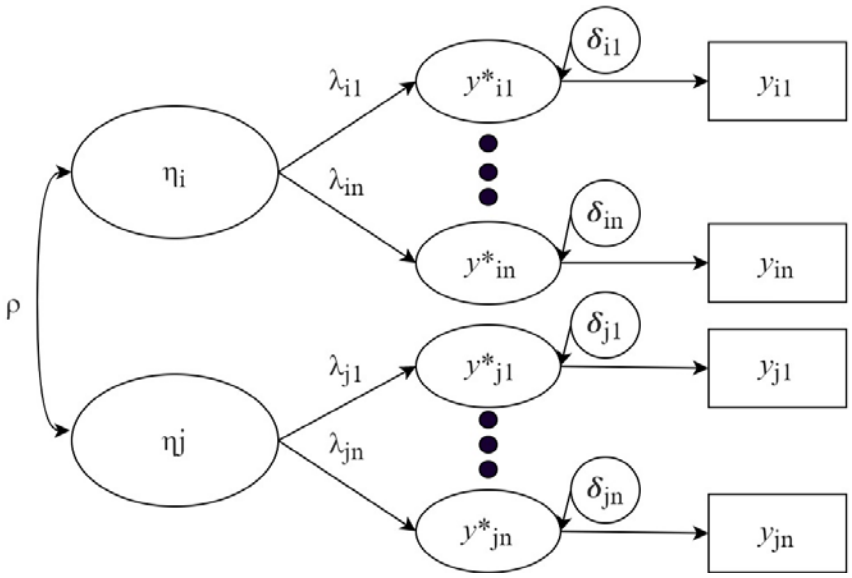
Table 1. Summary statistics

	Norway	**Italy**
Age	47.07 (17.66)	40.55 (11.86)
Female	0.53 (0.5)	0.51 (0.5)
Single	0.24 (0.43)	0.33 (0.47)
Children	0.58 (0.49)	0.52 (0.5)
Attained Third Level Education	0.64 (0.48)	0.36 (0.48)
Student	0.11 (0.32)	0.09 (0.29)
Personal Income per year (€000)	50.66 (22.38)	25.62 (16.24)
Employed	0.56 (0.5)	0.64 (0.48)
Retired	0.19 (0.39)	0.02 (0.16)
Unemployed	0.02 (0.12)	0.13 (0.34)

Member of Environmental Organisation	0.13 (0.34)	0.11 (0.32)
Visited Seaside Once in previous 12 months	0.63 (0.48)	0.8 (0.4)
Partakes in water based activities at least once every three months	0.37 (0.48)	0.48 (0.5)

Figure 1. Two-Factor Correlated CFA Model with Ordinal Data



η_i: Factor 1- Agreeability with restoring damaged ecosystems η_j: Factor 2- Agreeability with paying to restore damaged ecosystems	λ: Factor loadings y*: Latent response variable y: Observed variable δ: Error Variance

ρ: Between factor correlation	

Figure 2. Awareness of the marine environmental features and issues in their national seas

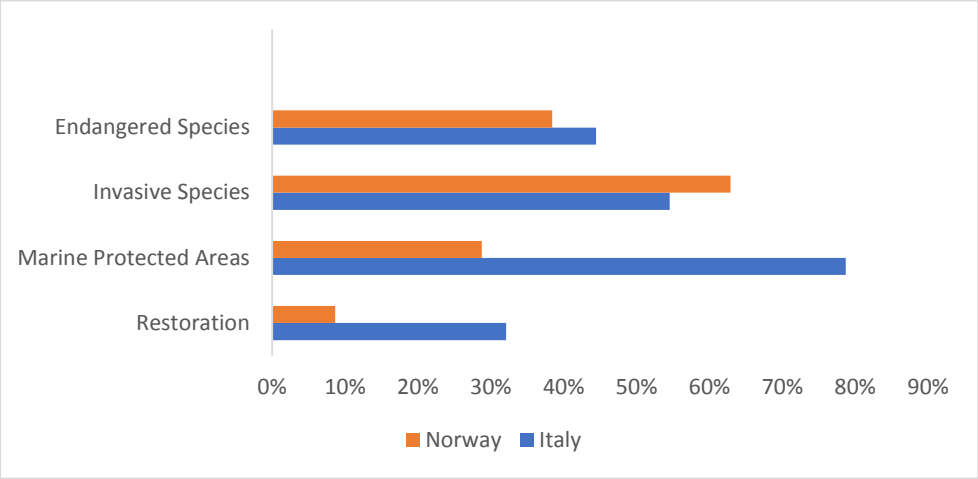


Figure 3. Perceptions of Quality of the Marine Environment

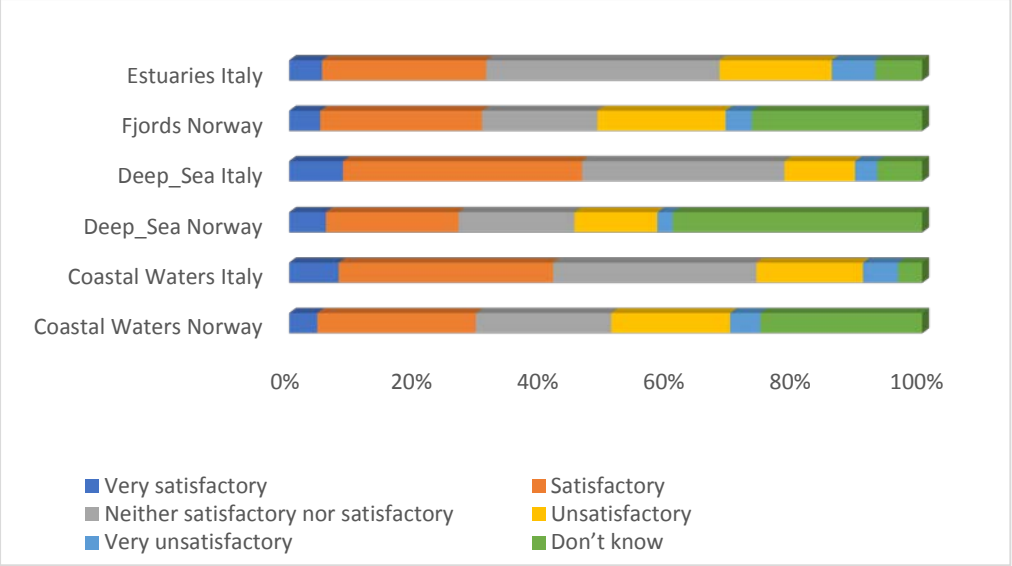
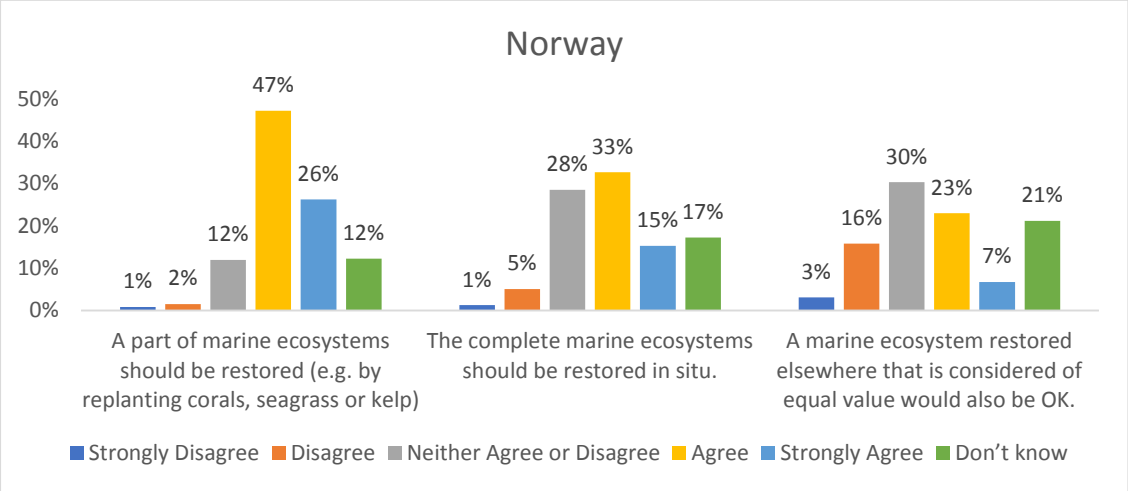


Figure 4. Attitudes toward marine restoration



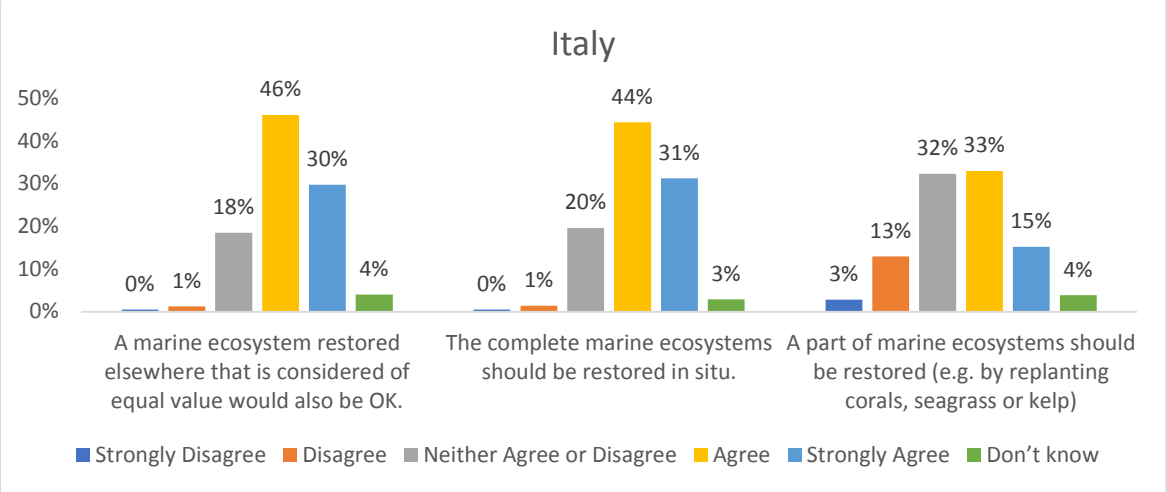


Figure 5. Agreement with statements surrounding willing to support marine restoration through monetary contribution