Willingness to Pay for Conservation in the North Atlantic Deep-Sea Ecosystems

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Abstract

This report presents an assessment of how the public perceives, and values deep-sea ecosystem services in the North Atlantic, and provides a foundation for evaluating and balancing Blue Growth with conservation management in the deep sea. Nonmarket valuation is used to evaluate public perceptions of the deep sea environment and the socio-economic values of new marine management plans. This report presents the results of two discrete choice experiment surveys that were employed to assess the values held by the Scottish and Norwegian public for the Mingulay reef complex and Hola off Lofoten-Vesterålen (LoVe), respectively.

Regarding public perception, the results show that public knowledge and awareness of deep-sea ecosystems is relatively higher among Norwegians than among the Scottish public. Specifically, awareness of cold-water corals is high for the LoVe case study amongst the Norwegian public and low for the Mingulay reef complex in the Scottish case. Despite this limited knowledge, many respondents thought changes in the deep sea would have at least some effect on them personally. On average, the public perceives deep-sea conditions to be at most 'fairly good' but are pessimistic about its management: a significantly higher share, 76% of Norwegians perceive the deep sea to be poorly-managed compared to 12% of those surveyed in Scotland.

Results from both countries highlight eco-centric attitudes towards the marine environment, implying that the general public recognise the value of ecosystem services, the current ecological crisis and the need for sustainable management. Demographic profiles of respondents and their experiences play influential roles, with exposure to media-art like the Blue-Planet II series showing prominence in most perception dimensions.

To determine whether the perceived public support translates into monetary support for new management scenarios, a discrete choice experiment was conducted to assess trade-offs for improvement in a number of deep-sea environment attributes; environmental health and quality, an increase in the size of marine protected areas (MPAs) and new marine related job creation. Latent class logit results revealed two distinct groups of public preferences: a minority of respondents who derive minimal value from the marine environment and a second group who exhibit significant positive preferences for all the management attributes and exhibit strong preferences for new policy options.

The most valued of the new policy attributes were those related to the key pressures of the marine environment: commercial fish stocks and marine litter designated as Descriptors 3 and 10 respectively in the GES of the MSF Directive. This was followed by the size of the marine protected area, whilst the creation of jobs is the least valued. Overall, however, weighted average willingness to pay estimates, indicate that the public in both countries is willing to pay to support conservation of the unfamiliar deep-sea ecosystem irrespective of the individual attributes delivered in a new marine management plan. The results highlight the importance of the deep-sea ecosystems to the public and provide support for further collective action required by the EU in moving beyond the 2020 Marine Strategy Framework Directive (MSFD) objective of achieving good environmental status for Europe's seas.

1 Introduction

The greatest gaps in our understanding of marine ecosystems lie in waters deeper than 200m, the deep sea, where certain populations and ecosystems are known to be under pressure (Glover and Smith, 2003). Over the last two decades, research has shown that the deep ocean and sea floor form part of an extensive and complex system (Dell'Anno and Danovaro, 2005) upon which human civilization and terrestrial life depends (Armstrong et al., 2012). It is now known that deep-sea ecosystem services include a wide array of supporting, provisioning, regulating and cultural services (Armstrong et al., 2012; Thurber et al., 2014). It is also known that climate change combined with extractive and polluting human activities at land and sea poses serious pressures on deep sea ecosystem services and functions (Huvenne et al., 2016; Puig et al., 2012; Pusceddu et al., 2014). As global population grows and demand for marine resources continues to increase, development of regulatory and policy measures will be essential in safe guarding and guaranteeing the flow of goods and services from marine ecosystems. For such regulatory measures to achieve sustainable use of the deep sea and marine ecosystem services, local and international support, as well as stakeholder and community acceptance is essential.

Keen on achieving and maintaining good environmental status (GES) of its marine waters by 2020, the European Union Marine Strategy Framework Directive (MSFD) (European Union 2008, Directive 2008/56/EC) requires member states to assess the current state of the marine environment, including physical, chemical and biological features; pressures and impacts; and Article 8.1 (c) calls for socio-economic analysis of use and cost of degradation of the marine environment. It further requires member states to develop future action plans with additional measures on how to reach the objectives in case GES is not achieved with existing measures. The MSFD expects the development of improved measures to be assessed inter alia by examining their cost effectiveness and by carrying out a cost-benefit analysis before their implementation (Bertram and Rehdanz, 2013; Oinonen et al., 2016). As most of the values of the marine ecosystem lie outside of the market, non-market valuation methods such as stated preference studies are pivotal in highlighting the economic importance of marine resources for policy considerations, particularly for deep-sea ecosystems considering their relative inaccessibility.

The EU MSFD uses an ecosystem-based approach to the management of human activities in the marine environment in order to achieve GES (Berg et al., 2015). One important primary tool enacted by the Directive is the implementation of a coherent network of MPAs. Global coverage of MPAs in 2019 is estimated to be 7.8%. In Europe, over 10% of the total EEZ is designated as MPAs (UNEP-WCMC and IUCN, 2019) and although the European level appears to reach the 10% target set by the UN Convention on Biological Diversity (CBD), many areas are portrayed as "paper parks" by conservation groups (WWF, 2019). This is because most MPAs still allow a variety of extractive and destructive activities to occur within them and fail to achieve key conservation goals. According to Dureuil et al. (2018), the average trawling intensity across MPAs in EU is at least 1.4-fold higher than nonprotected areas. Sala et al. (2018) indicate that by ignoring announcements of intent and legal designation of MPAs, only 3.6% of global oceans have MPAs truly implemented. Of these, only 2% of MPAs are actually fully implemented protected areas, and only 0.5% of EU MPAs are estimated to be no-take zones (EEA, 2015). This raises concern about MPA effectiveness, which has been shown to be dependent on age, size, level of protection and enforcement (Selig and Bruno, 2010; Edgar et al., 2014; Ban et al., 2017). Above all, MPA effectiveness is highly dependent on funding for conservation objectives to be met (Depondt and Green, 2006; Green and

Donnelly, 2003). This puts a burden on the public purse particularly when new improved measures are to be introduced. As such, the public's perceptions of and preferences for changes in the deep-sea environment become essential.

In line with the MSFD and the EU's long-term Blue Growth Strategy to support sustainable growth in the marine and maritime sectors as a whole, this report evaluates public perceptions of the deep sea environment and the socio-economic values of new marine management plans towards conservation of the North Atlantic deep sea ecosystems. The socio-economic aspects examined are primarily:

i. Public perception of the deep-sea environment in Mingulay, Scotland and Hola in Lofoten-Vesterålen (LoVe), Norway
ii. Non-market valuation of new deep-sea marine management scenarios for both areas, using discrete choice experiments (DCE).

We examine these two aspects using the discrete choice experiment approach. This is an environmental valuation method which firstly allows us to explore public perceptions for the marine environment and secondly whether this translates to monetary support. We evaluate four deep-sea environment attributes: changes in the health of commercial fish stocks, marine litter density, size of MPAs and the creation of more blue economy jobs and the motivations for selecting these attributes. Further detail is provided in Section 2. Discrete choice experiments in environmental valuation resulted from advances in different disciplines (Lancsar and Louviere, 2008) and its first application was reported by Adamowicz et al. (1994). The DCE approach involves construction of a hypothetical market through a survey and econometric analysis of choice data where respondents are asked to choose their preferred alternative from a series of choice sets. Here, individual choices imply implicit trade-offs between attribute levels in presented alternatives of the choice set. The presence of a cost attribute permits converting marginal utility estimates into 'willingness to pay' estimates (Hoyos, 2010). Over the last two decades, DCE applications have played an increasing role in environmental decisions. According to Alpizar et al. (2001), though DCE comes at the cost of a higher cognitive burden compared to the earlier more commonly used contingent valuation method (CVM), it is advantageous in reducing potential biases of CVM, capturing more information per respondent, and for testing internal consistency. As a stated preference approach is often characterized by hypothetical bias (significant differences in real and hypothetical valuation), survey designs are calibrated with cheap talk scripts and consequentiality (certainty) statements which help mitigate such hypothetical biases (Lusk, 2003;) and at times selectively impacting respondents facing higher payments (Murphy, Stevens and Weatherhead, 2005).

The deep sea is known to be the largest biome on earth, yet they are often areas of limited or highly ineffective governance. In many cases they lie outside national jurisdictions and are potentially open to all the well-known problems of open-access resources (Gjerde, 2006; Armstrong et al., 2012). One of the main legal tools for nature conservation, the EU Habitats and Birds Directive, now permits protected areas to be extended from territorial waters of 12 miles from the coast out to the 200nm Exclusive Economic Zones (De Santo, 2013), making conservation of some deep-sea ecosystems possible. Moreover, provisioning services of marine resources such as fisheries are quantifiable, but regulating or cultural services are not well known to the public (Rose et al., 2008; Jefferson et al., 2014; and Spence et al., 2018), limiting valuation exercises. Knowledge of marine ecosystem services and hence values have mostly been developed for coastal systems and in the tropics. Ledoux and Turner (2002) and Brander et al. (2007)

present reviews for beach and recreation, and coral reef marine parks, respectively. There is a dearth of empirical studies focused on remote offshore and deep-sea ecosystem services (Jobstvogt et al., 2014). Brouwer et al. (2016) indicate that it is the non-use values associated with remote marine ecosystems that are considered of most importance given their fewer use opportunities (Bertram and Rehdanz, 2013). This highlights the importance of non-market valuation stated preference methods for measuring the public's (users and non-users) preferences and willingness to pay.

A systematic review of literature focused on deep-sea economic valuation by Folkersen, Fleming, and Hasan (2018) shows the economic value of the deep sea is influenced by scope, value perspective, purpose and methodology of the study in question. For instance, using several variants of the concept of MPAs, Glen et al. (2010) and Wattage et al. (2011) found that the Irish public endorsed MPA strategies that banned trawling in all areas where corals are thought to exist, but failed to identify monetary values. In a comparative study, Armstrong et al. (2019) identified that the general public in Ireland and Norway had economic values for small and large increases in protected areas (NOK 341 and NOK 424, respectively), and even higher (NOK 880) if the area was an important habitat for fish. Armstrong et al. (2019) showed that heterogeneity between the two countries was due to Norwegians valuing the pure existence of cold-water corals more than the Irish, while the Irish were less willing to trade off industrial activities than Norwegians. The behaviour of Norwegians towards the protection of deep-sea cold corals is also reflected in Aanesen et al. (2015). They found significant average willingness to pay (WTP) values for cold water coral protection in the range of €274-287, despite awareness of the potential adverse effects on marine industries like oil/gas and fisheries.

In other regions in Europe such as the United Kingdom, a choice experiment of new MPA strategies was used to evaluate the UK Marine and Coastal Bill and significant net benefit were found for halting the loss of or increasing marine biodiversity (McVittie and Moran, 2010). The existence value of deep-sea species and option value of deep-sea organisms as a source of future medicinal products translated into average values of £70 and £77, respectively, among the Scottish public, despite the respondents' low level of deep-sea knowledge. Protection of species diversity has also been shown to be preferred to individual charismatic species in a marine ecosystem. This was shown in Ressurreição et al. (2011) who evaluated the economic value of the open sea (shallow and deep waters) for increased levels of species loss (10-25%) in five marine taxa and for all marine species. Average values of €45 for individual species and as high as €665 for all marine species protection were estimated for a one-off-payment.

In the context of the EU MSFD, Brouer et al. (2016) evaluated alternative remote MPA regimes in the North Sea and found that the Dutch public were willing to pay between 0.21% and 0.25% of their annual disposable income to ban access and economic use of these marine ecosystems. The literature reviewed so far has different scopes but overall points towards economic support for conservation goals despite trade-offs between economic activities and ecosystem and biodiversity conservation.

The public's economic support for conservation goals is dependent on perceptions of the ecosystem in question. Assessment of public perception is multifaceted and often used to denote knowledge levels, interests, social values, attitudes or behaviours (Jefferson et al., 2015). Empirical studies related to the marine environment generally reveal a low level of knowledge but high support for conservation planning polices (Potts et al., 2016; Lotze et al., 2018; Jefferson et al., 2014). Recognition of marine pressures is high (Lotze et al., 2018; Hynes et al., 2014) and pessimism exists regarding management of marine resources (Hynes et al., 2014; Hawkins et al., 2016). Perceptions have been shown to be influenced by

geographic and socio-economic variables (Buckley et al., 2011). Some heterogeneity, however, exists between national borders and within populations. These observed patterns are only drawn from a limited amount of available literature but show the need for more marine literacy activities within the populations.

The remainder of this report is organized as follows: Section 2 presents the method and Section 3 presents the results of the case studies. Discussion and conclusion are presented in Section 4.

2 Method

2.1 Survey design

A first draft of the surveys for Mingulay and Lofoten-Vesterålen (LoVe), was developed based on existing literature and best practice survey guidelines (Johnston et al 2017). This draft was then tested using focus groups in Scotland and Norway to ensure that the questions were easily understood and of interest to the general public. Based on the feedback of the first round of focus groups, the questionnaires were revised and then tested again in a second round of focus groups held with general public in Scotland and Norway. This was followed by a pilot test in the respective countries. The questionnaires for the Scottish public were implemented online through a market research company that drew from a recruited and registered online panel of respondents, while for the LoVe survey respondents were recruited by phone calls to ask for participation in the internet-based survey. The recruitment of respondents was in accordance with research code of conduct and data protection laws. The Mingulay survey started in January 2019 and spanned a period of 4 weeks while the LoVe survey started in March 2019 and lasted over a period of three weeks. A total of 1,025 and 1,024 respondents participated in the Mingulay and LoVe surveys, respectively.

The two surveys are of the same format, consisting of seven parts. Respondents first received an introductory text outlining the purposes of the survey and who would be using the results and why. Participants were then informed about the background to the survey. Information provided included the impact of changing environmental conditions and anthropogenic activities on the seas and wildlife, how the government was responsible for managing it and the potential cost of management for households. The *Lofoten-Vesterålen cold-water coral reef* (LoVe) in Norway and the *Mingulay reef complex* (MRC) in Scotland were then introduced in each survey as a unique ecosystem in Scotland and Norway, respectively, and the ecosystem services they provide, current management measures in place, potential economic benefits and threats were presented. The locations of these deep-sea ecosystems are shown in Figure 1 below.

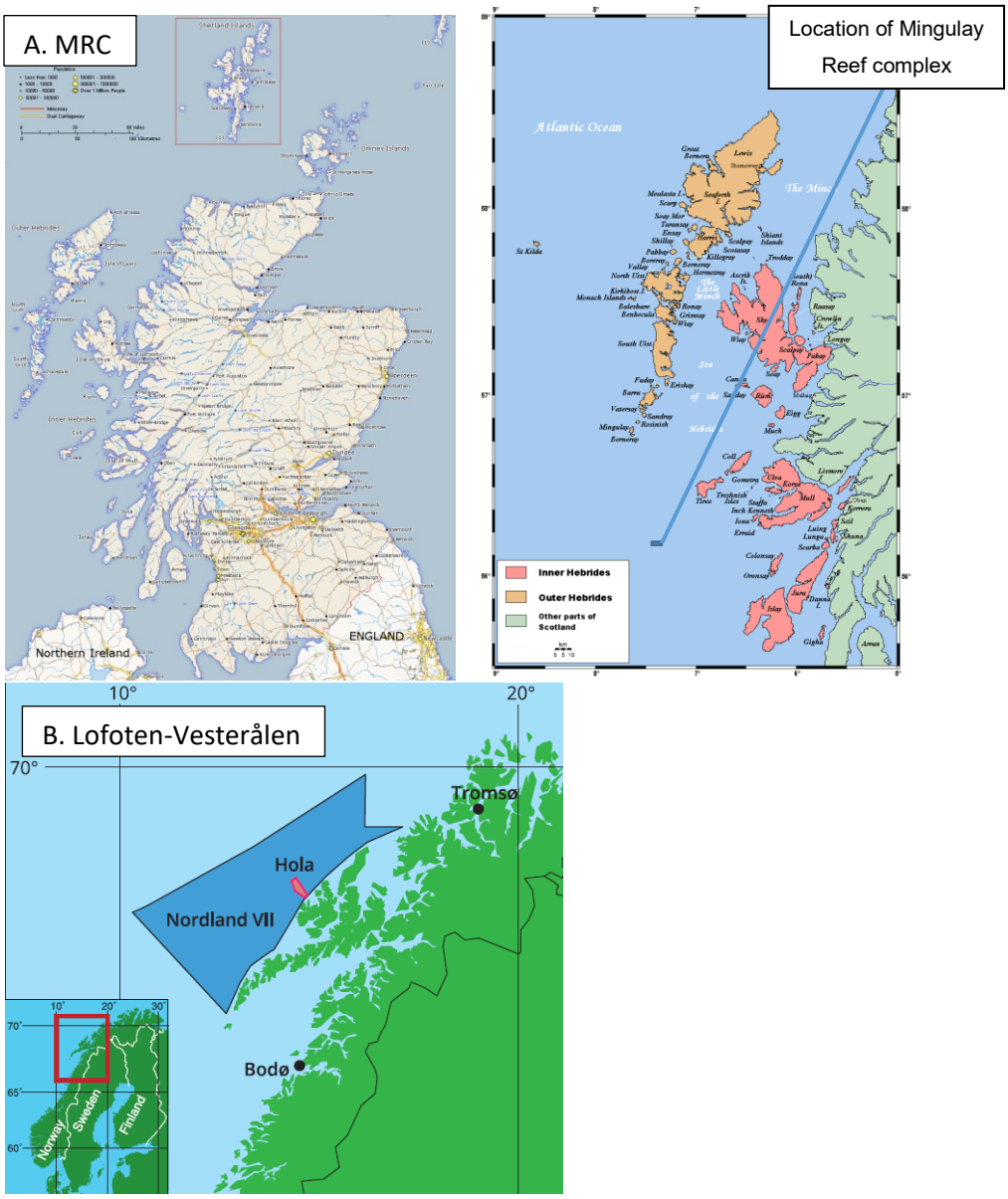


Figure 1. The Mingulay Reef Complex (top panel: A) and the Lofoten-Vesterålen (bottom panel: B)

Participants were then asked about their prior knowledge and perception of the information provided in the introduction of the questionnaire on the deep-seas and wildlife in the respective countries. Following this an introduction to discrete choice experiments (DCE) was given, followed by additional information about attributes, as well as eight choice tasks that are required completed by the respondents. Further statements capturing respondent attitudes as well as pro-environmental concerns and beliefs in relation to the marine environment were assessed. Finally, follow-up socio-demographic information was sought. The surveys can be found in appendix 1 and 2.

The structure of the DCE allows for trade-offs between attributes, and hence exposes the ranking of the attributes' relative importance (Aanesen *et al.*, 2018). After the literature review and focus groups, five attributes and their levels were identified to describe the management options of ecosystem services provided by the deep sea in the North Atlantic. The first two attributes, health of commercial fish populations and density of marine litter, were chosen based on the indicators of Good Environmental

Status (GES) (number 3 and 10) of EU marine water in the MSFD where GES is defined as: "the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive".

Fish are one of the main natural resources provided by the sea. Many fish stocks have been overexploited as a result of excess fishing capacity and limited regulation, and hence harvesting at sustainable levels is required. Specifically, GES demands that "populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock". Therefore, fish stock health was chosen as an attribute presenting the condition of commercial fish stocks. Fish health is measured by the ratio of adult fish to juvenile fish, following the criterion that the more adult fish, the healthier the population, as suggested in ATLAS WP3 work on GES. The chosen second attribute was the density of marine litter. Marine litter is a global concern. It can have damaging ecological and economic effects on the seabed and in the water column causing damage to marine life and ecosystems. Litter is known to be widely distributed on the seabed. The primary source of deep-sea based litter is from fishing such as discarded fishing nets, and shipping. Preventative measures will be needed to reduce the levels of litter in the deep sea. The levels used in the survey were based on the GES work in WP3.

To achieve GES of the EU's marine water by 2020, the Marine Strategy Framework Directive (MSFD) has been implemented since 2008. Unlike earlier EU policies, the MSFD has departed from a species-specific focus of nature conservation, to implement a whole-ecosystem-based management approach. One measure for achieving GES identified in the directive is the establishment of a representative and coherent network of (MPAs) which should adequately cover the diversity of the constituent ecosystem together with existing MPAs.[1] Vulnerable Marine Ecosystems such as deep water corals and sponges are protected under the EU Habitats Directive from the harmful impacts of human activities such as bottom trawling. Hence, the size of the protected area is chosen as the third attribute to describe the management options of ecosystem services provided by the deep sea in the North Atlantic. The levels, or percentage closures, were chosen based on discussions with the ATLAS case study leaders of Mingulay and LoVe.

The fourth chosen attribute for the DCE design is marine economy jobs. It has been shown in environmental valuation literature that people are generally involved in both environmental and economic factors (Blamey, Common and Quiggin, 1995; Blamey *et al.*, 2000; Aanesen *et al.*, 2018). The most popular economic factor that has been used in environmental valuation surveys is jobs which are framed in the concept of the non-use value of employment (Aanesen *et al.*, 2018). Morrison, Bennett and Blamey (1999) applied a DCE method to estimate both the non-use environmental values provided by a major wetland in New South Wales, Australia as well as the non-use value people place on preventing job losses for an environmental improvement. The authors show that people are not only willing to pay for the environmental attributes but also for the job attribute, i.e. respondents were willing to pay AUS $0.14 for an extra job versus AUS $4.16 for the presence of an additional endangered and protected species. Othman, Bennett and Blamey (2004) show both environmental and socio-economic attribute estimates to be positive and statistically significant at 1% level through a DCE study on non-market values related to the Mangrove Wetland in Malaysia. The results showed that people were willing to pay RM1.36 for 1%

[1] https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm

increase in employment, whereas RM0.92 for an additional percentage of the number of migratory bird species being presented in the wetland. People may not only have preferences for their own job opportunities but also receive satisfaction from knowing others are employed. The levels of the job attribute were selected based on discussions with ATLAS case study leaders.

In the North Atlantic, there are potential opportunities to further develop industries such as fisheries, tourism, oil/gas exploitation, cable routes, renewable energy, biotechnology of deep-sea creatures and shipping. It is possible that the development of these sectors will provide local/international employment. There is also the potential to rebuild depleted or collapsed fish stocks. There could however be trade-offs between developing the area commercially and protecting the deep-water corals, sponges, and associated marine wildlife. For example, new installations may damage the seabed when being anchored or disrupt the ocean currents in the area that feed the coral reefs and the fauna they support.

Different levels of each of these attributes can be delivered as part of the management plan: i.e. the number of jobs, amount of marine litter, health of fish stocks and size of protected area. Respondents were encouraged to think about different "bundles" of these aspects of management and as a tax payer how much they would be willing to pay for these different management aspects. Respondents were also informed that any changes from the status quo (i.e. current management situation) would need to be funded by taxpayers. This would take the form of an increase in annual personal income tax rates over a 10 year period and 'ring-fenced' into a secure marine fund. A description of the attributes and their levels is presented in Table 1.

Table 1. Attributes and attribute levels

Attribute Definition	**Levels**	**Scotland – Levels**	**Norway - Levels**
Health: % of commercial stocks at healthy stock levels.	Health3	High (>80%)	High (>80%)
	Health2	Moderate (40 – 80%)	Moderate (40 – 80%)
	Health1	Low (<40%)	Low (<40%)
Litter: Density of marine litter measured as number of items of litter per square distance unit. ***Scotland*** *- # per mile²* ***Norway*** *- # per km²*	Litter3	Good (0 to 1)	Good (0 to 1)
	Litter2	Moderate (2 to 4)	Moderate (2 to 3)
	Litter1	Poor (5 to 8)	Poor (4 to 6)
Area: size of protected area. ***Scotland*** *- % of the Sea of Hebrides* ***Norway*** *- % of the area of Nordland VII (current area of Hola protected area)*	Area4	15%	7.5%
	Area3	10%	5%
	Area2	6%	3%
	Area1	1%	0.5%
Jobs: number of marine economy jobs created from sea based commercial activities in the area	Jobs3	+ 40	+ 40
	Jobs2	+ 20	+ 20
	Jobs1	No employment change	No employment change
Additional costs: Unit currency per person per year	cost	£0 (for status quo option only), £5, £10, £20, £30, £40, £60	NOK0 (for status quo option only), NOK100, NOK150, NOK300, NOK450, NOK650, NOK850

Note: the cost attribute levels used in each survey for each country are converted by the purchasing power parity factor.

Our DCE design included 16 choice tasks that were divided into two blocks with eight choice tasks presented to each respondent. Choice tasks were processed by maximizing the expected Bayesian d-efficiency of a multinomial logit model (Scarpa and Rose, 2008). The design was updated after the pilot so that information about respondents' preferences from the pilot could be used to inform the design of the choice cards for the main survey. Each respondent was presented with eight choice tasks, either in block one or block two, and was asked to choose the option that he/she most preferred on each choice card.

In each choice task, there are three options: options A and B are two alternative future management options and will incur additional cost to the respondent, whereas option C is the same on each choice card and never involves a payment. It describes the situation that could result in the future when there is no further change from current management. Table 2 presents an example of a choice card.

Table 2. Example of choice card

SCENARIO 1	**Option A**	**Option B**	**Option C** (current management)
Health of commercial fish stocks	**High:** 80% of commercial stocks at healthy stock levels	**Moderate:** 50% of commercial stocks at healthy stock levels	**Low:** 40% of commercial stocks s at healthy stock levels
Density of Marine litter	**Moderate** (2 to 4 items of litter per mile^2)	**Good** (0 to 1 item of litter per mile^2)	**Poor** (5 to 8 items of litter per mile^2)
Size of protected area	**6% of the Sea of the Hebrides**	**15% of the Sea of the Hebrides**	**1% of the Sea of the Hebrides**
Marine economy jobs created from sea based commercial activities in the area	**+ 40 jobs**	**+ 20 jobs**	**No employment change**
Additional costs (per person per year) £	**£ 30**	**£ 40**	**£ 0**
Your choice for scenario 1 *(please tick A, B or C)*	□	□	□

Before respondents answered the WTP questions a so-called cheap talk script was presented in order to mitigate hypothetical bias as suggested in stated preference studies (Carlsson, Frykblom and Johan Lagerkvist, 2005). Particularly, the cheap talk script describes the potential problem of hypothetical bias and explains why hypothetical bias might occur. I.e. the script includes a presented paragraph "Some people say they are willing to pay more in surveys for these types of improvements in the deep sea than if we were actually collecting the money during the survey. This is because when people actually have to part with their money, they take into account that there are other things they may want to spend their money on". The cheap talk script also advises respondents to focus on the actual costs of the hypothetical alternatives. In the surveys, the cheap talk script read as follows: "All options other than option C 'current management' impose an additional financial cost on you and your family" or "Payment is expected to be made through a ring-fenced tax dedicated to protecting the marine environment collected through your income tax". Respondents are also asked to not overstate their true WTP and to consider their responses

as if they were in a real-life setting, i.e. “Imagine yourself **actually paying** the amounts specified and please consider your own budget and ability to pay when considering each option”.

2.2 Statistical Analysis

2.2.1 Logistic Regression

To capture public knowledge and attitudes related to the deep-sea environment in Scotland and Norway, the data were analysed using basic statistical summaries, charts and cross tabulations. Where necessary, a Pearson Chi-square test was used to test for statistical independence across samples and variables. Basic regression models including logistic and ordinal logistic regression were employed to evaluate the relationship between respondent characteristics and outcome variables of interest due to the ordinal and binary nature of the outcome variables.

Respondents’ prior knowledge of the information related to the deep-sea and wildlife in the respective countries were assessed using a scale of 1 to 5 where 1 indicates “I knew none of it” and 5 indicates “I knew everything”. Prior awareness of the MRC and LoVe were assessed through a Yes/No response. Respondents’ perception of the condition of the deep-sea areas were rated on a scale of 1 (indicating very poor) to 5 (indicating very good), personal effect of the deep-sea and wildlife was rated as “no effect on me”, “some effect on me” and “major effect on me” while perceived management of the deep-sea areas rating was scored as “well”, “neither” and “poorly”. “Don’t know” was given as an option in all scores.
The respondent's pro-environmental concerns and beliefs in relation to the marine environment were evaluated using 5-point Likert scale statements ranging from “strongly disagree” to “strongly agree”, with a don’t know option. The 11 statements covered areas including ecological crisis, pressures, conservation, and ecosystem services. The statements were an adaptation of 2 sentences (first two) from the New Ecological Paradigm (NEP) scale (Dunlap et al., 2000) and 9 author self-constructed sentences from the European Union Marine Strategy Framework Directive (MSFD) qualitative descriptors for good environmental status (GES) and other literature sources. It therefore reveals the convergence between public perception and the EU Directive on what good environmental status for the marine environment should be. For subsequent analysis, the scores of statement 10 (Economic growth is more important than protecting the marine environment) are reversed to match the other indicators so that higher overall scores reflect ecocentrism while lower values indicate anthropocentrism (see Table 3).

Table 3. Indicators of Pro-environmental concerns towards the marine environment

Items	Item Short Phrase	Source
The balance of marine biodiversity is very delicate and easily upset	Delicate marine biodiversity	NEP
Human activities are severely abusing marine ecosystems such as marine organism abundance and diversity, and biological integrity of the sea-floor	Human abuse	NEP
The key pressures on marine biodiversity are fisheries	Fisheries pressure	MFSD GES (D1)
The key pressures on marine biodiversity are physical damage to the sea floor	Sea floor damage	MFSD GES (D1)
All commercial fish stocks should be sustainably exploited in order to secure high long-term yield and healthy stocks	Sustainable exploitation	MFSD GES (D3)
Marine litter is one of the key challenges to the marine environment and biodiversity	Marine litter challenge	MFSD GES (D10)
Healthy seas are central to our well-being	Central to our well-being	author
Healthy seas are central to economic security	Central to economic security	author
Establishment of marine protected areas is one important measure for protecting valuable, vulnerable or threatened organisms	MPA is important	author
Economic growth is more important than protecting the marine environment	Economic growth	author
As humans we are responsible to protect natural resources to benefit future generations	Environmental citizenship	author

Author indicates author phrased statements sourced from marine literature.

Regarding the analysis of relationships between respondents' pro-environmental concerns towards the marine environment and personal characteristics, generalized structural equation modelling (GSEM) was employed. The GSEM can accommodate large numbers of endogenous and exogenous variables and builds models that include latent variables as well as response variables that are not continuous measures. In this study, the Multiple Indicators Multiple Causes (MIMIC) model is used, based on a generalized structural equation model founded on the following conceptual model (Figure 2).

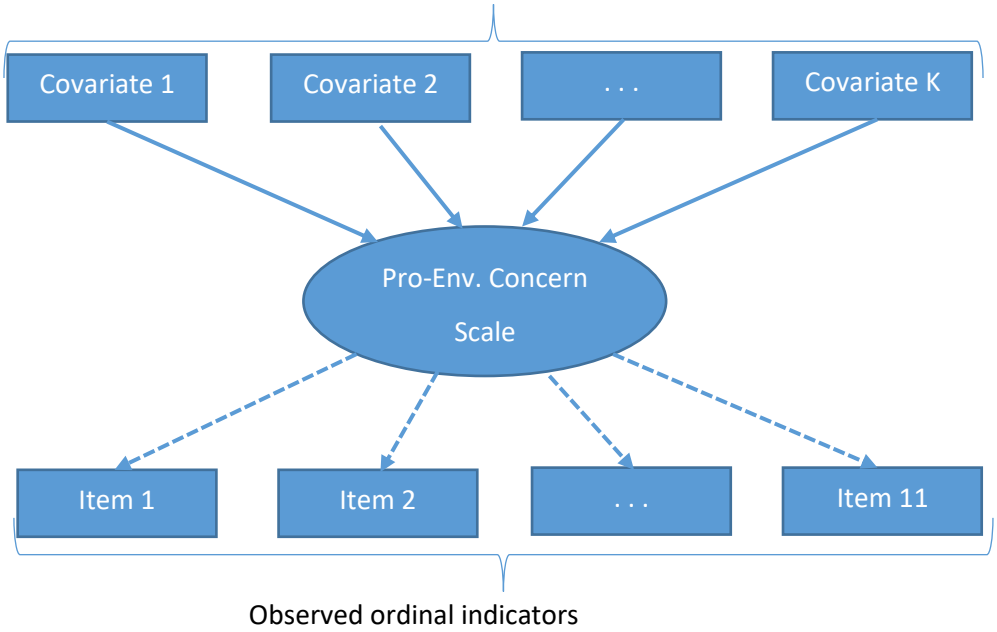


Figure 2. MIMIC Model of Single Latent Variable: Pro-Environmental Concern

In the MIMIC model, it is assumed that the observed indicators ($\mathbf{y}$) are manifestations of a latent concept (unobserved pro-environmental concern, η) and that there are other exogenous variables (covariates 1 to S, $\mathbf{x}$) that influence the latent factor (Joreskog and Goldberger 1975 and Rabe-Hesketh et al., 2004). In the dataset, we captured the pro environmental concern items as discrete indicators which are generalized responses of a categorical (ordinal) nature. Therefore, the generalized structural equation model (GSEM) is employed as opposed to structural equation models which assume continuous indicator responses. The GSEM formulation of MIMIC consists of simultaneous estimation of two equations. The measurement model for pro-environmental concern can be written in terms of the underlying continuous responses

$$\mathbf{y}^* = \Lambda_y \eta + \mathbf{e} \quad (1)$$

and the structural equation is written as

$$\eta = \boldsymbol{\beta}\mathbf{x} + \mathbf{v} \quad (2)$$

with the reduced form

$$\mathbf{y}^* = \boldsymbol{\pi}\mathbf{x} + \mathbf{u} \quad (3)$$

where $\mathbf{y}^*$ is the latent component for $\mathbf{y}$, $\boldsymbol{\beta}$ and Λ_y are the corresponding structural parameters relating the latent dependent variable to the covariates, and factor loading matrix respectively. $\boldsymbol{\pi} = \boldsymbol{\beta}\Lambda_y'$ is a vector of parameters to be estimated. $\mathbf{v}$ is a vector of respondent disturbance, $\mathbf{u}$ is a random error term assumed to be standard logistic and $\mathbf{u}$ is the reduced form error composed of $\mathbf{u} = \Lambda_y \mathbf{v} + \mathbf{e}$. To achieve model identification, typically the first factor loading is restricted to unity.

With respect to the measurement equation, we can let $j(j = 1,2, \dots, J)$ and $\tau_j$denote agreement levels and thresholds associated with these agreement levels, respectively. These unknown thresholds are assumed to partition the propensity into $J - 1$ intervals. The unobservable latent variable $\mathbf{y}^*$ is related to the observed ordinal variable $\mathbf{y}$ by the τ with a response mechanism of the form:

$$y_i = j, if\ \tau_{j-1} < y_i^* < \tau_j, for\ j = 1,2, \dots, J \quad (4)$$

To ensure well defined intervals and natural ordering of observed agreement levels, the thresholds are assumed to be ascending in order, such that $\tau_0 < \tau_1 < \cdots < \tau_J$ where $\tau_0 = -\infty$ and $\tau_0 = +\infty$.

2.2.2 The Choice Experiment Model

In order to evaluate public preferences for the deep sea and wild life protection, discrete choice experiments were used. The theoretical foundation of the econometric approach to discrete choice experiments comes from the random utility framework (McFadden, 1974) and consumer choice theory (Lancaster, 1966). The consumer choice theory assumes that individuals derive utility from the observed features of the good, here, features of the marine management scenarios. The random utility theory also assumes that individuals would choose one alternative over another when the utility derived from the chosen alternative is higher. Under these assumptions, the analyst can identify the respondents' preferences based on their discrete choices in a survey by decomposing the utility of choice into two components: the deterministic or systematic term and idiosyncratic error term. The idiosyncratic taste shock is independent and identically distributed Type 1 Extreme Value.

The utility of respondent *n* for choosing alternative i in the choice situation *t* can be expressed as follows:

$$U_{nit} = \beta_n X_{nit} + \varepsilon_{nit} \quad (5)$$

where β_n is the coefficient vector associated with attribute X_{nit}, representing individual preferences, observed by the respondents but unobserved by researchers and varies in the population with density denoted $f(\beta|\theta)$, where θ denotes the parameters describing this density. X_{nit} is a vector of the attributes of alternative i in choice occasion *t*, and ε_{nit} is a random component of the utility.

The preferences may be heterogeneous, and allowing for preference heterogeneity can improve statistical model fit as well as provide the distributional consequences for a better insight on policy outcomes (Ruto and Garrod, 2009). The random parameter logit (RPL) model and latent class model (LCM) have evolved to be the most preferred models that allow for preference heterogeneity as they overcome the independence of irrelevant alternatives (IIA) problem associated with the multinomial logit model (MNL). While an RPL model allows parameters to vary randomly over the respondents, providing a continuous distribution of tastes, an LCM places parameter estimates into discrete distributions. It can be said that an LCM is a semi-parametric version of the RPL model, where respondents are identified by distinct groups and do not require any assumption on the distribution of parameters (Kaczan, Swallow and Adamowicz, 2013). In this study, we employ the LCM in order to segment preferences among Norwegian and Scottish public because the identification of groups of respondents might be more interesting in use for policy design than the identification of a continuous distribution of preferences (Kaczan, Swallow and Adamowicz, 2013).

Considering the LCM, the choice probability that an individual n of class s chooses alternative i from a particular set J, which comprises j alternatives, can be expressed as (Greene and Hensher, 2003):

$$P_n(i) = \sum_{s=1}^{S} L_{ni|s} \; H_{ns} \quad (6)$$

where $L_{ni|s} = \frac{exp(\beta_s' X_{in})}{\sum_{j=1}^{J} exp(\beta_s' X_{jn})}$ and $H_{ns} = \frac{exp(\gamma_s' Z_n)}{\sum_{s=1}^{S} exp(\gamma_s' Z_n)}$ for $s = 1, \dots, S$. From these equations, $L_{ni|s}$ denotes the multinomial logit expression for probability for choosing alternative i within the classes. H_{ns} is the class membership function from standard logit formulation denoting the probability of person n belonging to class s. The parameter β_s' represents the class specific parameters associated with vector of attributes X_{iq}. Additionally, the classification model is a function of some individual-specific attributes Z_n, used to explain the heterogeneity across classes with the corresponding parameter, γ_s'. The individual-specific parameters for one of the classes is normalized to zero to secure identification of the model.

The most challenging aspect of model identification is determining the optimal number of classes given that this is not a parameter to be estimated. Often variants of information criteria are used, but solely relying on information criteria can lead to intractable parameter estimates. We follow recommendations by Scarpa and Thiene (2011) to use information criteria, theoretical insights (e.g., looking for negative cost parameter), model parsimony and interpretability of parameters across classes.

Following the identification of class specific preferences, we use the delta method to estimate the welfare estimates by computing the class specific willingness to pay (WTP) estimates as the ratio between the coefficient for each attribute and the price coefficient. The WTP for attribute j in class s is:

$$\widehat{wtp_{sJ}} = -\frac{\hat{\beta}_j}{\hat{\beta}_{cost,s}} \quad (7)$$

Moreover, we also compute the weighted average WTP (WAWTP) estimates defined as (Scarpa and Thiene, 2011):

$$\overline{\widehat{wtp_J}} = \sum_{s=1}^{S} \widehat{wtp_{sJ}} * \widehat{w_s} \quad (8)$$

where w_s is the class share estimate. The WAWTP is then compared to see how different they are from MNL WTP estimates.

2.3 Sampling

A total of 1,025 and 1,024 respondents participated in the Mingulay and LoVe surveys, respectively, and the demographic profiles are presented in Table 4. In both surveys, young adults were the least represented. The age group (55+ years) were the most represented (44%) in the LoVe survey while the 36-55 years group were the most represented (49%) in the Mingulay survey. Males constituted 44% and 57% respectively for Mingulay and LoVe. Gender is slightly skewed from the respective national population ratios of approximately 50%. While about half of the Mingulay respondents had tertiary education, approximately 86% of LoVe respondents fell into this category.

Table 4. Descriptive statistics for respondents

	Mingulay		LoVe	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Age group1 (18-35)	0.101	0.302	0.168	0.374
Age group2 (36-55)	0.493	0.500	0.394	0.489
Age group3 (>55)	0.406	0.491	0.438	0.496
Male	0.440	0.497	0.572	0.495
Tertiary Education	0.518	0.500	0.864	0.343
Full time employed	0.380	0.486	0.592	0.492
Part time employed	0.133	0.339	0.092	0.289
Student	0.064	0.246	0.052	0.222
Unemployed	0.044	0.205	0.021	0.145
Resident of Highlands and Islands	0.063	0.244	-	-
Marine Sports	0.384	0.487	0.466	0.499
Member of environmental organization	-	-	0.108	0.311

3 Results

3.1 Public Perceptions of Deep-Sea Environment: Evidence from Scotland and Norway

3.1.1 Knowledge and Awareness of Deep-Sea Areas

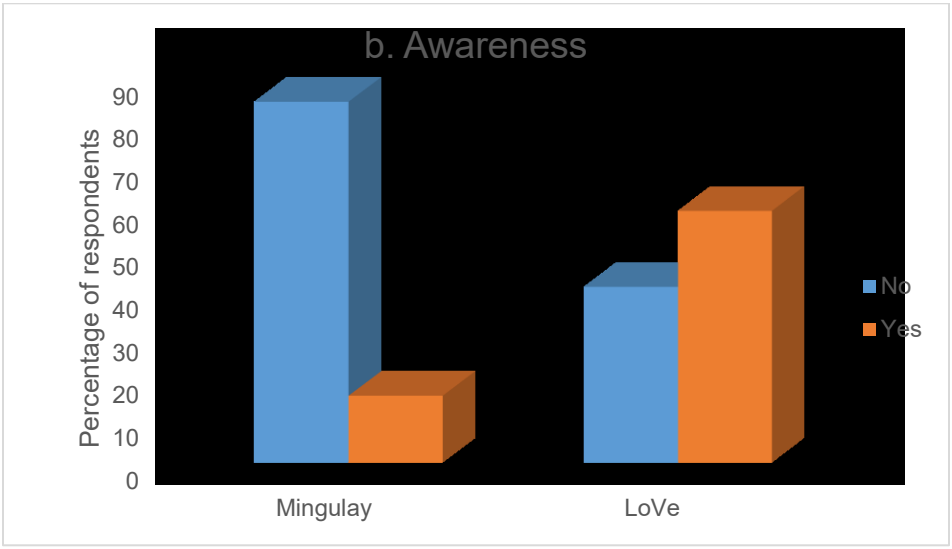
Figure 3a below presents the distribution of prior knowledge levels of the information presented in the introduction section of both the Mingulay and LoVe surveys. The LoVe responses appear symmetric while Mingulay is positively skewed with respective mean (standard deviation) scores of 3.13 (0.88) and 1.75 (0.78) and a median score of 3 and 2. This indicates that on average, the majority of the Norwegian respondents perceived themselves as more knowledgeable of the deep-seas and wildlife within their marine environment than did the Scottish. However, the average prior knowledge levels were low with Scottish respondents lying close to "I knew little of it" while Norwegians, on the other hand, were close to "I knew some of it". A Pearson Chi-square test of independence of distribution of responses between the two samples was $x^2(4) = 883$ $(pvalue = 0.00)$. This shows that independence is rejected and hence confirms that Norwegians had higher prior knowledge than their Scottish counterparts. The standard deviation estimates relative to the mean show higher variation in knowledge levels for the Norwegian respondents (Coefficient of Variation, CoV=50%) than the Scottish (CoV=25%).

In terms of awareness (Figure 3b), the Mingulay survey shows only 16% of Scottish respondents were aware of the MRC while a significantly higher share (59%) of the Norwegian respondents were aware of cold-water coral reefs off Lofoten-Vesterålen. In general, we conclude that knowledge levels related to the deep-sea environment are low among the Scottish and moderate among Norwegians, but the latter with high variance.

Given the ordinal and binary nature of responses to prior knowledge and awareness, we use ordered and binary logistic regressions to evaluate how responses differ across respondents. The results are shown in Table 5 below. On prior knowledge, we do not identify any significant differences between gender and age in the Mingulay survey. However, the senior-aged group in the LoVe survey appears to have more

prior knowledge of their seas and wildlife. Variables including tertiary education, having watched the Blue Planet II deep-sea documentary, association with a sea-related industry, engagement in marine sports and those who had visited the coastal areas were more likely to have high prior knowledge with statistical significance at the 1% level. Moreover, living in the region of the Highland and Islands (in the case of Scottish respondents) and being a member of an environmental organization (in the case of Norwegians) have significant positive effect on prior knowledge.

In relation to awareness of cold-water coral reefs, no significant differences exist for gender and having a tertiary education. However, the age cohorts 36-55 and 56 and above were more likely to be aware of the MRC while age had no significant effect on the awareness of the Lofoten-Vesterålen cold-water coral reefs for both surveys. Those who had watched Blue Planet II, are associated with a sea industry or had visited the sea areas have significantly more likely to be aware. Marine sport participation has a significantly positive impact on awareness of the Lofoten-Vesterålen cold-water coral reef as does being a member of an environmental organization. No significant differences existed among those living in the region of the Highlands and Islands.



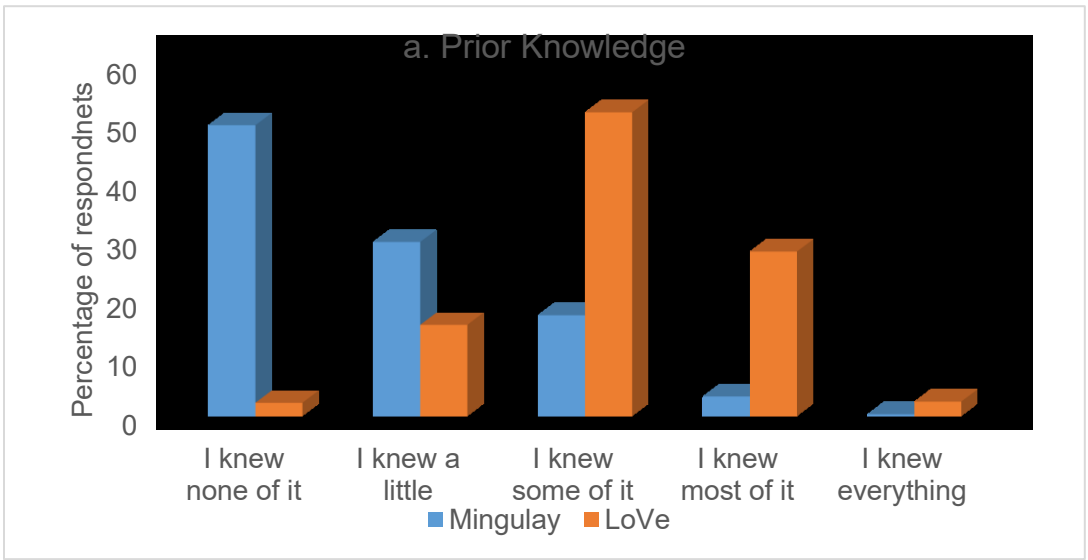


Figure 3. Awareness of cold-water coral reefs

Table 5 Influencers of Prior Knowledge and Awareness

	Mingulay				**LoVe**			
	Prior Know (Ologit)		Awareness (Logit)		Prior Know (Ologit)		Awareness (Logit)	
Variables	Coef	S. E	Coef	S. E	Coef	S. E	Coef	S. E
Male	0.134	0.122	0.089	0.184	-0.113	0.124	0.224	0.138
Age 36-55	0.066	0.211	0.911**	0.459	0.223	0.180	0.174	0.196
Age 56 and above	0.289	0.216	1.571***	0.456	0.414**	0.181	0.285	0.200
Tertiary Education	0.322***	0.123	-0.198	0.186	0.575***	0.179	0.275	0.196
Blue Planet II	0.495***	0.124	0.473**	0.191	0.543***	0.125	0.870***	0.141
Highlands and Islands	0.677**	0.248	0.349	0.311				
Sea Industry	1.088***	0.216	0.902***	0.276	0.612***	0.171	0.572***	0.195
Marine Sport	0.488***	0.125	0.252	0.186	0.614***	0.125	0.481***	0.139
Visit to Sea Areas	0.874***	0.137	1.209***	0.188	0.451***	0.132	0.547***	0.144
Member of Env. Org	-		-	0.480	0.551***	0.198	0.624**	0.239
Constant	-		-3.761***		-		-1.255***	0.258
Observations	1,025		1,025		1,024		1,024	
Wald Chi2	133.71***		89.14***		100.59***		104.84***	
Pseudo R2	0.061		0.113		0.049		0.087	

Robust standard errors (S.E) reported. ***, ** and * indicate 1%, 5% and 10% significance level respectively.

3.1.2 Public Perceptions of the Deep-Sea Condition, Management and Personal Effect

Respondents' ratings of the deep-sea condition, management and whether they perceive changes in the deep sea to have an effect on them were assessed with the distribution of responses presented in figures 4, 5, and 6. Perceptions of the deep-sea condition show a similar distribution for both Mingulay and LoVe surveys where most respondents rated it as "fairly good" with respective fractions of 46% and 50%. The mean (standard deviation) rating for LoVe was 3.5 (0.81) and Mingulay was 3.6 (0.81) which are relatively similar. A Pearson Chi-square test of independence rejects the null: $x^2(5) = 145$ $(pvalue = 0.00)$ and shows that the odds (odds ratio=1.3, excluding the 'don't know' group) of Scottish respondents rating the deep-sea condition to be in "good condition" is higher than for the Norwegian respondents.

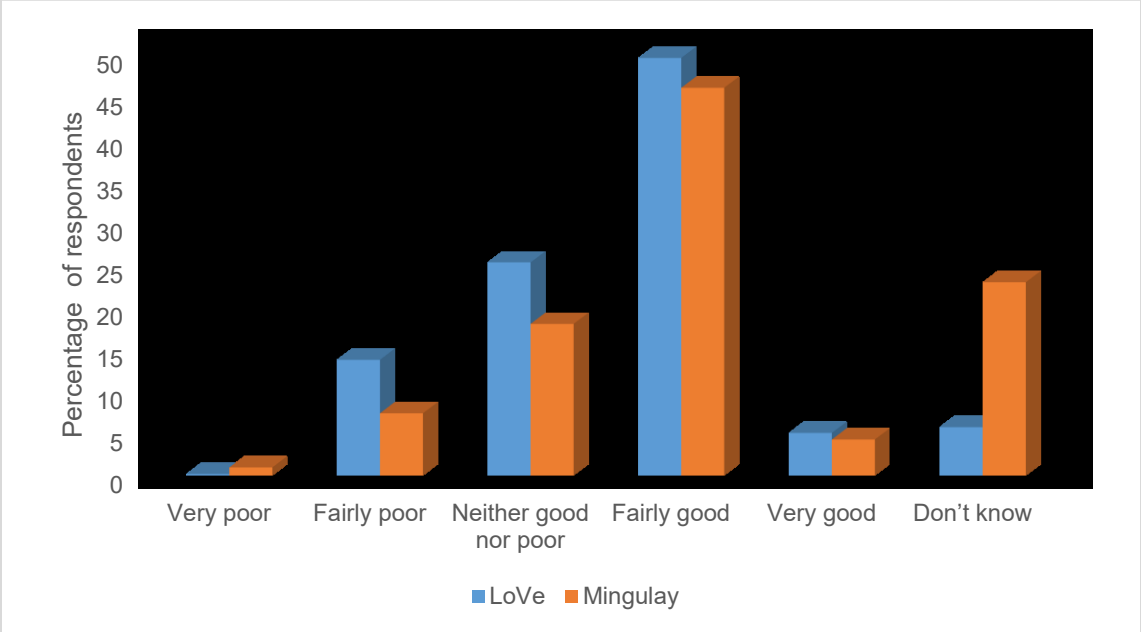


Figure 4 Rating of Deep-Sea Environmental Condition

With the ordinal nature of the deep-sea condition responses, an ordinal logistic regression shows that males were more likely to rate the deep-sea condition to be higher for the LoVe survey, but no significant differences existed for Mingulay. For both surveys, those older than 35 years perceived the deep-sea condition to be good as opposed to the age cohort 18-35 years. However, slightly higher odds were observed for age 56 and above in Scotland and age 35-55 in Norway. Moreover, the Blue Planet II effect was significant and positively impacted the Mingulay rating of deep-sea condition, though not for LoVe. On the other hand, association with a sea-industry and visits to the sea-shore had a significant effect on the LoVe deep-sea condition rating.

With the rating of deep-sea management outcomes shown in Figure 5, we observed 34% and 22% of respondents rating the deep-sea as being well managed for Mingulay and LoVe respondents respectively while 12% and 76% rated it poorly. Moreover, Figure 5 shows no observed frequencies for the 'neither' and 'don't care' responses in the LoVe and Mingulay surveys respectively. For ease of comparison, we evaluated the differences in responses to be binary (1/0) outcome where 1 indicates 'well-managed' and 0 otherwise.

A logistic regression of deep-sea management shown in Table 6 indicates significant variations that occurred between those who had watched the Blue Planet II documentary and those who visited the sea-areas in the Mingulay survey. These relationships were significantly positive. Regarding the LoVe survey, management of the deep-sea was significantly positive for males, as was association with a sea-industry, participation in a marine sport, a visit to the sea areas and being a member of an environmental organization at the 1% significance level.

Regarding respondents' perception of whether changes in the deep-sea has 'personal effect on them', Figure 6 shows that for both Mingulay and LoVe surveys, most respondents perceive it has 'some effect' on them with respective shares of 61% and 62% respectively. A Pearson Chi-square statistic of: $x^2(3) = 147$ $(pvalue = 0.00)$ reveals that the test of independence is rejected and an odds ratio of 0.40 for Mingulay shows that Norwegian respondents perceive changes in the deep-sea to have a larger effect on them than their Scottish counterparts. This is reflected in the mean (standard deviation) rating scores of 1.82 (0.60) for Mingulay and 2.09 (0.59) for LoVe. The Mingulay regression analysis shows that respondents who have tertiary education, are associated with a sea-industry, and those who have visited the sea areas think that changes in the deep sea have significant effect on them. These variables are significant at the 1% level. Similarly for the LoVe survey, respondents were more likely to be females, were 36-55 years, watched the Blue-Planet II documentary, engaged in marine sports and were members of an environmental organization.

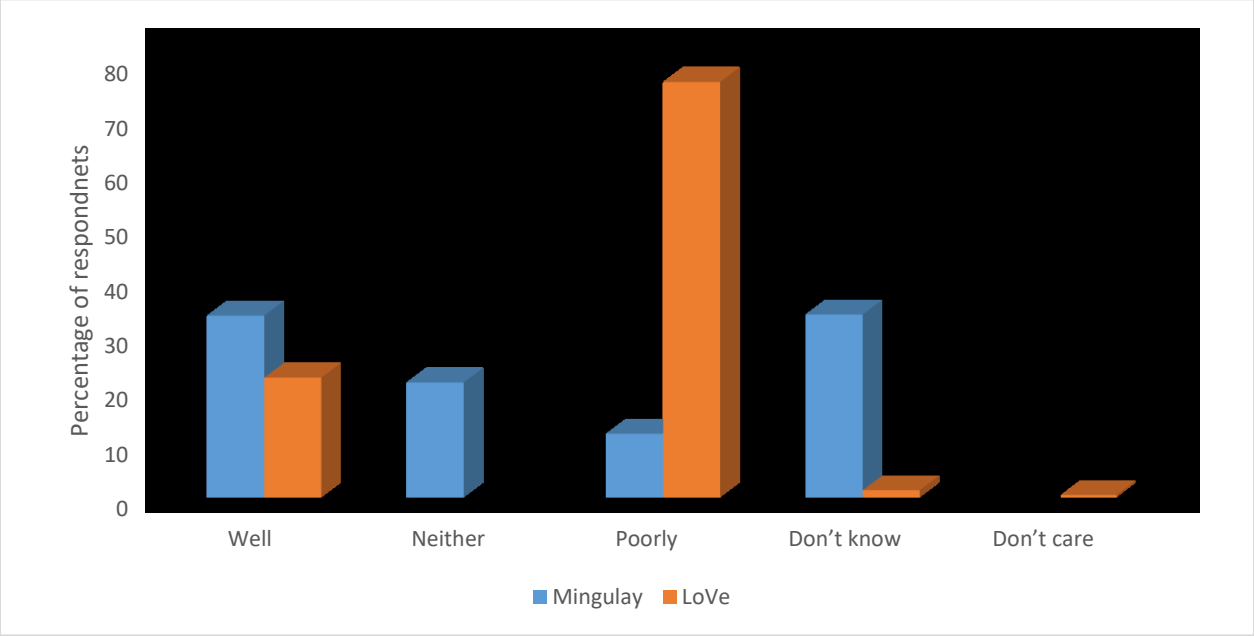


Figure 5 Rating of Deep-Sea Management

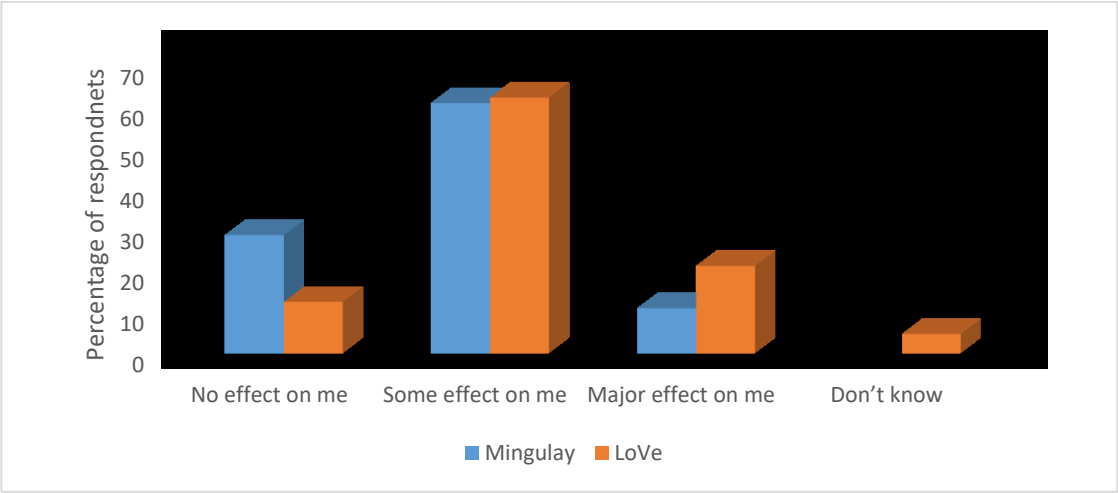


Figure 6 Perception of Deep-Sea Effect on Respondents

Table 6 Influencers of Deep-Sea Condition, Management and Personal Effect

	Condition (Ologit)				Management (Logit)				Effect on me (Ologit)			
	Mingulay		**LoVe**		**Mingulay**		**LoVe**		**Mingulay**		**LoVe**	
Variables	Coef	S. E.	Coef	S. E.	Coef	S. E.	Coef	S. E.	Coef	S. E.	Coef	S. E.
Male	0.029	0.143	0.593***	0.126	0.042	0.136	0.735***	0.176	-0.104	0.129	-0.777***	0.143
Age 36-55	0.463**	0.228	0.440**	0.190	0.230	0.245	0.268	0.253	0.213	0.207	0.400**	0.190
Age 56 and above	0.629***	0.238	0.385**	0.193	0.300	0.247	0.304	0.253	-0.223	0.212	0.127	0.191
Tertiary Education	0.202	0.142	0.122	0.188	-0.156	0.135	-0.338	0.234	0.324**	0.129	0.124	0.213
Blue Planet II	0.401***	0.144	0.009	0.129	0.353**	0.136	0.274*	0.165	0.140	0.127	0.572***	0.139
Highland and Islands	0.309	0.267	-	-	-0.302	0.292	-	-	0.117	0.262	-	-
Sea Industry	-0.416	0.256	0.502***	0.186	-0.320	0.250	1.104***	0.202	0.528**	0.251	0.157	0.188
Marine Sport	0.074	0.147	-0.068	0.130	0.106**	0.137	0.795***	0.168	0.044	0.130	0.768***	0.142
Visit to Sea Areas	0.273*	0.164	0.285**	0.137	0.322***	0.150	0.700***	0.186	0.610***	0.147	0.274*	0.141
Member of Env. Org	-	-	-0.274	0.196	-	-	0.671***	0.244	-	-	0.982***	0.204
Constant					-1.149	0.253	-3.006	0.346				
Observations	789		965		1,025		1,024		1,025		977	
Wald Chi2	31.54***		47.92***		17.18**		105.97***		41.58***		105.28***	
Pseudo R2	0.016		0.023		0.014		0.11		0.03		0.072	

Robust standard errors (S. E.) reported. ***, ** and * indicate 1%, 5% and 10% significance level respectively.

3.1.3 Pro-Environmental Concerns towards the Marine Environment

The public's concern in relation to the marine environment was captured by 11 item indicators and reflect attitudes towards ecological crisis, pressures on the marine environment, ecosystem service benefits and the need to protect it through sustainable management. The concerns were captured on a 5-point Likert scale where higher overall scores designate ecocentrism and lower values indicate anthropocentrism. The distribution of responses is shown in Table 7. The mean itemized score ranges from 3.59 to 4.62 with an overall mean of 4.17 for the Mingulay survey. The range for LoVe is 3.23-4.52 with an overall mean of 4.09. This reflects that on average the public tends to agree with the statements indicating a direction towards ecocentrism.

For the Mingulay survey, the highest mean score is linked to an agreement with the statement that humans are responsible for protecting natural resources to benefit future generations. The highest fraction, 91% either tend to or strongly agree with this statement. The same statement scores highest in the LoVe survey with 93% agreeing. The statement 'marine litter is one of the key challenges to marine environment and biodiversity' has the second highest mean score for Mingulay and fourth in the LoVe survey. For both surveys, the least agreed upon is the statement that the 'key pressures on marine biodiversity are fisheries', with the share of respondents agreeing with this statement being less than half of the sample.

Table 7 Distribution of Pro-Environmental Concern indicators

	Mingulay				**LoVe**			
Item Code	Obs.	Mean	SD	AGREE (Tend to + Strongly)	Obs.	Mean	SD	AGREE (Tend to + Strongly)
Delicate marine biodiversity	942	4.31	0.71	80.88	1,024	4.09	0.77	82.52
Human abuse	964	4.31	0.77	81.18	1,024	4.30	0.72	89.26
Fisheries pressure	812	3.59	0.87	44.19	1,024	3.23	0.79	33.1
Sea floor damage	806	3.87	0.82	53.27	1,024	3.49	0.79	49.03
Sustainable exploitation	937	3.97	1.04	67.03	1,024	4.34	0.77	88.87
Marine litter challenge	969	4.47	0.70	86.93	1,024	4.15	0.78	82.52
Central to our well-being	988	4.38	0.74	85.07	1,024	4.52	0.72	92.48
Central to economic security	948	4.14	0.80	75.22	1,024	4.19	0.80	83.01
MPA is important	973	4.36	0.72	83.8	1,024	4.12	0.87	80.47
Economic growth	979	3.86	1.06	65.85	1,024	4.04	0.93	75.49
Environmental citizenship	1,002	4.62	0.62	91.22	1,024	4.54	0.75	92.48
Mean		4.17	0.31			4.09	0.40	

Mean of items in Mingulay survey computed without the 'don't know' responses.

In order to determine the relationships between respondents' personal characteristics and their pro-environmental concerns towards the marine environment, we assume that the 11-item indicators form a unidimensional latent construct underlying their perceptions. This latent indicator is therefore explained by the respondents' characteristics. To validate this assumption, we first conduct a single latent exploratory factor analysis to determine whether the items are sufficiently correlated and reliable to qualify as a unidimensional latent construct. The Kaise-Meyer-Olkin (KMO) measure of sampling adequacy of the correlations resulted in an estimate of 0.903 (item range of 0.78-0.94) for the Mingulay survey and 0.892 (item range of 0.86-0.93) for the LoVe survey. These estimates

compared to the Kaiser (1974) thresholds[2] show values indicate sufficient correlation between items. The Cronbach Alpha coefficient for Mingulay was 0.827 (item range of 0.80-0.84) and LoVe was 0.849 (item range of 0.82-0.86). This coefficient by Cronbach (1951) is used to determine the internal consistency and acts as a measure of reliability. A value of 0.6 is considered acceptable and according to Hair et al. (2011), a value of 0.8 or higher is regarded as satisfactory.

Given the adequacy and reliability of using the statements as a unidimensional latent factor, we proceed to estimate the factor loadings and the latent-covariate relationships in a MIMIC generalized structural equation model. The results are presented in Table 8. The measurement model provides the factor loadings where all items are significantly loaded on to the latent variable at the 1% significance level. The first item had the factor loading coefficient constrained to unity. For both surveys, we observed a significant and positive association between pro-environmental concerns and those respondents who had watched Blue Planet II, those who believe that changes in the deep sea had personal effect on them and those who at least had some *a priori* knowledge of the seas and wildlife surrounding them. Being associated with the sea-industry however showed a significantly negative effect on pro-environmental concerns. In the LoVe survey, females were more likely to be pro-environmental (eco-centric) than males while no significant difference was observed in the Mingulay survey. While there was no age effect in the LoVe survey, the 56 and above age group appeared to be more pro-environmental in the Mingulay survey than the age cohorts below 56 years. Education was only weakly significant in the LoVe sample (at the 10% significance level) but had no effect in Mingulay and being a member of an environmental organization showed a positive and significant effect on pro-environmental concern in the LoVe sample.

Table 8 MIMIC GSEM: Influencers of pro-marine environmental concerns

	LoVe		**Mingulay**	
Structural	Coeff	S. E.	Coeff	S. E.
Male	-0.64***	0.14	-0.01	0.13
Age 36-55	0.17	0.20	0.28	0.23
Age 56 and above	0.14	0.20	0.54**	0.24
Tertiary Education	0.39*	0.22	0.20	0.14
Blue Planet II	0.69***	0.14	0.73***	0.14
Member of Env. Organization	1.13***	0.23	-	-
Highland and Islands	-		0.28	0.28
Sea Industry	-0.82***	0.19	-0.54**	0.24
Marine Sport	0.10	0.14	-0.05	0.14
Visit to Sea Areas	0.06	0.14	0.30*	0.16
Deep sea changes effect on me	0.71***	0.12	1.38***	0.14
At least some prior knowledge	0.38***	0.18	0.38**	0.18
Measurement* **				
Delicate marine biodiversity	1.00		1.00	
Human abuse	1.16	0.08	0.87	0.08
Fisheries pressure	0.20	0.04	0.38	0.04

[2] Kaiser (1974) threshold values of 0.8-0.89 and >0.90 indicate 'meritorious' and 'marvelous' correlations respectively.

Sea floor damage	0.45	0.05	0.58	0.05
Sustainable exploitation	0.65	0.06	0.78	0.07
Marine litter challenge	1.35	0.15	1.17	0.10
Central to our well-being	0.70	0.07	0.81	0.07
Central to economic security	1.02	0.08	1.40	0.12
MPA is important	0.77	0.08	0.44	0.04
Economic growth	1.48	0.16	1.53	0.15
Environmental citizenship	0.60	0.07	0.32	0.04
Obs	1024		1005	
Loglik	-10479		-11311	
BIC	21415		19679	

Robust standard errors (S. E.) reported. ***, ** and * indicate 1%, 5% and 10% significance level respectively.

3.2 Economic Valuation of Deep-Sea and Wild Life Protection: A Comparison of Norway and Scotland

Analysis of the data from the discrete choice surveys revealed the presence of protest respondents. Protesters included those who chose the status quo in all 8 choice cards and stating reasons that reflect that they do not have a genuine WTP of zero. As a result, the analysed sample excluded these respondents, leaving us with a total of 994 respondents for the Scottish sample and 966 respondents for the Norwegian sample. Table 9 shows the side-by-side LCM preference space estimation of the Scottish and Norwegian Surveys. Following Scarpa and Thiene (2011), a two-class LCM was identified for each survey based on information criteria, parsimony, and interpretability of class parameters. MNL parameters were used as priors in the LCM and the LCM is presented since it showed significant improvement in model fit compared to the basic MNL. An LCM with and without class membership variables was estimated for which a likelihood ratio test showed the restricted model is rejected at the 1 percent significance level. Hence, we focus on discussing the unrestricted LCM with class membership variables.

Table 10 presents the class specific marginal WTP estimates derived from the LCM with socioeconomic variables valued at the country's currency unit and Table 11 presents the LCM weighted average WTP compared to WTP from MNL estimation. The WTP estimates were computed as the ratio of non-monetary attributes to the cost attribute using the Delta method (Green, 2011). The two classes in each survey are characterized by respondents who have a preference for all attributes (i.e., class 2) and those who have a preference for selective or specific attributes (i.e., class 1). Though the class 1 respondents in the two surveys have preferences for selected attributes, they are a little bit different, for example, the class 1 respondents in Norway do not care about both the creation of the new job and expansion of marine protected area but the Scottish class 1 does. The respective class shares for class 1 are 46% and 19% for the Scottish and Norwegian respondents.

The Alternative Specific Constant (ASC) parameter indicates the marginal utility of choosing the current (status quo) deep-sea and wildlife management scenario. As shown in all classes for both surveys, the parameter estimates are negative and statistically significant at the 1 percent significance level. This indicates that both the Scottish and Norwegian public on average have a negative preference for the status quo management plan in their respective countries. To the Norwegian public, the status quo management plan is depicted as having low health of commercial fish stocks (<40%), poor density of marine litter (4 to 6 items per km^2), a protected area of about 0.5% of the area of Nordland VII and comes with no change in marine economy jobs. To the Scottish public, the variation

lies in the size of the area protected (1% of the Sea of Hebrides). It is therefore clear that the proposed future management plans are the most preferred.

The cost parameter for all classes is negative and statistically significant at the 1 and 5% significance levels. This is in accordance with economic theory and rational behaviour of demand model estimations. The class 1 respondents who show a preference for only selected attribute levels are the most sensitive to cost while class 2 members are the least sensitive.

Regarding the health of commercial fish stock attribute, the proposed future scenario offers a moderate (40-80%) and high (>80%) percentage of commercial fish at healthy stock levels. Using the current level of less than 40% as the reference level, class 1 respondents show preferences for high health of commercial fish stocks at the 1% statistical significance level for both Norwegian and Scottish public. Class 2 respondents conversely prefer both moderate and high healthy stock levels. The marginal utility of 'high' health is greater than the 'moderate' health stock level as expected. In order to allow comparison of parameter estimates across classes, we account for scale effects by calculating the marginal WTP estimates. As shown in Table 10, class 1 members in Scotland and Norway are willing to pay €7.72 and € 7.42 in annual income tax over a 10-year period. The Scottish class 2 members, however, are willing to pay €132.93 for high health fish stock and €85.02 for moderate stock levels. The Norwegian class 2 members, on the other hand, have a WTP of €218.89 and €181.43 for high and moderate stock levels respectively. The LCM weighted average WTP (Table 11) for high and moderate health of commercial fish stocks were estimated to be respectively €74.85 and €46.85for the Scottish public and €178.5 and €147.85 for Norwegians. These weighted average WTPs are greater than and lie outside of the MNL-WTP mean estimates and confidence interval bounds.

The density of marine litter per square unit area also shows heterogeneous preferences among respondents. Using the marine litter attribute level 'poor' as the reference, class 2 respondents show statistically significant marginal utilities at the 1% significance level for both 'moderate' and 'good' levels. As expected, the marginal utility associated with the 'good' level of marine litter density is higher than the 'moderate' level. In the case of class 1 members in the Scottish survey, a significant marginal utility is only identified for the 'good' level of marine litter density, indicating that respondents have no preference for the moderate level which equates the current poor level of marine density in the deep-sea environment. Contrastingly, Norwegian class 1 respondents show positive preferences for both 'good' and 'moderate' marine litter densities and expectedly, the preference for the 'good' outweighs the 'moderate'. The variation in preferences translates into a marginal WTP of about €2.79 for 'good' marine litter density for class 1 while class 2 members values 'good' and 'moderate' litter density levels at about €183.71 and €112.84 respectively in Scotland. The weighted average WTP values are about €99.79 and €61.31 respectively and higher than the MNL-WTP estimates as shown in Tables 4 and 5. In Norway, both class 1 and 2 members value 'good'/'moderate' marine litter density at €10.35/9.46 and €245.31/155.78 respectively. The corresponding weighted average WTP estimates for good and moderate litter densities are €200.44 and €127.83which are comparatively higher than the MNL-WTP values.

Using the current management scenario of MPAs in the respective countries equivalent to 1% of the Sea of the Hebrides or 0.5% of Nordland VII as the reference level, we uncover variations in preferences. With respect to the Scottish survey, class 2 members show significant positive preferences for future deep-sea and wildlife management scenarios that increase the size of the protected area as marginal utilities increase with the increase

in the size of the protected area. Class 2 members, on the other hand, have only significant and positive preference for the least increase in a protected area (Area2) from the current management (i.e., 1 to 6% of the Sea of Hebrides) but no preference for increases in the area to 10 (Area3) or 15% (Area4). This translates into an additional WTP in annual personal income tax of about €3 for 'Area2' for class 1 while class 2 members value 'Area2-4' at €94.06, €117.7, and €123.58 respectively with a corresponding weighted average of €51.95, €63.45, and €65.73. In the case of the Norwegian survey, and considering the 5% statistical significance level, we identified no preference for any increase in a protected area for class 1 members while 'Area2' and 'Area4' were preferred to the current protected area and 'Area3' for class 2 members. As a result, Norwegian class 2 members have additional WTP of €56.52 and €95.06 for 'Area2' and 'Area4'. At the 10% significance level, 'Area3' commands a marginal WTP estimate of €50.26. The weighted average WTP estimates for future management scenarios that seem to increase the size of protected areas are €45.01, €40.16, and €77.17 for 'Area2' to 'Area4' respectively.

The marine economy jobs created from sea-based commercial activities in the deep-sea and wildlife area propose an additional 20 or 40 jobs for future management scenarios from the current management plan of no change in employment. Again, using the 'no change in employment' as the reference level, statistically significant preference for jobs were identified for class 2 members in both Norway and Scotland. Class 2 members in Norway are different from Scotland with the former having relatively higher marginal utilities for a low number of jobs (+20) than high jobs (+40) while the contrary is observed for the Scottish public. Class 1 members in Norway have no preferences for additional jobs while Scottish class 1 members only have a positive preference for +40 jobs associated with future proposed deep-sea management plans. The additional annual income tax that Scottish class 1 members are willing to pay for the +40 jobs is on the average estimated to be €4.56. Scottish class 2 members WTP for +20 and +40 marine jobs are respectively €56.45 and €92.3and a weighted average WTP of €30.97 and €51.6. In Norway, class 2 members respectively value the additional marine jobs at €68.65 and €61.54 which is significantly different from the zero MNL-WTP estimates.

Overall, class 2 members show favourable preferences and have values for future marine management policy scenarios, and the analysis revealed that in both Scotland and Norway, those in class 2 are more likely to be females and likely have tertiary education. Scotland varies from Norway by class 2 more likely to be people in the age group between 36 and 55 years and those living in the Highland-Island region. In Norway on the other hand, class 2 members identify with people of age above 36 years, those engaged in marine sports and those who are members of an environmental organization.

Table 9 Latent Class Preferences Comparison for Deep-Sea Environment Attributes

	LC Model without Socioeconomics				LC Model with Socioeconomics			
	Mingulay-Scotland		LoVe-Norway		Mingulay-Scotland		LoVe-Norway	
	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2
Variables	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
ASC	-0.894***	-1.522***	-0.351	-2.337***	-0.898***	-1.523***	-0.786***	-2.552***
Health3 (high)	0.493***	0.849***	0.151	1.209***	0.488***	0.855***	0.312**	1.238***
Health2 (moderate)	0.172*	0.543***	0.169	1.022***	0.174*	0.547***	0.237	1.026***
Litter3 (good)	0.186**	1.172***	0.421**	1.358***	0.177**	1.181***	0.436**	1.387***
Litter2 (moderate)	0.120	0.718***	0.296**	0.882***	0.111	0.725***	0.398***	0.881***
Area4	-0.084	0.794***	-0.243	0.670***	-0.072	0.795***	0.057	0.538***
Area3	0.040	0.755***	-0.137	0.350**	0.047	0.757***	-0.109	0.284*
Area2	0.200**	0.605***	-0.200	0.400***	0.207**	0.605***	-0.156	0.320**
Jobs3 (+40)	0.291***	0.591***	-0.138	0.424***	0.288***	0.593***	-0.060	0.348**
Jobs2 (+20)	0.096	0.361***	-0.261*	0.408***	0.095	0.363***	-0.161	0.388***
Cost	-0.072***	-0.007***	-0.003***	-0.001***	-0.071***	-0.007***	-0.004***	-0.001**
Class Membership								
Constant	0.000	0.662	0.000	1.812***	0.000	0.145*	0.000	0.173
Senior-aged56p					0.000	0.156*	0.000	1.185***
Middle-aged55					0.000	0.327***	0.000	0.829***
Male					0.000	-0.105**	0.000	-0.537***
Tert-Education					0.000	0.518***	0.000	0.567***
Marine-sport					0.000	0.082	0.000	0.427***
Highland-Island					0.000	0.616***		
Environ. Member							0.000	2.567***
Number of Panels	994		966		994		966	
Class Share ($\widehat{w_q}$)	0.340	0.660	0.140	0.860	0.464	0.536	0.191	0.809
Loglikehood	-6450.5		-5808.5		-6440.40		-5776.50	
BIC	13107.50		11822.92		13141.34		11812.54	
LR-Test					20.05***		64.09***	
McFadden R^2	0.262		0.316		0.263		0.320	

***, **, and * indicate statistical significance at the 1%, 5% and 10% levels respectively.

Table 10 Class specific marginal WTP estimates in EUR

	Class 1			Class 2		
Variables		SE	C.I(95%)		SE	C.I(95%)
Mingulay-Scotland						
Health3	7.72	1.32	**[5.13,10.3]**	132.93	35.49	**[63.37,202.5]**
Health2	2.74	1.50	[-0.2,5.7]	85.02	24.49	**[37.02,133.01]**
Litter3	2.79	1.39	**[0.08,5.51]**	183.71	47.41	**[90.78,276.65]**
Litter2	1.75	1.39	[-0.97,4.47]	112.84	30.35	**[53.35,172.32]**
Area4	-1.13	1.96	[-4.97,2.71]	123.58	29.23	**[66.29,180.88]**
Area3	0.75	1.59	[-2.36,3.85]	117.70	30.90	**[57.13,178.28]**
Area2	3.27	1.56	**[0.21,6.34]**	94.06	27.08	**[40.99,147.13]**
Jobs3	4.56	1.43	**[1.51,7.37]**	92.30	25.63	**[42.07,142.53]**
Jobs2	1.51	1.44	[-1.33,4.35]	56.45	17.38	**[22.37,90.53]**
LoVe-Norway						
Health3	7.42	3.33	**[0.9,13.94]**	218.89	65.67	**[90.19,347.59]**
Health2	5.63	3.43	[-1.09,12.35]	181.43	50.56	**[82.33,280.53]**
Litter3	10.35	3.79	**[2.92,17.78]**	245.31	70.55	**[107.04,383.59]**
Litter2	9.46	2.86	**[3.86,15.05]**	155.78	49.86	**[58.04,253.51]**
Area4	1.35	4.03	[-6.55,9.25]	95.06	12.96	**[69.66,120.47]**
Area3	-2.60	3.69	[-9.84,4.64]	50.26	10.33	**[30.02,70.5]**
Area2	-3.70	3.81	[-11.16,3.76]	56.52	10.14	**[36.65,76.38]**
Jobs3	-1.42	4.18	[-9.61,6.78]	61.54	10.63	**[40.7,82.38]**
Jobs2	-3.83	3.33	[-10.35,2.7]	68.65	14.51	**[40.21,97.09]**

Values in bold indicate statistical significance at least at the 5% level. Exchange rate: £ 1 = € 1.12 and NOK 1 = € 0.10

Table 11 MNL and LCM Weighted Average WTP estimates in EUR

	MNL			LCM		
Var		SE	C.I(95%)		SE	C.I(95%)
Mingulay-Scotland						
Health3	40.45	2.52	**[35.52,45.39]**	74.85	19.03	**[37.54,112.16]**
Health2	23.48	2.39	**[18.79,28.16]**	46.85	13.14	**[21.11,72.6]**
Litter3	49.38	2.49	**[44.51,54.25]**	99.79	25.44	**[49.94,149.64]**
Litter2	27.47	2.36	**[22.86,32.1]**	61.31	16.28	**[29.4,93.22]**
Area4	27.87	2.52	**[22.92,32.8]**	65.73	15.70	**[34.96,96.51]**
Area3	26.44	2.53	**[21.48,31.4]**	63.45	16.59	**[30.95,95.95]**
Area2	25.82	2.72	**[20.48,31.14]**	51.95	14.53	**[23.48,80.43]**
Jobs3	29.78	2.32	**[25.23,34.33]**	51.60	13.74	**[24.66,78.53]**
Jobs2	17.21	2.28	**[12.73,21.68]**	30.97	9.33	**[12.68,49.25]**
LoVe-Norway						
Health3	171.55	36.2	**[100.59,242.51]**	178.50	53.15	**[74.34,282.66]**
Health2	132.65	25.8	**[82.09,183.2]**	147.85	40.92	**[67.65,228.06]**
Litter3	189.54	37.62	**[115.81,263.27]**	200.44	57.10	**[88.52,312.36]**
Litter2	139.8	33.17	**[74.8,204.81]**	127.83	40.35	**[48.75,206.9]**
Area4	29.65	15.93	[-1.57,60.88]	77.17	10.51	**[56.57,97.76]**
Area3	-11.33	21.74	[-53.93,31.28]	40.16	8.35	**[23.81,56.52]**
Area2	-6.36	20.96	[-47.44,34.72]	45.01	8.20	**[28.94,61.09]**
Jobs3	-16.3	25.98	[-67.22,34.63]	49.51	8.60	**[32.65,66.37]**
Jobs2	24.31	9.77	**[5.17,43.45]**	54.81	11.75	**[31.78,77.83]**

Boldened values indicate statistical significance at least at the 5% level

4 Discussion and conclusion

This report provides a socioeconomic understanding of deep-sea North Atlantic ecosystems and contributes to providing foundation to evaluate and balance Blue Growth and conservation scenarios. The European Union MSFD aims to achieve GES of Europe's waters by 2020. However, this goal is unlikely to be met and new measures are expected to be enacted beyond this period. There is continuing interest in implementing further marine spatial management tools such as MPAs in national and international jurisdictions. As MPAs restrict marine resource access, it is imperative that social license is obtained in order to achieve sustainable long-term management and successful Blue Growth. The two facets of socioeconomic assessment including public perception of the marine environment and nonmarket valuation of new management scenarios of deep Atlantic ecosystems provide timely assessment of the public in moving beyond MSFD 2020. The main results from the report are discussed in the subsequent paragraphs.

Public knowledge and awareness of deep-sea ecosystems is relatively higher among Norwegians than for the Scottish. Approximately 60% of Norwegians and 16% of Scots are aware of cold-water coral reefs in their marine environment. In terms of prior knowledge level, approximately 30% of Norwegians at least knew most of what was presented while cumulatively 80% at least knew some of it. This translates into 20% and 3% respectively for the Scottish public. The variation between the two countries might be due to Norway having the world's largest known *Lophelia* reef, the Røst Reef off the Lofoten Islands. Given that significant shares of the public lack knowledge and awareness, it can be concluded that the level of knowledge and awareness is low as shown in the literature (Jefferson et al., 2014; Spence et al., 2018).

The deep-sea condition rating is similar but management rating is dissimilar between the two countries. About half of the respondents in both countries perceive the deep sea to be in ´fairly good´ condition. A significantly higher share, 76% of Norwegians perceive the deep sea to be certainly poorly-managed; the Scots in this category make up 12%. Those who perceive it to be well-managed are 34% and 22% for Scottish and Norwegians respectively. 12% and 29% of the Norwegian and Scottish respondents perceive the deep-sea changes to have no effect on them personally. Reflections of the deep-sea condition do not appear to correlate with the perception towards management and could indicate pessimism regarding management authorities. In the case of Norway, it could be driven by the contentious ongoing pressure to open LoVe for petroleum exploration.

In spite of the low knowledge and awareness of the marine environment and wildlife and pessimism regarding management, the public appears eco-centric. Generally, highly significant large shares of respondents recognize current key environmental pressures and the need to be environmentally conscious citizens by supporting the protection and sustainable management of marine ecosystems. In a five-point Likert scale of strongly disagree to strongly agree itemized statements showing pro-environmental behaviour, the most rated statement in Scotland and Norway was the statement "as humans we are responsible to protect natural resources to benefit future generation". This was followed by "marine litter as a key challenge" for the Scottish and "oceans being central to our well-being" for the Norwegians. Key threats to the marine environment such as fisheries and marine litter have been shown to be agreed upon by respondents in studies such as Lotze et al. (2018) who undertook a 21 cross-country comparison.

Socio-demographic variables and exposure to the sea through different mediums such as media related information, association with ocean industry and coastal visits, generally influenced public perception of the marine environment. Variations do however exist between countries. Different countries could adopt various ways of improving marine literacy in accordance with which socio-demographic variables impact the public's perception of the marine environment. Age, gender and education have varying associations with knowledge, awareness, deep-sea changes on human well-being, perceptions of deep-sea condition and management as well as general pro-environmental attitudes and values. Hence, formal education can be used as a medium for increasing public knowledge of the deep sea and its interaction with humans. Similarly, direct and indirect sea experiences such as living in the Highlands and Islands region, association with a sea-industry, marine sports, visits to sea areas or viewing documentaries like Blue Planet II influence the public's perceptions. These can be used to gather support for marine management options in targeted populations.

While there appears to be public support for conservation goals that would enhance the GES of Europe's waters, the perception study does not necessarily show that the public is willing to put money on the table. As effective MPAs are highly dependent on funding and since increased size of MPAs implies increased restricted access to more resources, it is imperative that changes to deep-sea ecosystems are actually being economically backed up by society through assessment of trade-offs people make.

A discrete choice experiment of the deep Atlantic ecosystem changes reveals that there are two distinct groups of the public who have a preference for new policy scenarios. In both countries, there are those who have only a limited preference for the new policy scenario attributes (class 1) and on the other hand, those who have a preference for almost all attributes (class 2). Class 2 forms the majority of the population (54% Scottish and 81% Norwegians). Overall, people are sensitive to the current status quo where the sensitivity of the major class in Norway is much higher than that of the Scottish public. This predisposition towards the new management is reflective of the pessimism observed in the perception analysis towards the current management of the deep sea, indicating that societal support for conservation goals is economically backed up by the public. This finding reflects the notion of Armstrong et al. (2012), that it is not always, or generally, necessary to know about something in order for a value to exist. Or, that values may be latent because they are information dependent and hence many individuals agree that it is worth giving something up in order to ensure conservation objectives.

The most valued of the new policy attributes were those related to the key pressures of the marine environment, commercial fish stocks and marine litter designated as descriptors 3 and 10 respectively in the GES of the MSF Directive, acknowledging the heterogeneous preferences within the population and focusing on the weighted parameter estimates. Healthy fish stock level is defined as the abundance ratio and measures the number of adult fish compared to juvenile fish. For both Norway and Scotland, positive values were estimated for proposed increase in stock levels, but the highest marginal WTP was for the level of '>80% fish stocks healthy'. For this level, the weighted average for the Scottish public is €75 and varies between €38 to €112 in the population. The corresponding value for Norwegians is €179 and varies between €74 to €283 in the population. According to EEA (2018), historic fishing beyond sustainable levels has made it difficult to reach the objective of healthy fish and shellfish populations. Approximately 67% of commercial fish and shellfish

stocks in Europe's seas are not in GES with strong differences between states. Given that the 2020 EU MSFD objective of ensuring healthy commercial fish stocks is unlikely to be met, further collective action is required, needing further financial sacrifices. The public are willing to pay to ensure healthy fish stock levels. In the worst case, more than half of the stated amount towards achieving more than 80% fish stock level is willing to be paid to attain the 40-80% level indicating that the current existing stock levels of 40% are not preferred.

For changes in deep-sea marine litter densities, the Scottish public has the highest weighted average values of €100, which varies from €50 to €150 in the population. The Norwegians weighted average value is €200 which varies from €89 to €312. These values represent a change in marine litter density from poor to good as defined in the attribute selection. Marine litter is known to present environmental, economic, health and aesthetic problems and as a marine environmental issue it has received global attention (Andrady, 2011; Eerkes-Medrano et al., 2015). There is the potential that the high WTP for a reduction in marine litter has been borne out of the current focus on marine plastic pollution within the oceans, which has received significant media attention. Despite the increase in policy discussions regarding marine litter in its various forms there is a very limited body of literature on the costs and impacts of marine litter on ecosystem service provision (Newman et al., 2015). Economic evaluations of marine litter are mainly focused on direct losses borne by the economic activities adversely affected (Mcllgorm, Campbell, and Rule, 2011; Macfadyen, Huntington, and Cappel, 2009).

Implementation of MPAs is seen as one way of protecting marine environments and the services they provide. MPA size is one of the determinants of MPA effectiveness (Edgar et al., 2014). Assessing the economic trade-offs for an increase in MPAs from the respective country's status quo levels, we observed a significant positive WTP for size increases in both countries. Contrary to the Scottish public, Norwegians revealed a WTP value for a 3% increase in area that is greater than for a 5% increase but lower than a 7.5% increase. This unusual result aside, it is evident in both countries that the best policy scenario identified corresponds to the largest deep-sea MPA size increase; from 0.5 to 7.5% of the area of Nordland for Norwegians and from 1 to 15% of the Sea of the Hebrides. In Scotland, the weighted average WTP for the largest area increase was €66 with a population range of €35 to €96. In Norway, it was €77 with a range of €56 to €98.

Despite the empirical literature showing that the size of the area protected has a positive effect on MPA effectiveness, the assessment of economic values for this feature of MPA is very limited. In Wattage et al. (2011) where 'banning all areas where corals are thought to exist to trawlers' was identified to be one of the preferred MPA features by the Irish public, no monetary trade-off was identified. Ruiz-Frau et al. (2019) assessed coastal MPAs in Wales, UK, and identified distinct heterogeneity among the public where a majority opposed potential reductions in MPA network size. Though Ruiz-Frau et al. (2019)'s coastal MPA valuation is not necessarily comparable to our deep-sea case, a three-class latent model showed class 1 respondents were willing to pay £43 and £35 to avoid reductions to 10% and 20% respectively of network coverage compared to the current status quo of 30%. In contrast, class 2 respondents, were willing to pay £13 to reduce it to 20% and class 3 was willing to pay £91 to avoid reductions to 10%. Our study confirms that size of coverage area matters in the designation of deep-sea MPA coverage in a similar vein to the more familiar coastal resources.

The concept of whether environmental restrictions such as MPAs are able to promote or restrict economic growth has long been debated. It is often perceived that MPAs may constrain economic activity and restrict opportunities for growth and jobs even including sectors that may benefit from improved marine environment conditions and biodiversity (Hattam et al., 2018). However, it is becoming increasingly evident that indeed, economic growth (profusion of new jobs and businesses) can complement MPAs (Klein et al., 2008, Ruiz-Frau et al., 2015) despite the possible perceived adverse effects of sectors that directly rely on the restricted resource (Ruiz-Frau et al., 2019). For literature valuing MPAs, individual preferences for economic activities that could be realized from the designation of MPAs have not received much research attention. It is often left out of economic valuation studies and so limits MPA importance in policy settings. Our study shows that although there is heterogeneity in preferences across the latent classes, Scottish respondents do value increased job prospects in the ocean economy connected with the Mingulay area with weighted average marginal WTP values of €52 for +40 jobs and €31 for +20 jobs. Norwegians also have a preference for additional jobs but their weighted average marginal WTP values for +20 jobs are higher than for +40 jobs, which are €55 and €50, respectively. The relative WTP between +20 jobs and +40 jobs for Norwegians seem to signal uncertainties regarding the acceptance of how many jobs can complement MPAs without adverse impacts. Alternatively, it could imply that Norwegians care more about marine environment improvement than too much economic growth and hence drive stakeholder resistance regarding pressures to open up LoVe for petroleum explorations. Nevertheless, there is an affinity for more jobs rather than having no increase in jobs.

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Appendix 1. Scotland's Sea and Wildlife Survey for Mingulay

- **Scotland's Seas and Wildlife Survey**

Get involved in shaping the future of new marine management options off the coast of Scotland.

This online survey has been launched to find out more about what people know about Scotland's seas and wildlife and how they would like this to be managed in the future.

- **WHAT IS THE SCOTTISH MARINE SURVEY?**

Researchers from across the UK and Europe are involved in an internationally funded project with scope to examine the marine biology and the economic management of the deep see in the North Atlantic.
Click here for complete project details ATLAS

FUNDING

Funding new management actions involves a cost to households so it is important that people from all over Scotland give their opinion. Results from the survey will be shared with interested policy makers.

You don't need to know about the topic to answer this survey. There is no right or wrong answer, we just want your honest opinion.

Page 2

- **ABOUT THE SURVEY**

- Participation is strictly voluntary and you may withdraw at any time.
- Data collected will be stored in an anonymised format on a password-protected computer system and will remain accessible to only the researchers involved in the project.
- The survey has been reviewed by the University of Edinburgh School of GeoScience's Research Ethics and Integrity Committee.
- The survey will remain accessible online for a period of 3 weeks

- What if I have concerns about this research?

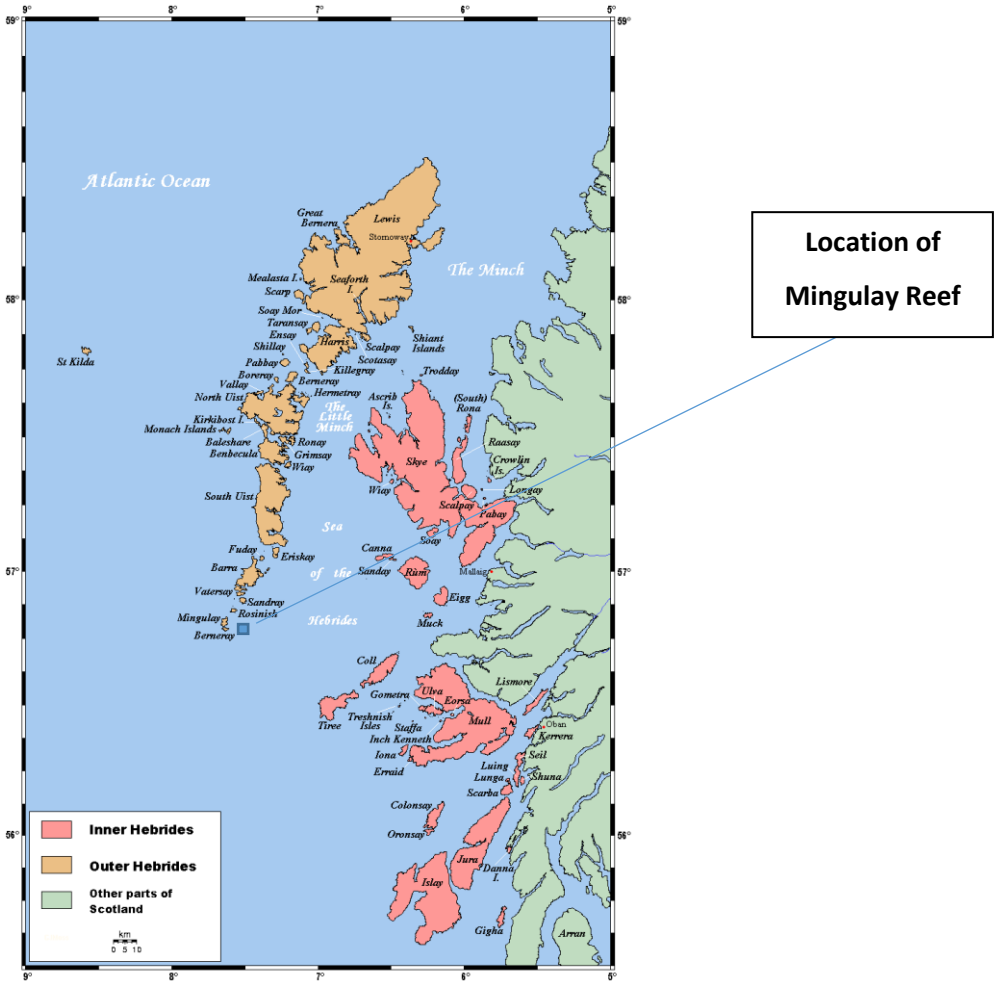
If you are worried about this research, or if you are concerned about how it is being conducted, you can contact the Chair of the GeoSciences Ethics Committee, University of Edinburgh, Drummond St, Edinburgh, EH8 9XP (or email at ethics.geos@ed.ac.uk).

I consent to participate in this survey (Please tick box to proceed) ☐

MANAGEMENT OF SCOTLAND'S SEAS AND WILDLIFE

- Changing environmental conditions and human activities can have major impacts on the distribution and sustainability of Scotland's seas and wildlife.
- The Scottish Government are responsible for delivering new plans on how best to manage deep sea areas and the wildlife found there.
- This includes balancing commercial activity with preserving deep sea wildlife and habitats.
- Funding these new management plans involves a cost to households, so it is important that residents are invited to give their opinions on the plans.
- We would like to learn more about your views on the management of Scotland's deep sea and wildlife. The outputs of this survey will be used to inform the development of appropriate plans.

- **THE MINGULAY REEF**



- The Mingulay Reef complex is found off the west coast of Scotland at a depth of 100-200m, 8.7 miles east of the Island of Mingulay in the Sea of the Hebrides.
- It is to date the only known near shore occurrence of cold-water coral reefs in Scotland.
- It supports a wide variety wildlife, including fish, marine plants and other animals. It also provides a wide variety of ecosystem services which we benefit from.
- Current management measures including limiting fishing activities that can potentially damage the reef. Fishers can use gear such as lobster pots in between the reefs that do not damage the reef.

- There are potential opportunities in the wider Sea of the Hebrides area for the growth of marine (marine economy) activities such as the lobster fishing industry, sea angling, recreational boating, other forms of eco-tourism, marine renewable wind and wave energy technology. Development of such economic activity could generate jobs for local communities but could also have negative effect on the unique ecosystems in the area. For example new installations may damage the sea bed when being anchored or disrupt the ocean currents in the area that feed the coral reefs and the fauna they support.

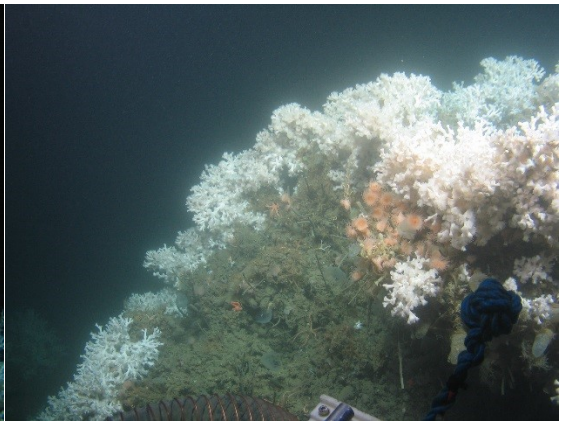
Pop up for further info on 'cold-water coral reef'

You may be already familiar with coral reefs found in the tropical seas - cold-water corals are similar to these in except they are found much deeper. These corals reefs can be formed of one, two or many species of coral. Unlike tropical corals, deep water corals don't need sunlight to feed. Instead they can trap tiny organisms from the passing currents.

Pop up for further info on Ecosystem Services

Ecosystem services are the many and varied benefits that humans gain from the natural environment. In the marine environment such services include fisheries, tourism opportunities and sites for renewable energy such as wind or wave power.

Cold-water coral reef images

Pop up for further info on Marine Economy

The marine economy is defined as those industries which rely on the sea. In Scotland this includes fish related activity (such as fishing and salmon farming), oil and gas, ports and shipping and marine recreation and tourism. In Scotland there is drive to increase our marine economy by creating more growth and job opportunities in the Scottish seas. People also talk about the **blue economy; this is where** the marine economic activity is in balance with the long-term capacity of marine ecosystems to deliver their services.

Please answer the following questions

1. **How much of what you just read about Scotland's deep seas and wildlife did you know beforehand?**

(1= none of it, 2= I knew a little, 3=knew some of it, 4=I knew most of it, 5=I knew everything)

1 ☐ 2☐ 3☐ 4☐ 5☐

2. Have you heard of the Mingulay Reef Complex previously

Yes	
No	

3. Do you or any member of your household work in an industry associated with the sea (e.g. Fishing, oil and gas, research, shipping, tourism)?

Yes	
No	

If yes, please specify the sector: _____

4. Thinking about the deep sea around Scotland, how would you rate its condition?

Very poor	
Fairly poor	
Neither good nor poor	
Fairly good	
Very good	
Don't know	

5. Do you think that changes to the Scotland's deep seas and wildlife affect you, personally?

No effect on me	
Some effect on me	
Major effect on me	
Don't know	

6. How well do you think Scottish deep sea areas are managed?

	Poorly	Fairly well	Well	Don't know	Don't care
Deep Sea					

CHOICE EXPERIMENT

The Scottish Government are responsible for delivering new plans on how best to manage Scotland's deep seas and wildlife. As part of this scientists are assessing the "health" or the environmental quality of the deep sea, including the Mingulay Reef Complex, with regard to:

- Health of fish stocks
- Amount of marine litter
- Size of area that is protected
- Creation of new marine jobs

HEALTHY FISH STOCKS

- High: > 80% of commercial stocks have healthy stock levels
- Moderate: 40 to 80% of commercial stocks have healthy stock levels
- Low: < 40% of commercial stocks in have healthy stock levels

The health of commercial fish stocks is measured by the number of adults fish compared to young fish (scientists refer to this as the abundance ratio). The more adult fish, the healthier the population. Commercial fishing can take place sustainably without risk of overexploitation. At the Mingulay Reef complex, commercial fishing is not allowed. The reef is an important nursery area for young fish where they can mature into breeding adults. These adult fish eventually move out of the reef complex into the surrounding seas where they can be commercially caught.

[SUGGESTION OF IMAGE/ GRAPH SHOWING HEALTHY ABUNDANCE RATIOS]

MARINE LITTER

- Poor (5 to 8 items of litter per mile^2)
- Moderate (2 to 4 items of litter per mile^2)
- Good (0 to 1 item of litter per mile^2)

Marine litter can have damaging effects on the seabed and on wildlife in the sea. It can also impose additional economy costs; for example by fouling intake pipes and propellers and by disrupting operation in aquaculture and by reducing the attractiveness of an area for tourism pursuits. The primary source of deep-sea based litter is from fishing such as discarded fishing nets, and pollution from shipping. Preventative measures will be needed to reduce the levels of litter in the deep sea.

SIZE OF PROTECTED AREA

- 1% of the Sea of the Hebrides (current management)
- 6% of the Sea of the Hebrides (six times the size of current management)
- 10% of the Sea of the Hebrides (10 times the size of current management)
- 15% of the Sea of the Hebrides (15 times the size of "current management)

The Mingulay protected area is currently 44 miles^2 (just under 2 times the size of Loch Lomond) and protects all known cold water corals in the area. The Sea of the Hebrides is an important area for lots of marine wildlife and the Mingulay Reef Complex accounts for approximately 1% of the Sea of the Hebrides. The area around the reef complex could be extended.

MARINE ECONOMY JOBS FROM SEA BASED COMMERCIAL ACTIVITIES IN THE AREA

- + 20 jobs,
- + 40 jobs,
- No employment change

In the Mingulay Reef Complex there is potential to develop new industries such as fisheries, new forms of aquaculture, tourism and marine renewable energy. It is possible that development of these areas will provide employment for local communities. There could however be trade-offs between developing the area commercially and protecting the cold water coral reef and associated marine wildlife.

Different levels of each of these can be delivered as part of the management plan: i.e. more or less jobs, more or less marine litter, healthier fish stocks and a larger protected area. We would like you to think about different "bundles" of these aspects of management and as a tax payer how much you would be willing to pay for these different management aspects.

Any changes from the status quo would need to be funded by the Scottish taxpayer. This would take the form of an increase to annual personal income tax rates over a 10 year period and 'ring-fenced' into a secure marine fund.

On the following pages you will be presented with eight choice cards like the one below:

SCENARIO 1	**Option A**	**Option B**	**Option C** (current management)
Health of commercial fish stocks	**High:** >80% of commercial stocks at healthy stock levels	**Moderate:** 40 - 80% of commercial stocks at healthy stock levels	**Low:** <40% of commercial stocks s at healthy stock levels
Density of Marine litter	**Moderate** (2 to 4 items of litter per mile^2)	**Good** (0 to 1 item of litter per mile^2)	**Poor** (5 to 8 items of litter per mile^2)
Size of protected area	**6% of the Sea of the Hebrides**	**15% of the Sea of the Hebrides**	**1% of the Sea of the Hebrides**
Marine economy jobs created from sea based commercial activities in the area	**+ 40 jobs**	**+ 20 jobs**	**No employment change**
Additional costs (£ per person per year)	**£ 30**	**£ 40**	**£ 0**
Your choice for scenario 1 *(please tick A, B or C)*	■	■	■

- Choose the option you most prefer on each choice card.
- ***<u>There are no wrong or right answers.</u>*** We are just interested in your opinion.
- Option A and B are two alternative future management options and will incur additional costs to you, each year, for 10 years.
- Option C is the same on each choice card and it never involves a payment. It describes the situation that could result in the future when there is no further change from current management.

Please consider:

- The impacts on you and your family on the management of the deep sea
- All options other than option C 'current management' impose an additional financial cost on you and your family.
- Payment is expected to be made through a ring fenced tax dedicated to protecting the marine environment collected through your income tax.
- Please consider how much money is available in your budget considering all your other expenses before making your decision. Example tax bands:
    - If you earn £15,000 per year you will pay £610 per year in income tax
    - If you warn £33,000 per year you will pay £4300 per year in income tax
    - If you earn £45,000 per year you will pay £7,134 per year in income tax

- Imagine yourself **<u>actually paying</u>** the amounts specified and please consider your own budget and ability to pay when considering each option.

USE BLOCK 1 <u>OR</u> 2 SHOWCARDS HERE

REASONS FOR CHOICES

1. Thinking back over the choice cards you've just gone through, how confident are you in the choices you made?

Not very confident	
Somewhat confident	
Fairly confident	
Confident	
Very confident	

2. Which of the management aspects were important when you made your choice among the alternatives on the choice cards?

Attribute	**Very Important**	**Somewhat Important**	**Not Important**	**Ignored this attribute**
Health of commercial fish stocks				
Density of Marine litter				
Size of protected area				
Jobs created				
Cost				

3. [TO BE ANSWERED BY THOSE WHO ALWAYS CHOOSE Option C]

Which of these statements, if any, best describes the MAIN reason why you always picked the **"£0 OPTION"**?

I would like to pay towards the management but I cannot afford to contribute	1
I do not value these types of ecosystems	2
Prefer other ways of paying rather than taxes	3
The government should pay from existing revenue	4
I do not visit the oceans or islands enough to justify it	5
I do not have enough information to make a decision	6
I do not believe any protection scheme will be implemented	7
I object to paying for marine ecosystem protection	8
Other reasons	9

4. Please indicate your response to the following statements where 1= strongly agree, 2= disagree, 3=neither disagree or agree, 4=agree, 5= strongly agree

The balance of marine biodiversity is very delicate and easily upset	1	2	3	4	5
Human activities are severely abusing marine ecosystems such as marine organism abundance and diversity, and biological integrity of the sea-floor	1	2	3	4	5
The key pressures on marine biodiversity are fisheries	1	2	3	4	5

The key pressures on marine biodiversity are physical damage to the sea floor	1	2	3	4	5
All commercial fish stocks should be sustainably exploited in order to secure high long-term yield and healthy stocks	1	2	3	4	5
Marine litter is one of the key challenges to the marine environment and biodiversity	1	2	3	4	5
Healthy seas are central to our well-being	1	2	3	4	5
Healthy seas are central to economic security	1	2	3	4	5
Establishment of marine protected areas is one important measure for protecting valuable, vulnerable or threatened organisms	1	2	3	4	5
Economic growth is more important than protecting the marine environment	1	2	3	4	5
As humans we are responsible to protect natural resources to benefit future generations	1	2	3	4	5

5. Please give the first four digits of your postcode _____
6. Have you ever visited the islands of Mingulay or Barra?

Yes	
No	

7. Have you ever visited the Outer Hebrides?

Yes	
No	

8. Which of the following activities do you consider a hobby (please tick all that apply)

Marine fishing, scuba diving, snorkelling, sailing (coastal/marine), sea kayaking, surfing, stand up paddle boarding (coastal/marine), open water swimming (coastal/marine), none of the above.

9. How confident are you that the results of this survey will be used by policy makers in deciding marine management at the Mingulay reef complex?

Very Unconfident ☐, Unconfident ☐, Neither unconfident or confident ☐, Confident ☐, Very confident ☐

10. Did you watch one episode or more of the TV series Blue Planet 2 as broadcast on BBC 1 (October – December 2017).

Yes	
No	

SOCIO-ECONOMIC CHARACTERISTICS OF SAMPLE

Q.1 Including you, how many people are there in your household in the following age groups:

USE LEADING ZEROS, E.G. 04 FOR 04 PEOPLE

	NO. OF PEOPLE
a) Below 5 years old	
b) Between 5-15 years old	
c) Between 16-60 years old	
d) Over 60 years old	

Q.2 Are you Male ☐, Female ☐ , Other ☐

Q.3 What age are you? _____ age

Q.4 Which of the following best describes your level of education? [IF STILL STUDYING: Which level best describes your level of education you obtained until now?] **CIRCLE ONLY ONE.**

Primary	1
Secondary	2
Professional qualification of degree level	3
College/University Degree (B.Sc., B.A., etc)	4
Post- Graduate Education (M.A., Ph.D., etc)	5

Q.5 Can you please indicate your current work status? **CIRCLE ONLY ONE**

Working full-time (occupation/paid job of 30+ hours per week)	1
Working part-time (occupation/paid job of 18-29 hours per week)	2
Working part-time (occupation/paid job of 17 or less hours per week)	3
Student	4
Home maker	5
Retired	6
Unemployed	7
Unable to work due to sickness or disability	8
Other	9

Q.7 Could you please indicate the letter that best describes your total <u>personal income</u> per year (whether from employment, pensions, state benefits, investments or any other sources) before deduction of tax.

A) Less than £10,000	1
B) £10,001 – £20,000	2
C) £20,001 – £30,000	3

D) £30,001 – £40,000	4
E) £40,001 – £50,000	5
F) £50,001 - £60,000	6
G) £60,001 - £70,000	7
H) £70,001 - £80,000	8
I) £80,001-£90,000	9
J) £90,001 - £99,999	0
K) £100,000+	X
L) Refused	V

Q.8 Please add any other comments you might have about this interview.

Thank you

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 678760 (ATLAS). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

Appendix 2. Norway's Sea and Wildlife Survey for LoVe

- **Norway's Seas and Wildlife Survey**

Get involved in shaping the future of new marine management options off the coast of Norway.

This online survey has been launched to find out more about what people know about Norway's seas and wildlife and how they would like this to be managed in the future.

- **WHAT IS THE NORWEGIAN MARINE SURVEY?**

Researchers from across Norway and Europe are involved in an internationally funded project with scope to examine the marine biology to the economic management of the deep see in the North Atlantic.

Click here for complete project details ATLAS

FUNDING

Funding new management actions involves a cost to households so it is important that people from all over Norway give their opinion. Results from the survey will be shared with interested policy makers.

You don't need to know about the topic to answer this survey. There is no right or wrong answer, we just want your honest opinion.

Page 2

- **ABOUT THE SURVEY**

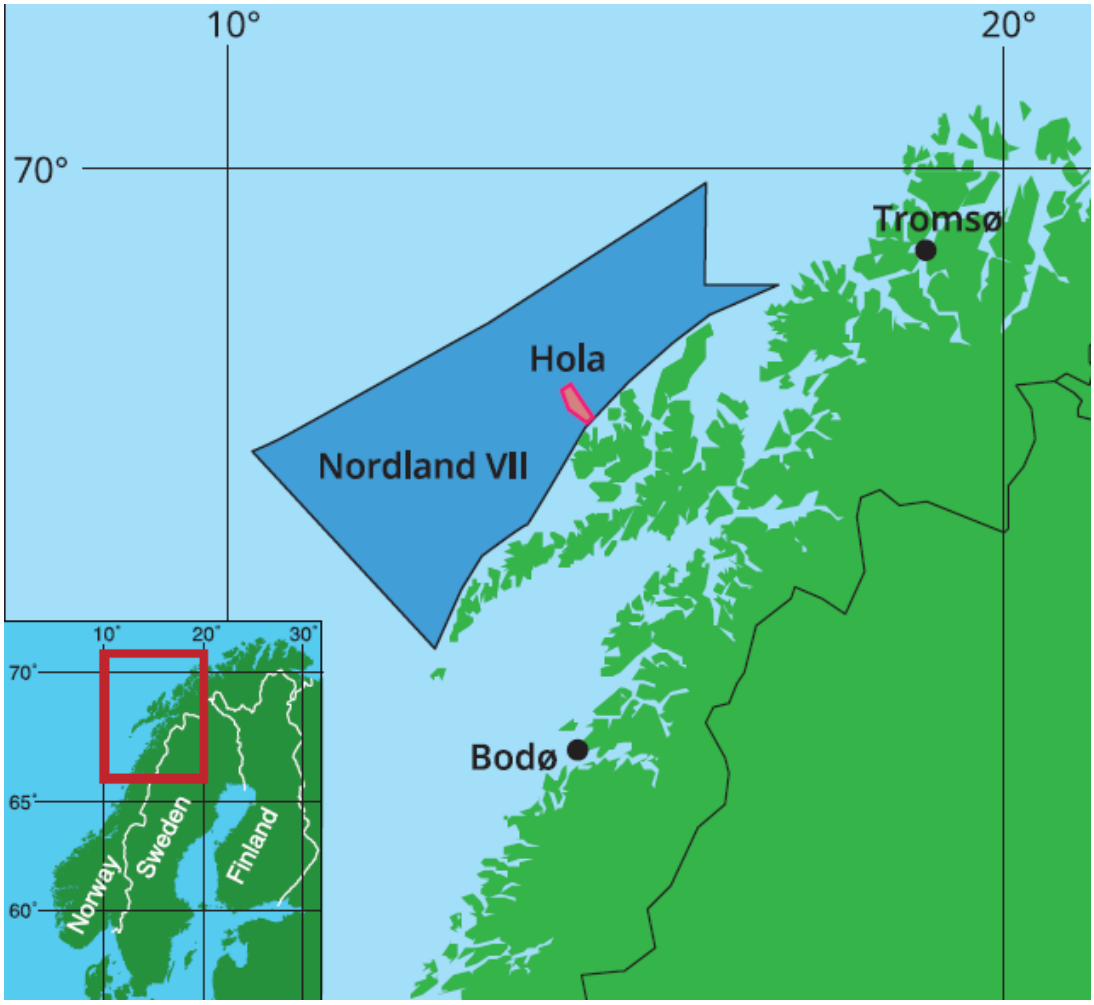
- Participation is strictly voluntary and you may withdraw at any time.
- Data collected will be stored in an anonymised format on a password-protected computer system and will remain accessible to only the researchers involved in the project.
- The data will be used for research purposes only.
- The survey satisfies the anonymity requirements of the Norwegian Centre of Research Data ethics process.

I consent to participate in this survey (Please tick box to proceed) ☐

- **MANAGEMENT OF NORWAY'S SEAS AND WILDLIFE**

- Changing environmental conditions and human activities can have major impacts on the distribution and sustainability of Norway's seas and wildlife.
- The Norwegian Government is responsible for delivering new plans on how best to manage deep-sea areas and the wildlife found there.
- This includes balancing commercial activity with preserving deep-sea wildlife and habitats.
- Funding these new management plans involves a cost to households, so it is important that residents are invited to give their opinions on the plans.
- We would like to learn more about your views on the management of Norway's deep sea and wildlife. The outputs of this survey will be used to inform the development of appropriate plans.

LOFOTEN VESTERåLEN AND THE PROTECTED AREA HOLA



- The islands of Lofoten and Vesterålen are part of an archipelago north of the Arctic Circle in Northern Norway. Due to the narrow continental shelf, the area is described as the gateway to the Barents Sea.

- This is an area of particular importance for cold-water coral reefs in Norway.
- It supports a wide variety wildlife, including fish and other animals. It also provides a wide variety of ecosystem services which we benefit from.
- Fisheries, aquaculture, and tourism are important economic sectors in the region. Fisheries currently operate in relation to defined environmental objectives in order to protect the deep-sea wildlife and habitats, as well as the potential goods and services they provide.
- There are potential opportunities in the wider sea of the Nordland VII area (see map) for the growth of marine (marine economy) activities both existing economic sectors (i.e. fisheries and aquaculture) and potential economic sectors such as oil/gas exploitation, marine wind farms, and maritime transport. Development of such economic activities could generate more jobs for local communities but could also induce negative effects on the unique ecosystems in the area. For example, new installations may damage the sea bed when being anchored or disrupt the ocean currents in the area that feed the coral reefs and the fauna they support.

Pop up for further info on 'cold-water coral reef'

You may already be familiar with coral reefs found in the tropical seas. Cold-water corals are similar to these except that they are found much deeper. Like tropical corals reefs these cold-water reefs are formed of stony corals that build a reef framework, but cold-water corals do not need sunlight to feed. Instead, they can trap tiny organisms from the passing currents. Did you know that among the largest densities of cold-water coral in the world are found in Norwegian waters?

Pop up for further info on Ecosystem Services

Ecosystem services are the many and varied benefits that humans gain from the natural environment. In the marine environment such services include fisheries, tourism opportunities and sites for renewable energy such as wind or wave power.

Cold-water coral reef images

Pop up for further info on Marine Economy

The marine economy is defined as those industries which rely on the sea. In Norway this includes fisheries related activity (such as fishing and salmon farming), oil and gas, ports and shipping and marine recreation and tourism. In Norway there is drive to increase our marine economy by creating more growth and job opportunities in the Norwegian seas. People also talk about the **blue economy;** this is where the marine economic activity is in balance with the long-term capacity of marine ecosystems to deliver their services.

Please answer the following questions

7. **How much of what you just read about Norway's deep seas and wildlife did you know beforehand?**

(1= none of it, 2= I knew a little, 3=knew some of it, 4=I knew most of it, 5=I knew everything)

2 ☐ 2☐ 3☐ 4☐ 5☐

8. Have you heard of the cold-water coral reefs in Lofoten-Vesterålen previously

Yes	
No	

9. Do you or any member of your household work in an industry associated with the sea (e.g. Fishing, oil and gas, research, shipping, tourism)

Yes	
No	

If yes, please specify the sector: _____

10. Thinking about the deep sea around Norway, how would you rate its condition?

Very poor	
Fairly poor	
Neither good nor poor	
Fairly good	
Very good	
Don't know	

11. Do you think that changes to Norway's deep seas and wildlife affect you, personally?

No effect on me	
Some effect on me	
Major effect on me	
Don't know	

12. How well do you think Norwegian deep-sea areas are managed?

	Poorly	Fairly well	Well	Don't know	Don't care
Deep Sea					

CHOICE EXPERIMENT

The Norwegian Government is responsible for delivering new plans on how best to manage Norway's deep seas and wildlife. As part of this, scientists are assessing the "health" or the environmental quality of the deep sea, including Lofoten-Vesterålen, with regard to:

- Health of fish stocks
- Amount of marine litter
- Size of area that is protected
- Creation of new marine jobs

HEALTHY FISH STOCKS

- High: > 80% of commercial stocks have healthy stock levels
- Moderate: 40 to 80% of commercial stocks have healthy stock levels
- Low: < 40% of commercial stocks in have healthy stock levels

The health of commercial fish stocks is measured by the number of adults fish compared to young fish (scientists refer to this as the abundance ratio). The more adult fish, the healthier the population. Commercial fishing can take place sustainably without risk of overexploitation.

MARINE LITTER

- Poor (4 to 6 items of litter per km^2)
- Moderate (2 to 3 items of litter per km^2)
- Good (0 to 1 item of litter per km^2)

Marine litter can have damaging effects on the seabed and on wildlife in the sea. It can also impose additional costs; for example by fouling intake pipes and propellers and by disrupting operation in aquaculture and by reducing the attractiveness of an area for tourism pursuits. The primary source of deep-sea based litter is from fishing such as discarded fishing nets, and pollution from shipping. Preventative measures will be needed to reduce the levels of litter in the deep sea.

SIZE OF PROTECTED AREA

- 0,5% of the area of Nordland VII (current area of Hola protected area)
- 3% of the area of Nordland VII (six times the size of current management)
- 5% of the area of Nordland VII (10 times the size of current management)
- 7,5% of the area of Nordland VII (15 times the size of current management)

An existing marine protected area - Hola in Lofoten-Vesterålen, has an area of 125 km^2. There are plans for a network of protected areas which are important for marine wildlife. The ocean area of Nordland VII (see the map) is an important area for a lot of marine wildlife. Hola accounts for approximately 0,5% of the Nordland VII area. The area around Hola, with rare ecosystems such as cold-water coral reefs, could be extended. (ADD MAP TO THIS LINK)

MARINE ECONOMY JOBS FROM SEA BASED COMMERCIAL ACTIVITIES IN THE AREA

- + 20 jobs,
- + 40 jobs,
- No employment change

In Lofoten-Vesterålen there is potential to develop industries such as fisheries, aquaculture, tourism, oil/gas exploitation, marine wind farms, and maritime transport. It is possible that development of these areas will provide employment for local communities. There could however be trade-offs between developing the area commercially and protecting the cold water coral reefs and associated marine wildlife.

Different levels of each of these can be delivered as part of the management plan: i.e. more or less jobs, more or less marine litter, healthier fish stocks and a larger protected area. We would like you to think about different "bundles" of these aspects of management and as a tax payer how much you would be willing to pay for these different management aspects.

Any changes from the status quo would need to be funded by the Norwegian taxpayer. This would take the form of an increase to annual personal income tax rates over a 10 year period and 'ring-fenced' into a secure marine fund.

On the following pages you will be presented with eight choice cards like the one below:

SCENARIO 1	**Option A**	**Option B**	**Option C** (current management)
Health of commercial fish stocks	**High:** 80% of commercial stocks at healthy stock levels	**Moderate:** 50% of commercial stocks at healthy stock levels	**Low:** 40% of commercial stocks s at healthy stock levels
Density of Marine litter	**Moderate** (2 to 3 items of litter per km^2)	**Good** (0 to 1 item of litter per km^2)	**Poor** (4 to 6 items of litter per km^2)

Size of protected area	**3% of the area of Nordland VII**	**7,5% of the area of Nordland VII**	**0,5% of the area of Nordland VII**
Marine economy jobs created from sea based commercial activities in the area	**+ 40 jobs**	**+ 20 jobs**	**No employment change**
Additional costs (per person per year) **NOK**	**NOK 450**	**NOK 600**	**NOK 0**
Your choice for scenario 1 *(please tick A, B or C)*	■	■	■

- Choose the option you most prefer on each choice card.
- ***There are no wrong or right answers.*** We are just interested in your opinion.
- Option A and B are two alternative future management options and will incur additional costs to you, each year, for 10 years.
- Option C is the same on each choice card and it never involves a payment. It describes the situation that could result in the future when there is no further change from current management.

Some people say they are willing to pay more in surveys for these types of improvements in the deep sea than if we were actually collecting the money during the survey. This is because when people actually have to part with their money, they take into account that there are other things they may want to spend their money on.

Please consider:

- The impacts on you and your family on the management of the deep sea
- All options other than option C 'current management' impose an additional financial cost on you and your family.
- Payment is expected to be made through a ring fenced tax dedicated to protecting the marine environment collected through your income tax.
- Imagine yourself **actually paying** the amounts specified and please consider your own budget and ability to pay when considering each option.

CHOICE CARD 1

SCENARIO 1	**Option A**	**Option B**	**Option C** (current management)
Health of commercial fish stocks	**Moderate:** 50% of commercial stocks at healthy stock levels	**Low:** 40% of commercial stocks s at healthy stock levels	**Low:** 40% of commercial stocks s at healthy stock levels
Density of Marine litter	**Poor** (4 to 6 items of litter per km^2)	**Good** (0 to 1 item of litter per km^2)	**Poor** (4 to 6 items of litter per km^2)
Size of protected area	**0,5% of the area of Nordland VII**	**7,5% of the area of Nordland VII**	**0.5% of the area of Nordland VII**
Marine economy jobs created from sea based commercial activities in the area	**No employment change**	**+ 40 jobs**	**No employment change**
Additional costs (per person per year) **NOK**	**NOK 150**	**NOK 850**	**NOK 0**
Your choice for scenario 1 *(please tick A, B or C)*	■	■	■

REASONS FOR CHOICES

11. Thinking back over the choice cards you have just gone through, how confident are you in the choices you made?

Not very confident	
Somewhat confident	
Fairly confident	
Confident	
Very confident	

12. Which of the management aspects were important when you made your choice among the alternatives on the choice cards?

Attribute	**Very Important**	**Somewhat Important**	**Not Important**	**Ignored this attribute**
Health of commercial fish stocks				

Density of Marine litter				
Size of protected area				
Jobs created				
Cost				

13. [TO BE ANSWERED BY THOSE WHO ALWAYS CHOOSE Option C]

Which of these statements, if any, best describes the MAIN reason why you always picked the **"NOK 0 OPTION"**?

A	I would like to pay towards the management but I cannot afford to contribute	1
B	I do not value these types of ecosystems	2
C	Prefer other ways of paying rather than taxes	3
D	The government should pay from existing revenue	4
E	I do not visit the oceans or islands enough to justify it	5
F	I do not have enough information to make a decision	6
G	I do not believe any protection scheme will be implemented	7
H	I object to paying for marine ecosystem protection	8
I	Other reasons	9

14. Please indicate your response to the following statements where 1= strongly disagree, 2= disagree, 3=neither disagree nor agree, 4=agree, 5= strongly agree

A	The balance of marine biodiversity is very delicate and easily upset	1	2	3	4	5
B	Human activities are severely abusing marine ecosystems such as marine organism abundance and diversity, and biological integrity of the sea-floor	1	2	3	4	5
C	The key pressures on marine biodiversity are fisheries	1	2	3	4	5
D	The key pressures on marine biodiversity are physical damage to the sea floor	1	2	3	4	5
E	All commercial fish stocks should be sustainably exploited in order to secure high long-term yield and healthy stocks	1	2	3	4	5
F	Marine litter is one of the key challenges to the marine environment and biodiversity	1	2	3	4	5

G	Healthy seas are central to our well-being	1	2	3	4	5
H	Healthy seas are central to economic security	1	2	3	4	5
I	Establishment of marine protected areas is one important measure for protecting valuable, vulnerable or threatened organisms	1	2	3	4	5
J	Economic growth is more important than protecting the marine environment	1	2	3	4	5
K	As humans we are responsible to protect natural resources to benefit future generations	1	2	3	4	5

15. Please give the first four digits of your postcode _____

16. Have you ever visited the islands of Lofoten-Vesterålen?

Yes	
No	

17. Which of the following activities do you consider a hobby (please tick all that apply)

Marine fishing ☐, Scuba diving ☐, Snorkelling ☐, Sailing (coastal/marine) ☐, Sea kayaking ☐, Surfing ☐, Stand up paddle boarding (coastal/marine) ☐, Open water swimming (coastal/marine) ☐

18. How confident are you that the results of this survey will be used by policy makers in deciding marine management at the Lofoten-Vesterålen?

Very Unconfident ☐, Unconfident ☐, Neither unconfident or confident ☐, Confident ☐, Very confident ☐

19. Did you watch one episode or more of the TV series Blue Planet 2 as broadcast on BBC 1 (October – December 2017).

Yes	
No	

SOCIO-ECONOMIC CHARACTERISTICS OF SAMPLE

Q.1 Are you Male ☐, Female ☐ , Other ☐

Q.2 What nationality are you? Norwegian ☐ Other _____

Q.3 What age are you? **CIRCLE ONLY ONE**

18-25 years	1
26-35 years	2

36-45 years	3
46-55 years	4
56-65 years	5
66-75 years	6
Over 75 years	7

Q.4 Which of the following best describes your level of education? [IF STILL STUDYING: Which level best describes the level of education you have obtained until now?] **CIRCLE ONLY ONE.**

Primary	1
Secondary	2
Professional qualification of degree level	3
College/University Degree (B.Sc., B.A., etc)	4
Post- Graduate Education (M.A., Ph.D., etc)	5

Q.5 Can you please indicate your current work status? **CIRCLE ONLY ONE**

Working full-time (occupation/paid job of 30+ hours per week)	1
Working part-time (occupation/paid job of 18-29 hours per week)	2
Working part-time (occupation/paid job of 17 or less hours per week)	3
Student	4
Unemployed	5
Other	6

Q.6 Could you please indicate the letter that best describes your total <u>personal income</u> per year (whether from employment, pensions, state benefits, investments or any other sources) before deduction of tax.

A) Less than NOK 200.000	1

B) NOK 200.000 – NOK 400,000	2
C) NOK 400.001 – NOK 600,000	3
D) NOK 600.001 – NOK 800,000	4
E) NOK 800.001 – NOK 1.000,000	5
F) NOK 1.000.001 – NOK 1.200,000	6
G) NOK 1.200.001 – NOK 1.400,000	7
H) NOK 1.400.001 – NOK 1.600,000	8
I) NOK 1.600.001 – NOK 1.800,000	9
J) NOK 1.800.001 – NOK 2.000,000	0
K) NOK 2.000,000+	X
L) Refused	V

Q.7 Please add any other comments you might have about this interview.

Thank you

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