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TWENTY THOUSAND STERLING UNDER THE SEA: ESTIMATING THE VALUE OF PROTECTING DEEP-SEA BIODIVERSITY

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Abstract

The deep-sea includes over 90% of the world oceans and is thought to be one of the most diverse ecosystems in the World. It supplies society with valuable ecosystem services, including the provision of food, the regeneration of nutrients and the sequestration of carbon. Technological advancements in the second half of the 20th century made large-scale exploitation of mineral-, hydrocarbon- and fish resources possible. These economic activities, combined with climate change impacts, constitute a considerable threat to deep-sea biodiversity. Many governments, including that of the UK, have therefore decided to implement additional protected areas in their waters of national jurisdiction. To support the decision process and to improve our understanding for the acceptance of marine conservation plans across the general public, a choice experiment survey asked Scottish households for their willingness-to-pay for additional marine protected areas in the Scottish deep-sea. This study is one of the first to use valuation methodologies to investigate public preferences for the protection of deep-sea ecosystems. The experiment focused on the elicitation of economic values for two aspects of marine biodiversity: (i) the existence value for deep-sea species and (ii) the option-use value of deep-sea organisms as a source for future medicinal products.

Key words: Deep-sea biodiversity, economic value, marine protected areas, choice experiment, option-use value, existence value

1. Introduction

1.1 Deep-sea ecosystem services

The deep-sea is the largest ecosystem on the planet (Thiel, 2003). It includes all ocean areas, from the shelf edge at -200 m water depth, down to the deepest trenches at -11,000 m, and covers 65% of the Earth's surface (Thistle, 2003; Tyler, 2003). Despite this vast geographical extent, it was long thought that the deep-sea environment hosts little or no life (Tyler, 2003), mainly because of its extreme conditions, such as total darkness, low temperatures, high pressure, and low food availability (Thistle, 2003). However, today we know that a high diversity of life is found in the deep oceans, which might even rival the diversity of tropical rainforests (Grassle & Maciolek, 1992; Van Dover, 2000). It is also an area that sustains major ecosystem services (ES), which are crucial for life on Earth as we know it. The deep-sea provides society not only with provisioning services such as food and hydrocarbons, but also with important regulating services, such as temperature regulation, regulation of atmospheric greenhouse gasses, and absorption of waste and pollutants (Armstrong et al., 2010 & 2012). Most importantly, it supports ocean life by cycling nutrients and providing habitat for a vast array of species.

Some authors have argued that only final ES should be taken into consideration for economic valuation, leaving supporting services out of the equation (Boyd & Banzhaf, 2007; Wallace, 2007), to avoid double counting of their value and because they are extremely difficult to value (Armstrong et al., 2012). However, in particular for the deep-sea environment, supporting services might constitute the biggest contribution to life on Earth and Armstrong et al. (2010 & 2012) highlighted the importance of considering them to identify the deep-sea's main values. Less tangible cultural ES such as the scientific, existence, and inspirational values of the deep-sea ecosystem are often overlooked, as well as the value of maintaining biodiversity for generations to come. Finally, we can consider the option-use value of deep-sea tourism and finding medicinal products. Such ES may sound like science-fiction, but future technological improvements might well allow these options to become reality. To date, the small amount of literature on deep-sea ES is mainly of a descriptive nature and next to nothing is known about the economic values of protecting this environment.

TABLE 1 SPACER

1.2 Main threats to deep-sea biodiversity

Marine ecosystem quality and the ES these ecosystems provide have declined dramatically over the last century (Barbier et al., 2011; Worm et al., 2006) and ecosystem degradation comes at a cost for society, as the provision of important ES is affected (Barbier et al., 2011; NRC, 2006). To be able to value these changes, it is crucial to understand the threats to the marine ecosystem and their effects on biodiversity. Scientists agree that despite its remoteness, the deep-sea is far from being unaffected by human activity and wide-spread changes are already noticeable today (Benn et al., 2010; Fosså et al., 2002; Ramirez-Llodra et al., 2011; Van den Hove et al., 2007). Climate change, which is resulting in increasing ocean surface temperatures and ocean acidification, is thought to be the biggest future challenge for the deep-sea ecosystem (Ramirez-Llodra et al., 2011). The most immediate threats however, are related to the fishing sector, oil and gas exploitation, cable laying, pipeline construction, underwater noise and water pollution from shipping routes, waste dumping, drill cuttings from mining activities, and pollution from terrestrial sources (Armstrong et al., 2010 & 2012; Benn et al., 2010; Ramirez-Llodra et al., 2011).

Whereas the environmental impact of mining on the seabed is still unknown, deep-sea fishing has been identified as having a major impact (Benn et al., 2010). Fisheries have targeted ever deeper fish stocks since the 1950s, even though deep-sea species are particularly vulnerable to overexploitation, due to their slow growth and late maturity (Morato et al., 2006). Many deep-sea activities are likely to increase globally over the next decades (Glover & Smith, 2003; Ramirez-Llodra et al., 2011), such as mining activities for deep-sea resources like rare earth metals (e.g. gold, copper, zinc, and cobalt), and hydrocarbons (e.g. oil, gas, and gas hydrates) which will pose new potential threats to the deep-sea ecosystem (Halfar & Fujita 2007; Kato, 2011; Ramirez-Llodra et al., 2011; Rona, 2003). Mineral and hydrocarbon resources are already technologically exploitable today, with extraction being mainly limited by cost considerations. As mineral and hydrocarbon prices rise, the economically viable exploitation of these remote resources is expected to increase.

1.3 Current marine legislation

Recognising and quantifying the economic value of biodiversity is key to sustainable ocean management (TEEB, 2012). Ocean ecosystems are particularly vulnerable to degradation, due to the fact that they are often located across political borders, and because there is a general deficit of good governance in ocean areas (TEEB, 2012). Some international agreements to administer and control the exploitation of marine resources already exist [we refer the reader to Thiel (2003) for further detail on regulatory organisations of deep-sea areas]. The UN Convention on Biological Diversity (CBD; 1992) triggered biodiversity conservation goals globally, so that today Marine Protected Areas (MPAs) not only exist in shallower waters, but also in the deep-sea. Aspirations of some conservation groups go as far as demanding protection for at least 20-30% of each ocean habitat (Balmford et al., 2004). Currently, it is very uncertain if such goals will be met in the near future.

The international community failed to meet its CBD target to protect 10% of the oceans by 2012 (UNEP, 2010 & 2012). In 2010 only 1.6% of the oceans were protected, and most of the MPAs are located in the shallower areas (UNEP, 2012). The UN has declared 2011-2020 the Decade on Biodiversity (DEFRA, 2011) and many nations are currently extending their national MPAs to apply with the CBD's Strategic Plan for Biodiversity 2011-2020 (EP, 2012). This plan highlights natural capital as society's life insurance, stresses the economic importance of biodiversity (EP, 2012) and sets the scene for environmental values to enter cost-benefit analyses (CBAs). When "hard" economic facts (i.e. monetary values) are presented to decision makers rather than qualitative types of value, they can serve as incentives for protection (Morling, 2005; Tinch et al. 2011). The inclusion of the non-use values of protection can have a positive influence on the acceptance for conservation management decisions (Tinch et al., 2011). However, non-use values are difficult to obtain in general and estimates are mostly non-existent for the deep-sea.

1.4 Main challenges to valuing deep-sea ecosystem services

Science has a limited understanding of how biodiversity is affected by human impacts, and how changes in biodiversity bring about changes to the supply of ES. The major part of the deep-sea remains unknown and some scientists refer to it as one of the “least understood” environments on Earth (Ramirez-Llodra et al., 2010; Tyler, 2003). The available information on deep-sea ES is mostly of a descriptive nature and the majority of experts would be reluctant to put numbers on the ES changes that we have to expect in the future. However, one of the biggest challenges of attaching economic values to deep sea ES and biodiversity is not the lack of scientific certainty about the baseline and future trends, but rather the unfamiliarity of the general public with the deep-sea environment. This is relevant given the likelihood that researchers will need to use stated preference methods to estimate values for deep sea biodiversity. Ocean literacy across the population is thought to be limited in general (Steel et al., 2005) and awareness can be expected to be even lower for the deep-sea. The deep-sea environment remains remote to the majority of people (Ramirez-Llodra et al., 2011). Most members of the general public also poorly understand complex ecological concepts such as biodiversity (Christie et al., 2006; Ressurreição et al., 2011; Spash & Hanley, 1995; Turpie, 2003). However, people are able to learn and form their values given an appropriate approach to measurement (Christie et al., 2006), by combining new information on biodiversity attributes with their attitudes and beliefs. Another factor that makes stated preference valuation difficult for the deep-sea is the lack of charismatic species, which has been shown to be an important factor determining WTP (Christie et al., 2006). However, interest in the deep-sea is rising (Tyler, 2003), thanks to public outreach incentives of international large scale projects, such as the Census of Marine Life, and documentaries like the BBC’s ‘Blue Planet’ (Beaumont et al., 2008).

1.5 Previous studies valuing deep-sea biodiversity and ecosystem services

The socio-economic valuation of marine ES lags far behind that of terrestrial ecosystems. A global valuation of ES estimated an annual flow value for the marine environment (including coastal waters) of \$20.9 trillion, or 63% of the value provided by all ecosystem services globally (Costanza et al., 1997), although there are well-known problems with the interpretation of this figure. For the UK, figures on marine ES values have been estimated based on benefit transfer and mostly market-based approaches (Beaumont et al., 2006 and 2008) and a related study looking into the economic value of implementing an MPA network for the UK waters estimated benefits of protection to range from £10.2-23.5 billion for a 20 year period (Hussain et al., 2010).

A study in Ireland estimated non-use values that the general public had for the protection of cold water coral (CWC; deep-sea species) habitats off the Irish coast (Glenn et al., 2010; Wattage et al., 2011). The respondents of this survey were willing to pay (WTP) for CWC protection between €0-10 per person. Follow-up questions identified different non-use motives for protecting CWCs, including existence and bequest values. Marine biodiversity valuation studies often focus on single or high profile species, such as CWC, and Ressurreição and colleagues (2011) argue that other ecosystem components and low profile species should be taken into account. A second case study, which included parts of the deep-sea in addition to shallower waters, focused on valuing species loss around the Azores archipelago (Ressurreição et al., 2011). A contingent valuation survey was undertaken which discussed the protection of a wide range of species, compared to the single species approach in the Irish CWC study. Choice scenarios were presented as one-off payments for avoiding reductions in species richness and resulted in WTP estimates of €405 to €605, per visitor or resident, for preventing 10-25% losses in marine species richness in the region. A study from the UK elicited respondents' values for a network of marine sites in coastal as well as off-shore areas and found WTP for halting the loss of marine biodiversity and environmental benefits, £20.92 and £16.16 respectively (McVittie & Moran, 2008 & 2010). A very broad range of ES was included here, but no distinction was made between ES from shallow compared to deep-sea areas.

There is thus a dearth of empirical studies which quantify the non-market benefits of protecting deep-sea areas. Our case study presents empirical data from a national stated preferences survey, undertaken in Scotland in 2012. We now describe the methods used in and the design of this survey (section 2). Section 3 presents results, and Section 4 provides a discussion and conclusion.

2. Methodology

2.1 Discrete choice experiments

The discrete choice experiment (DCE) method, as described by Hensher et al. (2005) and Louviere et al. (2000), is an increasingly popular approach to elicit monetary values for non-marketed goods. The DCE method belongs, like contingent valuation, to the family of stated preferences methods (Carson & Louviere, 2011). The DCE method has the advantage that the hypothetically marketed good is divided into its components or attributes. This improves its usefulness in a management context. Participants are asked to make a choice between alternatives with different attribute-levels. The method allows us to infer which attributes are most important for people's choices, estimate WTP for changes in attributes (i.e. marginal values), and predict WTP for future scenarios with different bundles of attributes (i.e. total value) (Hanley & Barbier, 2009).

Our un-labelled DCE offered three options per choice task, with two hypothetical management options and a business as usual or status quo option as described by Ryan and Skåtun (2004). Our DCE questionnaire reminded participants (i) to account for budget constraints, and (ii) to think about their other household expenses in making their choices. These reminders are intended to reduce the likelihood of hypothetical bias resulting from people ignoring their budget constraints .The focus area of this survey was the deep-sea area of the UK's North and Northwest Exclusive Economic Zone (12 – 200 nm off the coast), which for this survey was referred to as the Scottish deep-sea[1]. The hypothetical market consisted of options to establish different protected areas within this area, at a cost to households and to the sectors impacted by restrictions.

2.1.1 Designing the hypothetical DCE scenarios

The hypothetical scenarios were built around government plans to extend existing MPAs around the UK in the future as part of the UK's biodiversity conservation strategy. Details on how new MPAs

[1] The Scottish deep-sea is less than the full size of the EEZ, as quite a few parts of the EEZ are shallower than -200 m.

will be implemented in future, or to what extent, did not exist by the time of survey design. For the design of the choice experiment scenarios we therefore used a conservative MPA area estimate, which remained below the maximum values that conservation organisations were proposing (20-30% of each habitat; Balmford et al., 2004). Survey participants were told that certain deep-sea areas of about 7,500 km^2 (1.5% of Scottish waters; status quo in January 2012) are currently protected. The DCE's enhanced protection scenarios proposed a fourfold increase of the existing protected deep-sea area to 6% of Scottish waters. Participants were asked for their WTP for this increase. The sample was split into two groups, which were given different scenarios of how protection would be achieved. Group A was told that the additional MPAs would only affect the fishing sector (i.e. fisheries exclusion), and group B was told, that not only the fisheries sector, but also the oil and gas sector would be affected by the implementation of new MPAs. The two sectors had been identified as the most important marine sectors in deep-sea areas, and those sectors with the largest potential future impacts on deep sea ecosystems. The intention here was to investigate whether preferences for marine conservation depend on which sectors bear the cost burden. People were told that additional protection would impose costs on Scottish tax payers to cover the costs of environmental assessments, administration, and patrolling of the protected areas. Payments would be collected via an additional income tax per household. Participants were also told that the additional tax payments would take effect from the end of 2012, as protection plans would be implemented by the end of the same year. Both the payment vehicle as well as the cost of protection were of a hypothetical nature and solely developed for the DCE scenarios. It is very likely that future protection plans would indeed be paid for with tax revenues, so that a national tax increase was the most realistic payment vehicle to use, and had the advantage of being non-discretionary.

2.1.2 Developing the choice attributes

A list of deep-sea ecosystem services by Armstrong *et al* (2010 & 2012) and Hove *et al* (2007) served as a source of potential attributes for the DCE design. This list is, to date, the most extensive list of deep-sea ES available. The following criteria were used to pre-select ES from that list to enter into the potential attribute list:

(I) ES expected to be affected by anthropogenic impacts, excluding climate change

(II) Magnitude of the ES impact potentially manageable by marine protected areas

(III) ES of a biotic nature (excluding abiotic goods and services, such as minerals or water circulation; i.e. all ES greyed out in table 1)

(IV) Exclusion of supporting services, such as nutrient cycling, on account of concerns on double-counting ecosystem service values

(V) Adaptable to DCE framework (i.e. different levels are exchangeable across choice task options)

The potential attributes list was then further refined with five focus groups and face-to-face interviews with UK residents. A total of 37 people were included in this pre-pilot survey process and strongly influenced the in-/exclusion of attributes and the framing of scenarios and attributes respectively. Two ES were then chosen for the final experimental design. These were (I) potential for new medicines from deep-sea organisms (a measure of option value) and (II) number of protected species (a measure of existence value). We decided against the inclusion of a habitats attribute (e.g. cold water coral reef, seamount, and continental slope), as focus group participants were not familiar with these deep-sea habitats and the cognitive burden of developing preferences, based on brief introductory text, and within the time available, was seen as too high. Restriction on the fishery and hydrocarbon sectors operating in the MPAs entered the DCE via the scenarios as fixed attributes through the use of split samples, after the inclusion of restrictions into the DCE as an interchangeable attribute had been tested unsuccessfully. Focus group participants found it difficult to make judgements on the type of restrictions that should be imposed for protected areas when they had the choice between fisheries sector and oil & gas sector. The reason for this lack of confidence was thought to be a lack of information and the cognitive burden of processing new information on restrictions and their potential economic impact, if in the latter case an introduction on impacts related to marine activities was provided. Using a split sample with fixed restrictions per group of respondent was therefore preferred for the final design. This means that one half of respondents received a choice experiment where new deep-sea protected areas were created through restrictions on the fishery sector alone; and the other half received a choice experiment where these restrictions extended to the oil and gas industry as well as the fisheries sector (it was not realistic to consider *only* restricting oil and gas, since fisheries have the most important impact on deep sea biodiversity around the Scottish coast).

The number of protected species was used as a proxy for biodiversity since species richness (i.e. the total number of species) is a simple concept to assess and understand. Species richness has been successfully used by other stated preferences surveys (Ressurreição et al. 2011). From an ecological perspective, species richness is thought to be a good index when impacts and the ecosystem response have to be assessed (Olsgard, 1993). We used total species estimates, rather than non-quantitative attribute-levels for the species protection attribute (e.g. high / medium / low species numbers). Scientists are uncertain about the number of species in the deep-sea and information on species-area relationships varies very much between studies. We therefore decided to base our estimate on the most extensive study of deep-sea bed fauna that has been conducted to date (Grassle & Maciolek, 1992) and used the maximum species estimate of this study as our maximum species number: 1600 deep-sea species under protection. Grassle & Maciolek (1992) found 1597 species on a 180 kilometre long sampling transect across the North-western Atlantic continental slope. They also assumed that for every added transect kilometre only one more species would be found. The main objective of using a quantitative estimate was to present the potential relative possible change in regional species numbers between a high (i.e. large area) and a low protection scenario (i.e. small area) with a realistic baseline. Seafloor surveys showed that species numbers can be as much as 59% reduced in trawled areas compared to non-trawled areas (Koslow et al., 2001). We were therefore interested in a change of species numbers between 0% and 60% (a maximum of 1600 species compared to the hypothetical baseline of 1000 species).

Aspirations to find biomedically active compounds in the future are high within the science community (Arico & Salpin, 2005; Leary et al., 2009). Such medicinal products were chosen as a DCE attribute, to include an engaging and non-altruistic example for deep-sea ecosystem services, compared to the other often complex or less tangible deep-sea ES. Examples for biomedical discoveries in shallower, tropical waters are relatively plentiful compared to a handful of successful deep-sea case studies, due to the high costs of exploring the deep-sea ecosystem (Maxwell, 2005). To date, scientists have mostly discovered toxins from snails or sponges that are now used in cancer treatment or as pain killers. Future developments of currently unknown medications from deep-sea microorganisms are a major research aspiration (Arico & Salpin, 2005; Leary et al., 2009). Scientists are concerned that some of the potential useful compounds might never be found due to destructive marine activities that may wipe out species before they are discovered (Arico & Salpin, 2005; Maxwell, 2005). The medicinal products attribute combined uncertainty with a future use value (i.e. option value). Direct comparison with the preferences for species existence was possible as part of the DCE framework.

2.1.3 Choice tasks

For the design of the main survey a D-efficient design with two blocks and a total of 12 choice cards was chosen. A pilot survey with 42 participants was conducted to obtain informed priors for the design produced in Ngene (Econometric software; version 1.1.0). Participants were offered six choice cards each and were asked to choose from three different options per card, including a business as usual (BAU) option. An example choice card is provided in figure 1.

FIGURE 1 SPACER

The BAU option was described as a no-cost option with no additional protected areas. A total of 1000 species under protection was set as the baseline for the BAU option, as opposed to 1000, 1300, or 1600 species in the hypothetical protection scenarios (in the model dummy variables for these attribute levels are called SP1300 & SP1600). The baseline for medicinal products was described as currently unknown and with a possible change to high potential in one of the future scenarios (dummy variable: MED). The change from unknown to high potential was explained to participants through a lack of current scientific knowledge and the necessity of additional research effort and time to find biomedical substances in the future. Whereas, species protection was described as an outcome that would be immediately available (i.e. after implementation of protected areas), medicinal products were described as a future possibility, with an uncertain outcome in respect to its scope. It was pointed out to participants, that both species diversity and scope for medical products were expected to deteriorate outside the protected areas in the future. The cost attribute (variable: COST) was a continuous variable with six levels: £5, £10, £20, £30, £40, and £60. Participants were reminded to choose the BAU option if they felt that all other options were too expensive. They were also asked, after completing the six choice tasks, why they had decided to choose the BAU. This information was used to identify protesters among the respondents, which were then excluded from the statistical analysis.

2.2 Survey and questionnaire

All participants for the main survey were randomly selected from the Scottish phone directory and contacted via mail. In total 1,984 households around Scotland were contacted (0.05% of the Scottish population[2]). Addresses were known, but no information on gender, age, income or occupational status was available prior to the survey. A postal survey was selected as the preferred sampling method as being the most cost efficient approach and achieving a wide geographic distribution. Given that the majority of the population was thought to be unfamiliar with the topics of marine protection and the deep-sea respectively, people were more likely to participate in a short and anonymous postal survey as opposed to a workshop. Moreover, it is hard to achieve a random sample of the target population using a workshop design. However, self-selection biases are common for mail samples and should be taken into account in interpreting responses. A first reminder letter was sent two weeks after the first contact attempt and a third mail out, containing an additional copy of the questionnaire, followed five weeks after the initial mail out (sampling procedure based on Dillman, 1978). In principle, every adult household member was allowed to fill out the questionnaire. Of all 1984 mailed out questionnaires, 545 (27%) were returned at least partially completed, which is a high response rate for a postal survey. Only 3% of the addressees could not be contacted (i.e. addressee moved, deceased, or returned for unknown reason), and 4% chose not to participate. After three contact attempts, there was no information available for the remaining 65% of the originally contacted households.

The questionnaire contained 38 questions spread over ten A4 pages. Focus group trials suggested that participants needed 20-30 minutes to complete it. Participants were provided with a map of the

[2] According to the Scottish Population Census 2010 (NS, 2011), a total of 4.184 million people of age 18 and older lived in Scotland in 2010.

Scottish deep-sea and a one-page introduction on what was meant by the term "deep-sea". The introduction was followed by a self-evaluation (five-point scale from 'I knew everything' to 'I knew nothing') of participant's knowledge, depending on how much of the information, provided in the introduction, they thought they already knew before participating. Further on, choice attributes and scenarios were explained, followed by six choice tasks. Every choice task was accompanied by a question on how confident (five-point scale from 'very confident' to 'not very confident') the respondent felt to choose one of the three options. The statements on confidence provided valuable information on how people felt about completing the choice tasks and their perceived ability to make choices. A copy of the questionnaire is available on request.

2.3 Statistical analysis

The statistical analysis was conducted in STATA (version 12.1). The two survey samples, group A (the fisheries industry would be restricted in protected areas) and group B (the oil & gas industry as well as fisheries would be restricted in protected areas), were both analysed separately and as a merged dataset, which is referred to as MERGED below. For this merged data an additional dummy variable was introduced (REST), to account for the different scenario descriptions in respect to the marine sector restrictions and to parametrically test if the different treatments affected respondents' WTP. A likelihood ratio (LR) test did not show significant differences between a statistical model where all parameters were interacted with REST and the simpler model without this interaction (LR test with conditional logit model; $\chi^2=16.29$; df=12; $p>0.05$) and as a conclusion we did not have any objections to merging the dataset. Two different models were used to estimate attribute coefficients, the mixed logit model (ML; also known as the random parameter model), and the conditional logit model (CL). Our ML used normally- distributed random parameters with a fixed cost coefficient to assist in the computation of willingness to pay amounts. The ML model has the advantages of allowing preference heterogeneity and error correlation across choices made by each respondent. All variables used in the models were dummy variables, apart from the COST, AGE, FISH and CONF, which were treated as continuous variables (table 2). Implicit prices – willingness to pay for change in each of the attributes - were calculated.

A number of responses, in total 148 (27%), were excluded from the estimation process. The exclusion criteria were: (a) incomplete choice cards; (b) irrational choices (i.e. one scenario offered a better future scenario for lower cost); (c) protest responses (including answers such as 'others should pay', 'options are unrealistic and won't work', 'disagree with additional restrictions on the fisheries or oil and gas sector') and (d) missing data within the individual specific characteristics used as interactions.

TABLE 2 SPACER

3. Results

3.1 Sample characteristics

The socio-demographic analysis revealed that the sample was not representative of the Scottish population (Scottish National Statistics=SNS[3]). The largest age group in Scotland according to SNS (46-55 years) was well represented within our survey. However, pensioners made up 50% of the responses (SNS=14%). Age groups 45 years and below were underrepresented (12% compared to 47% in SNS) with a decreasing ratio towards the younger age groups, as well as women with only 35% participation rate (SNS=52%). Overall 12% of respondents stated that they worked for either the oil & gas (10%) or the fisheries sector (2%); an overrepresentation of both sectors ($SNS_{oil\ \&\ gas}$=0.5% and $SNS_{fisheries}$=0.07%). Affiliation to either of the two marine sectors entered the model as dummy variable SECTOR. The mean income band of £20,001 – £30,000 per household was close to the Scottish population mean and the mean household size at 1.9 members was only slightly lower than the national average (SNS=2.2). Respondents with university degrees were over-represented. Within the sample 49% were working (SNS=58%), 20% were or had been members of an environmental organisation, 11% stated that they had some dive experience, and 63% said that they eat fish at least once per week. The latter four individual specific variables (WORK, NGO, DIVER, and FISH; variables explained in table 2) entered the DCE model estimation as interactions with the BAU alternative or ASC. They were included as interactions since they were considered to have a potential

[3] Socio-demographics compared to Scottish National Statistics (2001, 2010, 2011 & 2013; URL: www.scotland.gov.uk/Topics/Statistics, last access 06/2013), and Scotland's Marine Atlas (2011).

effect on respondent choice behaviour in terms of whether people would prefer a change away from the status quo, that is, would prefer to increase deep-sea protection.

3.2 Attitudes towards marine conservation

The survey follow-up questions revealed that the majority (73%) of respondents found it worth paying for protection of deep-sea areas, because society would benefit from it in the long-term. 81% of respondents agreed that marine protection around Scotland would be beneficial for the marine environment and only 6% were opposed to this notion. People were more divided when it came to the impact that the additional protection would have on the marine economy in the future. Here, 22% saw a negative impact on the marine economy, whereas 48% did not believe that this would be the case. The extraction of marine resources was seen by 18% as more important than deep-sea protection.

The main reason for 178 respondents to choose a BAU option at least once was the costs of protection (61%). Beyond that, additional restrictions (33%) were an important factor, as was the sentiment that others should pay for protection (17%). A general lack of interest (9%) was the least selected reason for choosing the BAU. The ratio of respondents choosing BAU at least once to those who always chose additional protection was similar in sample group A (23%) and group B (21%). Many respondents stated that they were concerned about the effect that additional MPAs would have on remote communities and the fishing sector in particular (e.g. “the marine industries support many remote communities”; “I would not like to see our trawler men facing further restrictions”). Existing EU fisheries restrictions were seen as a problem (e.g. “there is already too much interference and regulation”; “local fishing industry should be protected”; “unfair advantage to foreign fleets”), but also the need for international agreements to manage the deep-sea areas (e.g. “Scotland cannot do it alone”; “international solutions needed”). Overall the opinions on human impacts were very wide spread, but people showed higher solidarity with the fishing sector than the oil and gas sector (e.g. “Oil and gas companies wreck the environment for profit”; “I think it is a shame to lump together the gas/oil and the fishing industry. Scottish fishermen have a long history.”). This attitude was similar in both treatment groups and thus thought to be independent of the DCE scenarios (i.e. Group A or B) that respondents had been told in the introduction.

The self-evaluation of deep-sea knowledge revealed that 63% of the respondents felt that they knew only half or less of the information discussed in the survey introduction. 17% of respondents stated they were familiar with most or all of the topics discussed in the survey (the remainder of 20% skipped this first question). Irrespective of how little knowledge people stated they had, 53% felt confident or very confident to answer the six choice tasks of the DCE. Only 19% did not feel confident or not very confident to choose from the three options. A relatively small percentage (6%) of respondents found the hypothetical market to be not credible, whereas 70% stated that they found the survey interesting.

3.3 Choice preferences

For the choice analysis 148 responses (27%) were excluded from the analysis, which left 397 fully completed surveys in the MERGED dataset. All main attributes showed *a priori* expected coefficient signs with MED, SP1300, and SP1600 being positive and the cost attribute being negative. This is true for both the Conditional Logit (CL) results in Table 3, and the Mixed Logit (ML) results in Table 4. The main attributes were significantly different (at the 1% level) from the baseline across all datasets and estimated models. Overall WTP was positive and significant for all attributes, across all samples and models. The average respondent had similar preferences for ‘new medicinal products’ as for the highest level of ‘number of protected species’..

We found that the respondents’ WTP for the “best” option (i.e. highest species protection plus high potential for new medicinal products) was on average £70 for the CL and £77 for the ML model respectively. Note that this is higher than the maximum value used for cost in the experimental design, since we do not assume that the highest bid value is equal to the right-hand tail of the underlying distribution of WTP, this is not unusual. It is also the case that WTP for the best option combines the values people placed on both attributes being improved. Respondent’s WTP was similar for the potential for medicinal products (MED) and the highest level of species protection (SP1600), with £35-38 (MED) and £35-39 (SP1600). Respondents held, as expected, a significantly higher value for the highest species protection (SP1600) as opposed to intermediate species protection (SP1300) expressed as a £12 higher WTP in both models. The ML model fits the data somewhat better than the

CL model (compare the AIC values), whilst there is some evidence of preference heterogeneity in terms of the statistically significant standard deviation parameters for MED and SP1600 in the ML model. Interactions between the ASC and individual specific characteristics were significant in both models for gender (GEND), fish consumption (FISH), being a member of environmental organisation (NGO), and confidence level (CONF). Being a member of an environmental organisation turned out to have a significant effect on respondents choosing one of the future protection options. Male participants were more likely to choose one of the protection options, as were people who ate relatively more fish, and people who felt more confident in their choices. It is interesting that AGE is not significant as an interaction with the ASC in either model, despite the sample being mainly un-representative with regard to the age distribution of respondents. It did not matter for choices if people had been working in one of the affected marine sectors (SECTOR). Being a diver was a very strong explanatory variable for choosing an option different from the BAU, at least in the CL model (note that a negative value for the interaction parameter in the tables shows that divers are less likely to prefer the status quo). The ASC for the BAU alternative was very high for both models but only significant for the ML model. It showed the widest standard deviation for the ML model, which indicated high preference heterogeneity for the unobserved part of the model. Finally, whether the costs of protection fall on just the fisheries sector or are shared between fisheries, oil and gas had no significant effect on choices, since the coefficient for REST was insignificant when looking at the MERGED data. Note that we did not test for interactions between these socio-economic and individual characteristics and each attribute, but only with the ASC.

TABLE 3 SPACER

TABLE 4 SPACER

3.3.2 Differences between samples according to which sectors face the costs of protection

Despite the lack of significance for the REST variable in Tables 3 and 4, we decided to investigate further whether there were differences in choice parameters depending on which sectors face the costs of enhanced future protection, since this is an important policy component. The analysis of the separate datasets with the ML model did not lead to any additional insight on choice behaviour beyond the CL model. Both models provided similar WTP values for species protection and medicinal products. Because of this, the discussion below and the results in Table 5 refer only to CL models.

The two samples A (n=208) and B (n=189) showed some important differences for the significant individual specific interactions (table 5). We found that, for group A respondents, fish consumption (FISH), being a diver (DIVER), and being male (GEND) had a significant negative effect on choosing BAU, whereas for group B these variables were not significant. Instead, being a member of an environmental organisation (NGO) and their confidence on completing the choice tasks (CONF) were the only significant explanatory variables apart from the main attributes. For group B the ASC was significant, which indicates a high unobserved utility within this model. As in the MERGED dataset, the age of the respondent and if they were working, were insignificant variables for choice making. The WTP for the "best" option was not significantly higher for group A at £72, compared to group B at £67.

TABLE 5 SPACER

4. Discussion

A lack of evidence on monetary values of deep-sea ES and biodiversity was one of the main research gaps highlighted by a recent review on deep-sea ES by Armstrong et al. (2012). Our Scottish case study can help to increase the understanding on deep-sea existence values, option-use values, and the valuation of unfamiliar and remote goods and services in general, albeit that these results derive from an un-representative sample of the general public. In the following discussion we highlight our experience on how to value species existence and option-use of deep-sea organisms, but also discuss the wider challenges of valuing ES that people are unfamiliar with.

4.1 WTP for deep-sea protection

It is uncommon in marine planning to include non-users into the decision process, even though non-users can hold high values for the ocean, as we demonstrated for the respondents in our survey. We argue that good ocean governance starts with a more democratic approach and should encourage the inclusion of the general public into the decision making process for conservation. High WTP for deep-sea protection, ranging from £70 to £77 for the "best" option, points out that survey participants cared for protection of vulnerable ocean areas, despite the remoteness of and their own lack of familiarity with these areas. At the same time it was important to some respondents *how* protection was achieved, as can be gathered from the general comments. However, our statistical model did not support the hypothesis that people have significantly different preferences for marine conservation depending on which sectors bear the costs of protection. It may well be that some people have a general concern for the viability of these sectors (fisheries, oil and gas), in terms of local economic activity, despite the fact that our split-sample treatment did not pick this up econometrically. One could care about a sector without the distribution of protection costs affecting one's preferences for the deep sea.

One key question is whether it is reasonable to promote the citizen as a steward of the marine environment, even though she possesses much less knowledge on the topic than marine users, conservation groups, or policy makers. The Scottish case study generally supports this idea. The majority of the citizens who participated in our survey were not affiliated with the marine economy and stated to have very little knowledge on deep-sea issues, which however did not translate into a general lack of interest. On the contrary, the high WTP for increasing the UK deep-sea protected areas mirrors the high value that people associate with medicinal products and species' existence, even though the latter ES was of no direct benefit to them.

Aldred (1994) explains existence value as a moral resource, which increases the valuer's utility in the absence of any direct benefit, and for which the valuer is willing to give up scarce resources, in this case part of her income. It is possible that the questions on the existence value of deep-sea species have caused decision conflicts for some participants, as they had to make trade-offs between their deeper held moral values for species protection, their personal economic loss (i.e. additional tax) and the economic loss of others (i.e. restrictions on the marine sector). The latter was a complex trade-off, because it involved not just the direct economic loss for fishermen, but also uncertain consequences for rural communities dependent on the fishing sector, and the cultural and historical importance of fishing to Scottish coastal areas. The trade-off with the personal economic loss through taxes seems to have been relatively easy for participants, as indicated by a high confidence during the DCE. However, the second trade-off, appeared to be much more challenging, as can be gathered from participants' comments. This had to do with the little knowledge that most people had on the marine economy and restrictions in general, but also the complex values that participants expressed for the fishing industry. In this respect some researchers have pointed out that one of the valuation challenges, when moral principles are involved, is that own values and values of others can become intertwined and increase complexity for the choice maker (Brennan, 1995; Chan et al., 2012). That means that it might be necessary to pose the question on deep-sea protection in a wider context, taking other societal issues into account. A social survey by Potts et al. (2011) for example found that ocean conservation had a very low priority for the UK general public. Ocean health was ranked last of 11 societal issues, such as the cost of living, the economy, and affordable energy. Only 32% of the UK participants stated that ocean health was "important" or "very important" to them.

The survey by Potts et al. (2011) can help to explain the societal context for the very specific question on deep-sea protection that we asked. It was apparent during our DCE survey that most participants found the topic interesting, but had mostly not thought about the issue of marine protection before being contacted. However, moral concerns for unsustainable deep-sea exploitation that ignores species protection were high. High WTP for protecting deep-sea areas in our study echoes the high WTP for species protection demonstrated by Ressurreição et al. (2011) for the Azores archipelago (Portugal), despite the fact that Portuguese respondents had shown equally low priority for ocean health as the UK (Potts et al., 2011). Potts and colleagues also demonstrated a positive relationship between support for MPAs and the amount of fish consumed on an international level. We found that this relationship appears to exist on a national level as well, as the variable for fish consumption was positively correlated with willingness to pay for deep-sea protection in our sample. The significant positive relationship that we found between protection and being a member of an environmental organisation or being a diver was less surprising. We find that divers had higher WTP for deep-sea protection, possibly because they had seen underwater landscapes (even though not those of the deep-sea) and could better relate to the marine environment, compared with people who had never looked below the ocean surface. Divers' appreciation for the deep-sea environment was therefore significantly higher, even though they will never be able to directly benefit from it in terms of visiting the species and habitats in those depths, whereas members of environmental organisations were expected to seek protection for its own sake (Chan et al., 2012), i.e. without any future direct personal benefit.

4.2 Unfamiliarity and uncertainty in DCE

The classic DCE comprises a bundle of attributes that people are familiar with. For our deep-sea DCE it is apparent that most respondents learnt for the first time about the deep-sea attributes that they were confronted with. Unfamiliarity with an environmental good or issue is not a sufficient reason to abandon the DCE approach (Barkmann et al., 2008). Participants are able to learn during an experiment (Christie et al., 2006) and to tell us about their newly developed preferences based on deeper held moral values (Kenter et al., 2011). Here we follow the arguments of Meinard & Grill (2011), who state that there is no study which shows that people are incapable of expressing their values for something for which they did not have a pre-existing preference and how much they are willing to pay for it. Some researchers go even further when they say that most people do not have clearly defined, pre-existing welfare preferences for environmental goods and services at the point of participation in a valuation survey (Chan et al., 2012). Either way, here it appears that people were able to construct preferences, in this case for new medicinal products, which have obvious benefits. This was despite the fact that the attribute contained some uncertainty about when these medicines would be found and if researchers would be able to identify medicines from deep-sea compounds at all. This framed uncertainty was a reflection of the scientific dispute on the potential of deep-sea organisms for industrial or medicinal use. Maxwell (2005) presented some examples for deep-sea compounds in development for medical use: six out of seven applications were for cancer treatment, thus the potential in the DCE is not exaggerated. However, due to the high costs for deep-sea exploration, part of the science community remains dubious about the success rate of this enterprise

(Leary et al., 2009). We were interested to see the degree of support across the sample to set aside areas to search for potentially interesting substances and found that it was equally important for choices as species protection.

To avoid embedding effects in our survey (i.e. respondents stating their value for the whole marine environment instead of their value for the deep-sea alone) we presented participants with a coloured map highlighting the off-shore areas (i.e. off the Scottish shelf) and emphasised that those were very deep waters below -200m depth. A UK study by McVittie and Moran (2008 & 2010) finds values of similar magnitude to our biodiversity proxy (i.e. species number), for halting loss of marine biodiversity in UK waters (£34.83 and £20.92 respectively). However, the scope of their study was different, as their study used a larger network of MPAs closer to the coast. Following on from the McVittie and Moran study, it would have been interesting to directly compare people's values for coastal waters relative to those of the deep-sea, but this question was beyond the potential of our study. Indeed, there remains some uncertainty if people are able to make the distinction between the benefits obtained from remote areas such as the deep-sea and coastal areas.

Despite respondents' unfamiliarity with the deep-sea, their confidence levels throughout the choice tasks were overall very high and we are confident that using only two relatively easy understandable attributes such as the number of species and potential for medicinal products did not result in comprehension problems. In this sense, our experimental design converted the unfamiliar into the familiar. The good fit of the choice models and the ability to estimate models which explain choices in a rational way, further support the impression that respondents did not have undesirable choice-processing problems during the experiment. We deliberately did not use more abstract terms such as biodiversity as an attribute, which most certainly are more prone to problems of understanding (Meinard & Grill, 2011). Ressurreiçao et al. (2011) and Christie et al. (2006) have shown that in interview or workshop settings such abstract goods can be successfully conveyed to participants, but that was not the data collection method used here.

The considerable WTP expressed by participants for deep sea protection suggests that lack of knowledge rather than the lack of interest explains the near absence of wider societal values associated with deep-sea protection found by Potts et al. (2011). Thus, the lack of ocean literacy undermines the value of marine biodiversity and it is therefore crucial to increase public understanding for ocean ES if their value is to be recognised and accurately accounted for.

4.3 Policy application

It is virtually certain that the provision of ecosystem services would change drastically if we allow marine activities to continue in the same way over the next decades. Nonetheless, there remains much uncertainty about the scope and direction of changes that have to be expected for the ocean as a whole (Ramirez-Llodra et al., 2011). Direct links between deep-sea species and direct benefits to society have not been successfully shown to date, except for the fishing sector (Foley et al., 2010), and might not be shown in the near future. That means that a fully monetary approach to estimate the total economic value of the oceans, using only final ES and ignoring supporting services, would likely drastically undervalue the deep ocean. Protection for the sake of species and habitat diversity should remain a priority, since several deep-sea habitats (e.g. cold-water coral reefs and seamounts) have been identified as biological hotspots (Ramirez-Llodra et al., 2010) and should be protected under the precautionary principle. Regarding trade-offs with the marine industry, the kinds of non-market values that we have identified can help decision makers to justify marine conservation on a more democratic basis than it is often the case today. The value estimates of this study however, should not be used in a full cost-benefit analysis (CBA), as they are not based on a representative sample. The main objective of our study was to explore whether a DCE approach can be used to measure preferences for deep-sea conservation, but further research will be necessary to produce values that may be used in a CBA, since our WTP results reflect the un-representative nature of those who decided to participate in the survey. We have no evidence on the preferences of non-participants.

Given the strong values for potential medicinal products even whilst taking uncertainty into account, we recommend using this ES more often in justification for protecting certain areas, such as hydrothermal vents among others, which host low biodiversity, but have high biotechnological utility (Leary et al., 2009). The possibility of medicines from deep-sea organisms has a huge potential for public outreach programmes, as there is an option value associated with the ES, and survey participants found this topic particularly interesting. To increase appreciation for deep-sea ES in general, more educational programmes are necessary to highlight the potential links between the ocean and societal benefits. We expect that the more certainty arises around actually being able to benefit from ES such as medicinal substances, the higher WTP in future studies such as ours will be.

4.4 Conclusions and further research

Our survey showed that Scottish participants supported the idea of increased protection of deep-sea habitats. Despite very limited public knowledge about such habitats, the results show that given basic information, citizens can be useful participants in policy formation regarding the deep sea. We successfully demonstrated that policy makers are better off to consider the existence value that people associate with species protection in combination with the direct benefits of marine protection, and that overlooking non-users will necessarily lead to undervaluation of marine ecosystems. For the successful transfer of our results to other settings it would be beneficial to look into the cultural differences between countries and how the availability of information (low vs. high amount of information prior to the DCE) affects people's preferences (Hynes et al., 2013). Comparing experts' preferences with that of the general public might be a good indicator in this respect.

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Table 1: Deep-sea ecosystem goods and services

Supporting services	Biodiversity
	Chemosynthetic primary production
	Habitat
	Nutrient cycling
	Resilience and resistance
	Water circulation and exchange
Provisioning services	Carbon sequestration and storage
	Chemical compounds
	Construction and shipping space
	Finfish, shellfish, and marine mammals
	Minerals, and hydrocarbons
	Ornamental objects
	Waste disposal sites
Regulating services	Biological control
	Gas and climate regulation
	Waste absorption and detoxification
Cultural services	Aesthetic, spiritual, and inspirational
	Educational and scientific
	Existence and bequest

Goods and services that are not dependent of deep-sea biota, are greyed out. Source: van den Hove and Moreau (2007), and Armstrong et al. (2010 and 2012) with alterations.

Table 2
Click here to download Table: Table 2.docx

Table 2: Attribute variables and levels used in DCE

MED	Potential for the discovery of new medicinal products from deep-sea organisms. a) High potential and b) unknown potential (baseline).
SP1300 & SP1600	Number of deep-sea species under protection. a) 1600 species (SP1600), b) 1300 species (SP1300), and c) 1000 species (baseline).
COST	Additional annual income tax per household. Levels: £5, £10, £20, £30, £40, and £60.
ASC	Alternative specific constant (1 = BAU).
GEND	Gender (1 = male)
WORK	Working (1 = yes) as opposed to not working, students, or pensioners
AGE	Age (range 18 to 75+ years)
FISH	Fish consumption (0 = ”never eat fish”, 3 = “eat fish at least once per week”)
DIVER	Diver (1 = yes)
NGO	Member of environmental organisation (yes = 1)
SECTOR	Worked in one of the affected marine sectors (1 = yes); either fisheries or oil & gas sector
CONF	Confidence on completing the choice task (0 = not very confident to 4 = very confident)
REST	Economic restriction in the introduction (1 = fisheries and oil & gas sector)

The main attribute variables and the levels that were used for the DCE are listed in the upper block of the table, and interactions with individual specific parameters in the lower block. All interactions were created with the ASC [1 = business as usual (BAU)].

Table 3: Attribute coefficients and WTP estimates for the conditional logit model for the MERGED dataset.

Variable	Coefficient	WTP (£)
ASC (business as usual option)	2.059 (0.904)**	-
MED (high potential for medicinal products from deep-sea organisms)	1.056 (0.065)***	35.43
SP1300 (intermediate level of species protection)	0.670 (0.066)***	22.48
SP1600 (high level of species protection)	1.038 (0.091)***	34.83
COST (additional income tax per household)	-0.030 (0.002)***	-
GEND (male)	-0.732 (0.271)***	
WORK (working)	-0.343 (0.363)	
AGE (years)	-0.008 (0.015)	
FISH (high fish consumption)	-0.374 (0.158)**	
DIVER (some dive experience)	-1.026 (0.556)*	
NGO (member of environmental organisation)	-0.718 (0.406)*	
SECTOR (affiliation with fisheries or oil and gas sector)	0.090 (0.564)	
CONF (very confident about choice)	-0.351 (0.131)***	
REST (restrictions for fisheries and oil and gas sector)	-0.355 (0.281)	

Significance levels are shown as ***, **, * for 1%, 5%, and 10% level respectively. The dataset contained 7146 observations over 397 individuals (max LL = -1938; pseudo R^2 = 0.26; AIC = 3905). Interactions of individual specific characteristics with the BAU are presented in the second part of this table. A negative interaction coefficient indicates that respondents preferred not to stay with the BAU.

Table 4
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Table 4: Attribute coefficients and WTP estimates for the mixed logit model for the MERGED dataset.

Random parameters	Mean of coefficient	WTP (£)
ASC (business as usual option)	2.907 (2.022)	-
MED (high potential for medicinal products from deep-sea organisms)	1.459 (0.108)***	37.85
SP1300 (intermediate level of species protection)	1.012 (0.104)***	26.28
SP1600 (high level of species protection)	1.501 (0.136)***	38.70
	SD of mean coefficient	
ASC	-4.248 (0.471)***	
MED	0.865 (0.118)***	
SP1300	0.000 (0.107)	
SP1600	1.126 (0.472)***	
Non-random parameters	**Fixed coefficient**	
COST (additional income tax per household)	-0.038 (0.002)***	
GEND (male)	-1.701 (0.671)**	
WORK (currently working)	-0.376 (0.806)	
AGE (years)	-0.023 (0.030)	
FISH (high fish consumption)	-0.813 (0.371)**	
DIVER (some dive experience)	-1.402 (1.129)	
NGO (member of environmental organisation)	-1.585 (0.855)*	
SECTOR (affiliation with fisheries or oil and gas sector)	-0.423 (1.133)	
CONF (very confident about choice)	-0.874 (0.188)***	
REST (restrictions for fisheries and oil and gas sector)	-0.575 (0.627)	

The standard deviation (SD) is given for the four random parameters (ASC, MED, SP1300, and SP1600). The dataset contained 7146 observations over 397 individuals (max LL = -1643; AIC = 3322; pseudo R^2 = 0.27; 1000 Halton draws). Interactions of individual specific characteristics with the BAU are presented in the second part of this table. A negative interaction coefficient indicates that respondents preferred not to stay with the BAU.

Table 5: Conditional logit model estimates for DCE attribute coefficients and WTP of the two sampled groups

	Group A		Group B	
Variable	**Coefficient**	**WTP (£)**	**Coefficient**	**WTP (£)**
ASC	1.468 (1.150)	-	2.665 (1.547)*	-
MED	1.100 (0.083)***	35.95	1.010 (0.100)***	34.81
SP1300	0.723 (0.094)***	23.64	0.614 (0.092)***	21.17
SP1600	1.113 (0.133)***	36.38	0.959 (0.124)***	33.04
COST	-0.031 (0.003)***	-	-0.029 (0.003)***	-
GEND	-0.880 (0.363)**		-0.573 (0.416)	
WORK	0.037 (0.442)		-0.931 (0.590)	
AGE	0.002 (0.018)		-0.025 (0.026)	
FISH	-0.389 (0.203)*		-0.324 (0.233)	
DIVER	-1.356 (0.793)*		-0.764 (0.959)	
NGO	-0.450 (0.537)		-1.225 (0.598)**	
SECTOR	0.228 (0.650)		-0.318 (1.098)	
CONF	-0.351 (0.197)*		-0.345 (0.171)**	

Group A with fisheries restrictions (observations = 3744; individuals = 208; max LL = -1038; AIC = 2102; pseudo R^2 = 0.24) and group B with oil & gas sector and fisheries restrictions (observations = 3402; individuals = 189; max LL = -893; AIC = 1813; pseudo R^2 = 0.28). Significance levels are shown as ***, **, * for 1%, 5%, and 10% level respectively. A negative interaction coefficient indicates that respondents preferred not to stay with the BAU.

Figure 1: Choice card example

Figure 1

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SCENARIO 1	Option A	Option B	Option C ("Business as usual")
New medicinal products (potential for the discovery of new medicinal products from deep-sea organisms)	**Unknown** (potential for new medicinal products unknown)	**High potential for new medicines** (protect animals with potential for new medicinal products)	**Unknown** (potential for new medicinal products unknown)
Number of protected species (includes animals such as fish, starfish, corals, worms, lobsters, sponges & anemones)	**1300 species** (300 more than "business as usual")	**1600 species** (600 more than "business as usual")	**1000 species** (base level)
Additional costs (per household per year) £	**£ 5**	**£ 60**	**£ 0**
Your choice for scenario 1 *(please tick A, B or C)*	☐	☐	☐