Ecological Economics 189 (2021) 107142

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Analysis

Have environmental preferences and willingness to pay remained stable before and during the global Covid-19 shock?

Stephen Hynes [a,*], Claire W. Armstrong [b], Bui Bich Xuan [b], Isaac Ankamah-Yeboah [a,f], Katherine Simpson [c], Robert Tinch [d], Adriana Ressurreição [e]

[a] Socio-Economic Marine Research Unit (SEMRU), Whitaker Institute, National University of Ireland, Galway, Ireland
[b] Norwegian College of Fishery Science, UiT, The Arctic University of Norway, Tromsø, Norway
[c] Institute of Biodiversity, Animal Health & Comparative Medicine, University of Glasgow, Glasgow, UK
[d] IODINE Sprl, Brussels, Belgium
[e] University of the Azores, Ponta Delgada, Portugal
[f] College of Basic and Applied Sciences, University of Ghana, Legon-Accra' Ghana

ARTICLE INFO

Keywords:
Covid-19 pandemic
Environmental preference stability
Willingness to pay
Ecosystem management plans
Marine litter
High seas
Flemish cap

ABSTRACT

This study tests the stability of environmental preferences and willingness to pay (WTP) values using a discrete choice experiment (DCE) across three countries pre and post the peak of the first wave of the Covid-19 pandemic. A DCE examining the public's preferences for alternative environmental management plans on the high seas, in the area of the Flemish Cap, was carried out in Canada, Scotland and Norway in late 2019 and was rerun in early May 2020 shortly after the Covid-19 pandemic had officially peaked in the three countries. The same choice set sequence is tested across the two periods, using different but nationally representative samples in each case. Entropy balancing, a multivariate reweighting method, is used to achieve covariate balance between the pre and post Covid samples in the analysis. The results suggest that both preferences and WTP remain relatively stable in the face of a major public health crisis and economic upheaval.

Before the final acceptance of this paper, our friend, colleague and co-author Isaac Ankamah-Yeboah unfortunately passed away after a short illness. As such, this paper is dedicated to his memory.

1. Introduction

The Covid-19 pandemic has demonstrated that a sudden global disaster can have devastating effects on daily lives and the global economy. As the pandemic has spread, concerns over access to the global supply chain for essential goods and services, such as food, water, and shelter, have also grown (O'Hara and Toussaint, 2021). Never in living memory have so many countries been affected by the same crisis, in much the same way, at the same moment in time. The closest comparable event is perhaps the ozone depletion crisis of the late 1980s which saw a reasonably rapid and effective international agreement (the Montreal Protocol) to tackle it. It has been suggested that the current crisis will have brought home to many the reality that the looming climate and biodiversity crises could have even more negative effects on our daily lives and that those effects will be much more long-lasting (Bang and Khadakkar, 2020). Could this lead to a greater willingness to tackle issues such as biodiversity loss, species extinction or the escalating ocean crisis brought about by overfishing, ocean heating, acidification, pollution, etc.? Or will increased uncertainty around job security make people more concerned about their own short-term and long-term finances and less willing to pay for environmental conservation and planning?

As pointed out by Helm (2020) the economic theory of choice provides a good basis for understanding how the Covid-19 pandemic might change such environmental preferences. A cornerstone of the neoclassical theory of demand is that individual preferences are exogenous and defined over all possible states of the world (Tversky and Kahneman, 1991). Preferences will only change if there is a change in the available information. As the crisis has unfolded societies have been digesting much more information online (Jones, 2020; GWI, 2020). The stories that people consume, whether true or false, have also been shown to affect economic outcomes and influence people's decisions on where

* Corresponding author.
E-mail address: stephen.hynes@nuigalway.ie (S. Hynes).

https://doi.org/10.1016/j.ecolecon.2021.107142
Received 19 February 2021; Received in revised form 26 May 2021; Accepted 30 June 2021
Available online 7 July 2021

to invest, how much to spend, and how they prioritise potentially competing interests such as economic prosperity and the environment (Shiller, 2019). People have also been experiencing more of nature and in some instances, cleaner air and less pollution as human activity has reduced during enforced lockdowns.

Against this backdrop, this study examines how the crisis may have impacted people's preferences for ecosystem services and willingness to support conservation efforts using a discrete choice experiment (DCE). This was was run in late 2019 and repeated in early May 2020, across three countries, Canada, Scotland and Norway. This multi-country assessment provides a much broader test than a single-country survey could. It increases the potential robustness of the conclusions drawn on the stability of environmental preferences and willingness to pay (WTP) during a global shock. The DCE was employed to assess the preferences and WTP of each country's residents for several key ecosystem service benefits derived from conservation efforts on the Flemish Cap, an area of the high seas beyond national jurisdiction. In effect, we attempt to answer the question raised but left unanswered by Helm (2020): "*The empirical issue is the extent to which income (and subjective insecurity) and the willingness to pay for environmental goods and services are correlated. In the context of the coronavirus, will lower incomes lead to a lessening of the demand for better environmental outcomes, or will the experience of losing access to nature make it more highly valued?*"

In what follows, Section 2 briefly reviews previous research on the stability of valuation functions and WTP estimates. Section 3 then outlines the survey used in the study while Section 4 briefly introduces the choice modelling framework. Section 5 presents the model results including two sets of choice models for each region. The first set are country-specific multinomial logit models with attribute interaction terms for the post Covid-19 survey period. The second set of country-specific mixed WTP space models are run on the pre and post Covid-19 periods separately. All models include interactions of the status quo alternative with several socio-demographic characteristics. Tests of preference and WTP estimate stability are run on the joint period multinomial logit models and the separate period WTP space models for each country. Finally, Section 6 discusses the broader implications of the results and offers some concluding remarks.

2. The stability of valuation functions and WTP estimates

Environmental valuation is based on standard neoclassical or utilitarian economic theory. Individual agents are assumed to be rational and sovereign with a set of preferences across a range of goods and services that can be ordered, both logically and consistently. A number of axiomatic restrictions are imposed on these preferences in order to derive a utility function. Based on these restrictions, an individual's WTP for environmental goods is taken as a reflection of his/her preferences. The basic rational choice theory allows for WTP estimates to change as variables that co-determine an individual's demand for a good change or as additional information on the good is obtained (Munro and Hanley, 2002). However, the strength of the standard rational choice model derives from the assumption that preferences remain relatively stable. This is what allows the analyst to observe choices in one situation and then draw inferences about choices in related situations. As summarized by Levin and Milgrom (2004) "that preferences are fundamental, focused on outcomes, and not too easily influenced by one's environment and that people are generally to reason through choices and act according to their preferences – that allow economic analysis to yield sharp answers to a broad range of interesting public policy questions".

The stability of preferences, model parameters and WTP estimates have been the subject of a long line of productive research in the field of environmental economics with testing of stability within and between studies and over different time periods, across both DCEs (Brouwer et al., 2010; Hoeffler and Ariely, 1999; Bliem et al., 2012; Liebe et al., 2012; Schaafsma et al., 2014; Czajkowski et al., 2016; Mørbak and Olsen, 2014 and Brouwer et al., 2017) and contingent valuation studies (Loomis, 1989; Loomis, 1989; Carson et al., 1997; McConnell et al., 1998; Whitehead and Hoban, 1999; Berrens et al., 2000; Bliem and Getzner, 2012). McConnell et al. (1998) present eleven earlier studies where researchers indicate stable valuation estimates. The estimates remain stable irrespective of the type of good being valued (public or private); the time between repeated surveys and the tests used to assess the stability of preferences and WTP. In general, the broader literature also points to the relative stability of value estimates over time.

The stability of valuation functions and WTP estimates across time needed in order to undertake value transfer exercises has been the focus of some of the above-mentioned studies as well as others. The robustness of the coefficient estimates within functions from past stated preference studies is a key consideration if they are destined for use in value transfer (Brouwer, 2006; Fetene et al., 2014; Hynes et al., 2018). Ji et al. (2020) were concerned with the temporal reliability of welfare estimates for use in value transfer but from the perspective of revealed preference data. Based on their repeated travel cost models they argue that if issues related to omitted variable bias and model misspecification are adequately accounted for in the study design, then revealed preferences are stable over time.

In the environmental valuation literature related to the use of DCEs, a number of studies have administered the same choice set sequence to the same sample of respondents to test preference and welfare estimation stability. Liebe et al. (2012) and Schaafsma et al. (2014) for example found similar results in terms of choice stability and WTP estimates. However, Schaafsma et al. (2014) found that although WT*P* values remain stable, underlying preferences in the estimated choice models changed significantly over one year. In other work, Brouwer et al. (2017) surveyed the same sample three times over two years using the same choice sets. They found that while there was evidence of inconsistent choices between the three surveys, the underlying preference parameters in the estimated choice models were stable over time. The mean WTP values derived from the DCEs across the three survey periods did however demonstrate a significant decline.

Similar to our study, Bliem et al. (2012) also tested the same choice set sequence over one year, but used different samples, as we do here. Their choice experiment method examined preferences for ecological improvements along the Danube River and they found no significant differences in preferences or marginal WTP estimates for the DCE attributes over time. Indeed, in overviews of the literature testing stability of preferences and WTP, it has generally been concluded that stated preferences and WTP values are stable over short time periods (see McConnell et al. (1998) for an overview of the contingent valuation literature and Mørbak and Olsen (2014) for an overview of the DCE literature in this regard and Rakotonarivo et al. (2017) for a review of the validity and reliability of environmental DCEs more generally).

The DCE study by Lew and Wallmo (2017) is of particular interest as their survey was administered to different samples from the same population and the subject matter was also related to the protection of the marine environment. The intervening period also saw a high level of economic uncertainty as it coincided with the global financial crisis. In their case, the surveys were 17 months apart (spring 2009 and autumn 2010).Their results suggest stability of both preference functions and WTP values across the time periods. Since we are also dealing with different samples in each period, stability is defined as the maintenance of statistically equivalent choice model parameters and statistically equivalent marginal WTP estimates. To be able to compare results across the periods a reweighting method is applied to achieve covariate balance between the pre and post Covid samples in the analysis.

Based on the theory and the available empirical evidence, our a priori expectation is that the relative preferences for the environmental attribute levels in the DCE such as the health of the commercial fish stock, and management of marine litter would remain stable. However, due to heightened uncertainty and concerns over future income, the marginal WTP for the attributes might fall following the widespread

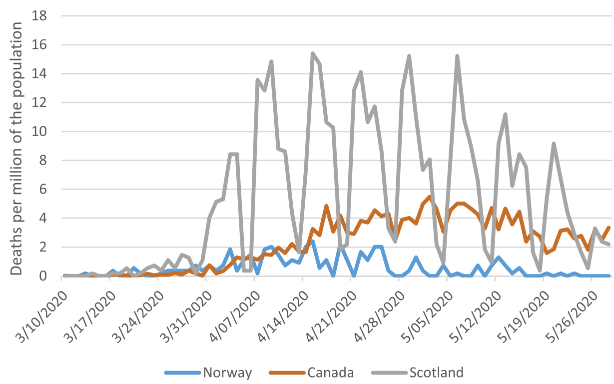

Fig. 1. Covid 19 deaths per million of the population in Norway, Scotland and Canada.
Source: European CDPC – Situation Update Worldwide - Data downloaded 29th May, 11:07 https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases.

onset of the pandemic. This, however, is by no means certain. The concerns over future income could be considered as an increase in the expected marginal utility of income, which would result in lower WTP for the attributes, assuming they are normal goods. On the other hand, it is also possible that option values associated with the environmental attributes could increase WTP following the pandemic if lower incomes and increased uncertainty do not outweigh the increased value put on the unplanned potential need for environmental goods. Variation across the time periods and between the countries may also be expected due to differences in cultures, national policies, the severity of the pandemic across the regions and the economic resources of the countries involved.

In general, the literature suggests the validity of valuation methods concerning the preference stability assumption of consumer choice theory. McConnell et al. (1998) and Morrison and Hatfield-Dodds (2011) do warn however that stable preferences and WTP may also be observed due to poorly designed survey instruments or overly complex information which might tempt respondents to repeatedly use the same heuristics, or cues build into the survey, to answer the valuation question. This is less of an issue when the samples are different across the periods as is the case here. We, therefore, add to this literature by testing for stability of environmental preferences and WTP before the start of the global Covid-19 pandemic and briefly after the peak of the first wave of infections in the three case study countries. No previous study has to our knowledge examined the stability of preferences over such a dramatic upheaval in the lives of so many people on such a global scale.[1]

3. Survey design

This study makes use of an online survey that was carried out in October and November 2019. To test the impact of the Covid-19 pandemic on the public's preferences and WTP the survey was repeated in all three countries from the 7th to the 13th of May 2020. This week was past the peak of the first wave of the pandemic in all three countries. According to the European Centre for Disease Prevention and Control (ECDPC, 2020), this first peak occurred during April in all three countries and was likely the earliest for Norway. This is also evident in the graph of reported daily deaths from Covid-19 per million of the population in Fig. 1. However, though past the peak of the first wave, the three countries were still deeply affected, with several similar public restrictions still in place.

The original survey aimed to obtain information relating to the Canadian, Norwegian and Scottish publics' preferences for the management of the ecosystems on the Flemish Cap. The Flemish Cap is an oceanic bank of high ecological productivity located about 600 km to the east of Newfoundland, in an area beyond national jurisdiction and within the Northwest Atlantic Fisheries Organization (NAFO) regulatory area. A DCE was included in the survey instrument to generate data for the estimation of the public benefit value of such conservation planning. The survey of public preferences towards protecting high-sea ecosystems on the Flemish Cap was designed based on previous surveys of public preferences for protecting national deep-sea ecosystems conducted in Norway and Scotland (Ankamah-Yeboah et al., 2021). The survey design followed best practice guidelines (Johnston et al., 2017) and is further described in Xuan et al. (2021) who present results using the original 2019 dataset.[2]

The questionnaire was pretested in two focus groups held with the general public in Norway. Following the focus groups, a survey instrument was finalised for a pilot-test with 50 respondents in each country. While no further issues were raised with the survey instrument in the pilot-test phase, the responses were used to establish the choice sets for the main survey. The market research company YouGov Norway Ltd. was employed to collect the data for the pilot and both pre and post Covid-19 (henceforth we use post Covid-19 to denote the survey carried out during the Covid-19 crisis) main surveys using their established online panel of the general public in all three countries. The questionnaire and DCE were the same across all three countries for both pre and post Covid-19. The samples were different across both phases of the survey in each country but the individuals were chosen to be representative of the respective populations in each case. A total of 501, 503, and 503 respondents took part in the Canadian, Norwegian, and Scottish surveys, respectively in the pre Covid-19 run of the survey. A further 500, 500, and 508 respondents took part in the Canadian, Norwegian, and Scottish post Covid-19 wave 1 surveys, respectively.

As commonly presented in environmental DCEs, each choice card included three options: a status quo option describing the attribute levels that would be achieved in the future if there was no further change from the current management plan and is associated with no additional financial cost to respondents, and two experimentally designed management plan alternatives representing management plans that would lead to improvements in the delivery of the ecosystem service benefits, denoted by varying attribute levels, and a positive cost. Each respondent was provided with eight choice cards and asked to select their most preferred option in each case. Of the five attributes that appeared in each choice card (as shown in Table 1), three were associated with the environmental aspects of high seas management, one with economic development in the area, and one with the cost of the proposed management plan option. The cost attribute was presented as an annual income tax increase, expressed in currency units corresponding to each country where the survey was conducted. Given that the Flemish Cap is

[1] Even in the case of Lew and Wallmo (2017) the gap between surveys occurs after the start of the Great Recession and it is interesting that the authors only make one reference in a footnote to the fact that this is a period of economic uncertainty where they state that the "study occurred during the first few years of the Great Recession, during which average household incomes fell as unemployment rose and multi-generational households increased".

[2] The original survey was carried out as part of the EU Horizon 2020 ATLAS project and was concerned with the assessment of ecosystem service benefits derived from protecting ecosystems in the high seas. Given an interest in determining WTP for marine ecosystems beyond national jurisdictions and in examining distance decay effects the survey was carried out across the three countries of Canada, Norway and Scotland. This is reported on in Xuan et al. (2021). Given the timing of the original survey, the fact it was conducted in three countries and the fact that there was funding available to redo the survey the authors thought it was an ideal opportunity to test the possible impacts of the pandemic on environmental preferences and WTP. Xuan et al. (2021) also provide a detailed description of the study area in terms of location, the main ocean economy activities taking place, the existing governance structure, its main habitats and its historical significance. A map of the area is also provided.

located in international waters, if such a tax was to be implemented it should be applied proportionally in all countries, taking into account non-use values, or at a minimum those that effectively use the area (i.e. taking into account use-values).[3] The status quo alternative had the same attribute levels across all choice cards while the attribute levels of the alternative management plan options varied on each card based on the efficient design of the choice experiment.

In deciding on the choice task design, a Bayesian D-efficient experimental design optimized for the multinomial logit model using the NGENE software (ChoiceMetrics, 2018; Hoyos, 2010) was employed. To generate the efficient design, priors for the unknown model parameters were first established based on similar surveys carried out in Norway and Scotland and used to generate the experimental design in the pilot survey. Data from the pilot was then analysed and the resulting parameter estimates used as new priors in NGENE to generate a more efficient design for the DCE in each of the main pre Covid-19 survey instruments. To ensure consistency across time periods no further updates of the design were carried out for the post Covid-19 run of the survey, i.e. the exact same DCE was run in the main surveys for each country both pre and post Covid-19. The three final designs comprised 16 choice tasks that were assigned into two blocks of eight choice cards. Respondents were randomly allocated to one of the blocks. An example choice card was then presented (Fig. 2).

In the final survey instruments, respondents were given background information on the Flemish Cap, including what its high seas status means and how it is currently managed. For the DCE, respondents were first informed that: "Changing environmental conditions and human activities can have major impacts on the distribution and sustainability of the Flemish Cap's seas and wildlife. NAFO[4] has closed a number of areas to protect coral and sponges from the harmful impacts of bottom trawling but scientists have recommended that more areas should be closed to bottom trawling. As a taxpayer, you can contribute to marine management in the high seas. Funding these new management options involves a cost to taxpayers so it is important that you are invited to give your opinion on the plans". Respondents were encouraged to think about the different management plan "attribute bundles", to imagine actually paying the amounts specified and to consider their own budget and ability to pay when considering each option.

Respondents were then presented with a description of the five attributes used in the choice cards; the health of commercial fish stocks, the density of marine litter, the size of the area that is protected, the possible expansion of the ocean economy in the area associated with the creation of new marine-related jobs (Blue Growth[5]) and the price of each management option. The original surveys in this study were carried out as part of the EU ATLAS project that amongst other things developed indicators of Good Environmental Status (GES) for the deep seas in the North Atlantic Ocean as defined in the EU Marine Strategy Framework Directive and generated insights for potential economic developments in this region as outlined under the EU Blue Growth Strategy. The choice of attributes used for the survey design was guided by what the ATLAS marine scientists deemed was most relevant for the EU policy-making community when making decisions about the deep seas. The levels of each environmental attribute were selected based on expert opinion and best available scientific evidence from the marine scientists in the project while estimates of current economic activity in the study area and knowledge of the Canadian scientists on the Atlas project working in the case study area were used to develop the levels for the marine jobs attribute (Kazanidis et al., 2020).[6] The levels used for the cost attribute were derived from the focus group discussions and also informed by other valuation work under the ATLAS project carried out on home water ecosystem service delivery in Norway and Scotland. The levels of the cost attribute used in three surveys (in national currency) were adjusted for differences in income levels between the countries using purchasing power parity indices from the OECD (2018). The description of these attributes and their levels are presented in Table 1.

Following the DCE, a series of questions were asked to determine if

Table 1
Attributes and levels description.

Attribute Definition	Levels	Variable Name used in Models
Health: % of commercial stocks at healthy stock levels.	High (>80%) Moderate (40–80%) Low (<40%)	Health3 Health2 (base case)
Litter: Density of marine litter measured as number of items of litter per square distance unit (km2 in Canada and Norway, and mile2 in Scotland)	Good (0 to 1) Moderate (2 to 4) Poor (5 to 8)	Litter3 Litter2 (base case)
Area[a]: size of protected area as % of the area of the Flemish Cap	35% of the Flemish Cap 30% of the Flemish Cap 25% of the Flemish Cap 21% of the Flemish Cap	Area4 Area3 Area2 (base case)
Jobs: number of marine economy jobs created from sea based commercial activities in the area	+ 200 + 100 No employment change	Jobs3 Jobs2 (base case)
Additional costs: Unit currency per person per year	**Canada (CA $)**: $10, $20, $40, $60, $80, $110; **Norway (kr)**: 100kr, 150 k, 300kr, 450kr, 650kr, 850kr; **Scotland (£)**: £5, £10, £20, £30, £40, £60 [0 for status quo options]	Cost

[a] The area to be protected was also described in the survey instrument as an approximate of familiar geography. In the case of Scotland it was compared to the equivalent proportion of Northern Ireland and Scotland together. In the case of Norway it was compared to the equivalent proportion of Denmark and in the case of Canada it was compared to the equivalent proportion of Vancouver Island.

[3] Information on the average conversion rates during the survey periods for the pre and post covid samples are provided as Supplementary Material (Table S1). The rates suggest no major inter-temporal monetary effects between the two periods.

[4] NAFO is the Northwest Atlantic Fisheries Organization, a multi-national regional fisheries management organization for the high seas of the Northwest Atlantic.

[5] Blue Growth refers to the potential for innovation, economic growth, and job creation from the use of ocean resources. It has been argued that people may not only have preferences for their own job or job opportunities but may also derive satisfaction from knowing about the existence or creation of other jobs, a concept referred to in the choice experiment literature as the non-use value of employment (Morrison et al., 1999; Bennett and Blamey, 2001; Aanesen et al., 2018). The jobs attribute may though be seen as having a more direct impact on the economy and therefore may be viewed as having some quasi-use value also.

[6] No constraints on attribute level combinations were imposed in the experimental design. Generally marine litter may have a negative impact on health of commercial fish stocks but as can be seen from the levels used in this case, in the deep sea what the marine scientists considered a bad level involves relatively few item of litter that were not expected to impact the fish stocks in the same way as in other parts of the ocean. Also it is possible that there could be negative interaction between the environmental attributes and the jobs attribute and following the description of economic activity in the case study area in the survey instrument respondents were informed that "Development of such economic activities could generate more jobs internationally but could also lead to negative effects on the unique ecosystems in the area." This was followed up however with a description of the policy goal of blue growth where the aim is to have development such that the marine economic activity is in balance with the long-term capacity of marine ecosystems to deliver their services. As such it was felt that the highest level for the economic attribute could be allowed with the highest levels of fish health, litter and area to be protected.

SCENARIO 1		Option A	Option B	Option C (current management)
Health of commercial fish stocks		**Moderate:** 40% to 80% of commercial stocks at healthy stock levels	**Low:** <40% of commercial stocks at healthy stock levels	**Low:** <40% of commercial stocks at healthy stock levels
Density of Marine litter		**Good** (0 to 1 item of litter per km^2)	**Poor** (4 to 6 items of litter per km^2)	**Poor** (4 to 6 items of litter per km^2)
Size of protected area		**30%** of the area of the Flemish Cap	**35%** of the area of the Flemish Cap	**21%** of the area of the Flemish Cap
Marine economy jobs created from sea based commercial activities in the area		**+ 100** jobs	**+ 200** jobs	No employment change
Additional costs (per person per year)	CAD	CAD 10	CAD 80	CAD 0
Your choice for scenario 1 *(please tick A, B or C)*		☐	☐	☐

Fig. 2. Sample choice card.

the respondents ignored any of the attributes informing their choices and to acquire an explanation if respondents picked the status quo option on all choice occasions. Further questions were asked related to the socio-demographic profile of respondents and their marine-related activities.

4. Methodology

The econometric analysis of the two-period DCE used in this study was based on the standard random utility modelling framework developed in psychology by Thurstone (1927) and popularized by McFadden (1974). The random utility model (RUM) assumes that individuals are rational utility maximizers who will choose alternative options of a good that gives the greatest utility. The utility obtained by person n from choosing alternative j in choice task t can be decomposed into two separable parts; the systematic and stochastic components and can be expressed as:

$$U_{njt} = V_{njt} + \varepsilon_{njt}; n = 1, 2, \dots, N; j = 1, 2, \dots, J; t = 1, 2, \dots, T \quad (1)$$

where U_{njt} is the unobservable but the true utility of respondent n obtained from choosing alternative j in a choice set t. The term V_{njt} captures the systematic or observable part of the overall utility and e_{njt} is the stochastic error term that is independent and identically distributed (IID) extreme value. The systematic component is a function of the observable attributes of the chosen alternative in the choice task and the observable characteristics of the respondent which can also generally be expressed as

$$V_{njt} = \beta X_{njt} \quad (2)$$

where X_{njt} represent vectors of attributes (including both monetary and non-monetary attributes) of the good. β is a vector of unknown parameters to be estimated and correspondingly represent attribute preferences (including alternative specific constants) and how they vary with respondent characteristics. The expression in (2) substituted in (1) is a multinomial logit (ML) model which is the natural starting point for estimating parameters. However, it imposes the independence of irrelevant alternatives (IIA) assumption, that states that the odds of choosing alternative A over B should not be affected by the presence or absence of alternative C (Hensher and Greene, 2003). Violations of this assumption are common in the literature and result in biased estimates of parameters. Also, preferences are assumed to be homogeneous across the population.

Instead, a mixed multinomial logit (MML) model relaxes the IIA assumption and incorporates preference heterogeneity by allowing parameters in the model to vary across individuals in the population with density function $f(\beta)$. The MML model is highly flexible, allows for the modelling of panel data and can approximate any random utility model (McFadden and Train, 2000; Sillano and de Dios Ortúzar, 2005). The MML incorporates unobservable heterogeneity by modelling the distribution of β_n as $\beta_n = \beta + \eta_n$, which has mean β and variance $var(\eta_n)$. The distributions of the random parameters are commonly assumed to be normal though researchers can also assume them to be exponential, lognormal, triangular, amongst others (Hensher et al., 2005). The choice probability of the MML can be expressed as:

$$P_{njt} = \int \frac{e^{\beta X_{njt}}}{\sum_j e^{\beta X_{nit}}} f((\beta|\theta)d\beta)$$

where θ contains the means and variances. The MML cannot be solved analytically since the related integral does not have a closed form solution. The choice probability can therefore be estimated through simulation and the unknown parameters can be estimated by maximizing the simulated log-likelihood function. Interested readers are hereafter referred to Hensher and Greene (2003) for a detailed description of the computational approach.

A common goal of using choice models is the calculation of marginal WTP estimates for the choice attributes. For models in preference space, such as the ML and MML, the marginal WTP for an attribute is calculated by the ratio of each attribute's coefficient to the price coefficient. Given the already noted limitations with the ML model, the associated WTP estimates may not be reliable. As Train and Weeks (2005) point out, even in the case of the MML, where heterogeneity in preferences and the panel nature of the data can be controlled for, the ratio of two randomly distributed parameters will cause a skewed distribution of WTP. Many applications of the MML, therefore, specify the price's coefficient as fixed so that WTP values do not 'explode' but this assumes that all individuals have the same preferences for the price which may be unrealistic and can still lead to biased estimates (Meijer and Rouwendal, 2006).

To overcome this problem Train and Weeks (2005) suggest the WTP is directly estimated by reformulating the MML model such that the WTP of attribute coefficients are directly obtained. Based on eq. 1 and 2, the price attribute from the vector of attributes can be made separate such that

$$U_{njt} = \beta_n X_{njt} + \alpha_n p_{njt} + \varepsilon_{njt} \tag{3}$$

where p_{njt} denotes the price attribute and α_n is the random parameter for price. Following Train and Weeks (2005) it is assumed that ε_{njt} is extreme value distributed with variance given by $k_n^2(\pi^2/6)$ where k_n is an individual-specific scale parameter. As discussed by Tu et al. (2016) dividing eq. 3 by k_n does not affect behaviour and results in a new error term which is IID extreme value distributed with variance equal to $\pi^2/6$ such that:

$$U_{njt} = c_n X_{njt} + \lambda_n p_{njt} + \varepsilon_{njt} \tag{4}$$

where $\lambda_n = \alpha_n/k_n$, $c_n = \beta_n/k_n$ and $\varepsilon_{njt} = \varepsilon_{njt}/k_n$.[7] Since the marginal WTP for the attributes is given by $\gamma_n = c_n/\lambda_n$ eq. 4 can be written as utility in WTP space such that:

$$U_{njt} = \lambda_n \left[\gamma_n X_{njt} + p_{njt}\right] + \varepsilon_{njt} \tag{5}$$

The mixed WTP space model is estimated using a maximum simulated likelihood estimation approach. Given that the country-specific samples are different in the pre and post Covid-19 period it could be the case that there are differences in the underlying characteristics of individuals across the periods that influence the choices made, making it difficult to disentangle the true effect of the pandemic on preferences and WTP. Therefore, Entropy balancing (EB) is used to reweight the pre Covid-19 samples to be similar to those in the post Covid-19 samples, in terms of the mean, variance, and skewness of a range of observed covariates (Hainmueller, 2012).

Deriving a causal conclusion from observational data such as presented in this paper is difficult because the treatment exposure of having experienced the effects of the global pandemic may be related to some covariates that are also related to the choice outcome. In such cases, those covariates may be imbalanced between the treatment and control groups and the naive mean causal effect estimator can be severely biased. EB, a multivariate reweighting method, is used as a preprocessing technique to achieve covariate balance in such situations. It involves a reweighting scheme that directly incorporates covariate balance into the weight function that is applied to the sample units. The balanced samples can then be used for the subsequent estimation of treatment effects. As discussed by Hynes et al. (2020) the EB reweighting approach has desirable appeal in discrete choice modelling when the researcher is interested in possible differences in preference parameters between one group (referred to as the treatment group) and a counterfactual comparison group (referred to as the control).

As described by Hainmueller (2012) when applying the reweighting method the researcher begins by imposing a set of balance constraints, which imply that the covariate distributions of the treatment and control group in the preprocessed data match exactly on all prespecified moments (mean, variance and skewness in our case). The EB approach then searches for the set of weights that satisfies the balance constraints but remains as close as possible (in an entropy sense) to a set of uniform base weights to retain information. This recalibration of the unit weights effectively adjusts for systematic and random inequalities in representation. Once the covariate distributions are adjusted and the EB weights fitted, the estimated individual level weights are incorporated into the log-likelihood function of the choice models to examine the impact of the Covid-19 pandemic on a person's environmental preferences and WTP for marine ecosystem conservation (Hainmueller and Xu, 2013).[8] Only variables that were considered not to be significantly impacted by Covid-19 were included in the matching process.

The first set of country-specific ML preference space models pool the pre and post survey observations and include attribute interaction terms for the post Covid-19 survey period. In this case, the coefficients on the covid attribute interaction terms capture the mean difference between pre and post Covid-19 preferences. The second set of country-specific mixed WTP space models are run separately for each period sample for each country. The simulation across the models are performed using 500 Halton draws for each sampled respondent. The coefficients for the fish health, marine litter, jobs and cost attributes are assumed to have lognormal distributions implying that WTP for these attribute level dummies is positive for all individuals relative to the attribute base case. The area attribute dummies are assumed to be normally distributed as it has been shown previously that when it comes to preferences for the size of the sea area to be conserved some persons prefer the smaller sized options (Hynes et al., 2020).

The estimated mean and standard deviation (SD) coefficients for the area attribute dummies can be directly interpreted as estimates of the WTP relative to the base case. However, the reported mean and SD estimates of the remaining attribute coefficients which are assumed to be log-normally distributed are interpreted as the mean and SD for the log of the WTP coefficients. The coefficient of cost is interpreted as the estimated mean of the log of the price coefficient. While the same interaction terms of socio-demographic variables with the status quo ASC as in the ML model were also included as controls in the mixed WTP space models, in the interest of space they are not reported here but supplied as supplementary material.

Following the ML model estimations, the joint significance of the attribute post Covid-19 survey interaction terms in each model is tested, using a χ^2test. This is equivalent to testing if the estimated conditional preference parameters β in the utility function of the pre and post populations are the same. Whether there is equality in the estimated mean WTP across both surveys is examined through analysis of the WTP confidence intervals in the ML preference space model and testing of the difference in WTP estimates across the pre and post Covid-19 periods and through analysis of the WTP parameter estimates in the mixed WTP space model. A Poe et al. (2005) test of the difference in the two empirical distributions of the individual level WTP coefficients from each of the mixed WTP space models is also carried out. Therefore, the two hypotheses tested are:

$$H_0^1 : \beta_{n,pre\ Covid19} = \beta_{n,post\ Covid19}$$

[7] ε_{njt} and U_{njt} should strictly speaking have new notations following division by k_n. However, the same notations are maintained for brevity and readability following Train and Weeks (2005).

[8] For a detailed presentation of the EB reweighting method, the interested reader is directed to Hainmueller (2012).

Table 2
Summary Statistics per country, Mean (Std. Dev.) pre and post Covid-19 Crisis.

	Canada		Norway		Scotland	
	Pre Covid	Covid	Pre Covid	Covid	Pre Covid	Covid
Age	45.9 (16.0) *	49.2 (16.9)	46.9 (17.3) *	46.4 (16.9)	49.1 (17.3) *	50.4 (17.0)
Male	0.49 (0.50)	0.48 (0.50)	0.50 (0.50)	0.50 (0.50)	0.47 (0.50)	0.47 (0.50)
Third level education	0.66 (0.47) *	0.70 (0.46)	0.66 (0.47) *	0.71 (0.45)	0.75 (0.43) *	0.62 (0.48)
Full time employed	0.42 (0.49) *	0.35 (0.48)	0.35 (0.48) *	0.43 (0.50)	0.41 (0.49) *	0.37 (0.48)
Part time employed	0.14 (0.35)	0.13 (0.34)	0.13 (0.34)	0.13 (0.34)	0.16 (0.37)	0.15 (0.35)
Currently a student	0.07 (0.25)	0.05 (0.21)	0.11 (0.32)	0.09 (0.29)	0.05 (0.21)	0.05 (0.22)
Unemployed	0.16 (0.37) *	0.20 (0.40)	0.06 (0.24)	0.06 (0.23)	0.06 (0.24) *	0.12 (0.33)
Married or cohabiting with partner	0.49 (0.50)	0.50 (0.50)	0.56 (0.50) *	0.53 (0.50)	–	0.58 (0.49)
Number in Household	2.58 (1.39) *	2.50 (1.35)	2.33 (1.30) *	2.47 (1.37)	2.54 (1.35) *	2.37 (0.00)
Member of Environmental Organization	0.04 (0.20)	0.03 (0.18)	0.09 (0.28)	0.08 (0.27)	0.04 (0.20)	0.02 (0.13)
Marine sports enthusiast	0.43 (0.49)	0.40 (0.48)	0.62 (0.48)	0.63 (0.48)	0.61 (0.49) *	0.66 (0.47)
Agrees with statement that "Economic growth is more important than protecting the marine environment"	0.19 (0.39) *	0.15 (0.35)	0.17 (0.38) *	0.14 (0.35)	0.06 (0.24)	0.08 (0.27)
Had heard of the Flemish Cap's deep seas and wildlife previously	0.24 (0.43)	0.25 (0.44)	0.20 (0.40)	0.18 (0.39)	0.16 (0.37)	0.15 (0.35)
Respondent or member of household employed in sea related industry	0.05 (0.23)	0.04 (0.19)	0.09 (0.34)	0.09 (0.28)	0.05 (0.21) *	0.07 (0.25)
Number of Respondents	501	500	503	500	503	508

Figures outside brackets are the means while figures inside brackets are the standard deviations. * indicates significant average difference between pre and post Covid-19 samples at 95% significance level. For the continuous variables of age and income a two sample t test was employed while for the remaining dummy variables that indicate proportions a two sample z test was used.

$$H_0^2 : WTP_{pre\ Covid} = WTP_{post\ Covid}$$

5. Results

Table 2 provides summary statistics for the pre and post Covid-19 samples for each country. Two-sample *t*-tests were used to examine whether the mean of age and income are equal across the time periods while for the remaining dummy variables that indicate proportions, two-sample z tests were employed. The tests suggest some differences in the pre and post Covid-19 samples. There are statistical differences in age, third level education, full-time employment and number in household across all three samples. The gender and age distribution in all three country samples are close to the known Census of population national statistics. Across all three countries, the proportion of the samples with third level education are higher than the national average.[9] As expected the unemployment levels increase and average incomes fall over the time periods in both Canada and Scotland. The unemployment level remains unchanged in the Norwegian sample however and average income increases marginally although the difference is not statistically significant.

Even though the economies in all three regions would have taken a significant hit over the period the proportions that agree or strongly agree with the statement that "economic growth is more important than protecting the marine environment" significantly falls in both Canada and Norway. For the Scottish survey, agreement with this statement sees a slight but significant increase. In absolute terms, however, the Scottish sample has a much lower agreement with the statement than either Canada or Norway perhaps reflecting the economic importance of the sea to the latter economies compared to Scotland. In the Norwegian and Canadian case it may also be the fact that during the pandemic, people became increasingly conscious of the value of nature (Morse et al., 2020).

The results of Table 2 imply that the mean of a number of the socio-demographic characteristics are significantly different at a 5% level between the pre Covid and post Covid periods. Results based on the comparison of such unbalanced covariates will not be reliable. The EB matching method is therefore used to construct more balanced samples for use in the DCE analysis. Respondents in the pre Covid samples were weighted to meet the targets of balance on the three moments (mean, variance, and skew) of seven independent variables; age, gender, third level education, marine sports enthusiast, currently a student, married and had heard of Flemish Cap previously. The EB procedure produces an almost perfect balance between the pre and post Covid 19 samples across all observed covariates. The individual-level EB weights generated in the preprocessing step were stored for use in the subsequent discrete choice analysis where they enter the log-likelihood function of the chosen models.

We first present a weighted ML model (without random parameters) results to establish a baseline. As pointed out by an anonymous reviewer of an earlier version of the paper, the extra layer of complexity and estimation procedure of mixed WTP space models (or even mixed preference-based models) could mask important preference changes after Covid-19 that may be observed in a standard conditional logit model. While the mixed choice model formats have certain advantages,

[9] As detailed in Table 2 of Xuan et al. (2021) where the authors compare the summary statistics of the original sample to national level population averages the representativeness of the samples was deemed satisfactory. Only in the case of third level education, was there an observed oversampling across all the three countries and this was also observed in the repeat survey. This is particularly so for the pre Covid-19 Scottish sample although this falls by 13 percentage points in the second period so that it is comparable to the other countries.

Table 3
Multinomial Logit Models with Post Covid-19 Interaction Effect.

	Canada		Norway		Scotland	
	Coefficient	*Standard Error*	*Coefficient*	*Standard Error*	*Coefficient*	*Standard Error*
Health3	0.591***	(0.059)	0.664***	(0.058)	0.932***	(0.064)
Health2	0.437***	(0.058)	0.543***	(0.061)	0.706***	(0.069)
Litter3	0.630***	(0.060)	0.746***	(0.059)	1.286***	(0.063)
Litter2	0.421***	(0.062)	0.483***	(0.061)	1.003***	(0.066)
Area4	0.266***	(0.065)	0.354***	(0.064)	0.458***	(0.078)
Area3	0.221***	(0.062)	0.060	(0.069)	0.270***	(0.073)
Area2	0.208***	(0.061)	−0.009	(0.067)	0.099	(0.075)
Jobs3	0.258***	(0.057)	0.219***	(0.054)	0.268***	(0.059)
Jobs2	0.180***	(0.058)	0.194***	(0.059)	0.409***	(0.066)
Cost	−0.007***	(0.001)	−0.001***	(0.000)	−0.015***	(0.001)
Asc3	−0.760***	(0.227)	−0.276	(0.204)	−0.712**	(0.305)
Covid-19 Interactions						
Health3*Covid	−0.072	(0.081)	−0.089	(0.081)	0.068	(0.085)
Health2*Covid	−0.005	(0.080)	−0.112	(0.084)	0.056	(0.092)
Litter3*Covid	0.039	(0.083)	0.034	(0.081)	0.004	(0.085)
Litter2*Covid	0.039	(0.085)	0.088	(0.084)	−0.092	(0.089)
Area4*Covid	−0.059	(0.090)	−0.039	(0.089)	−0.111	(0.101)
Area3*Covid	0.003	(0.086)	0.005	(0.095)	−0.037	(0.097)
Area2*Covid	−0.042	(0.085)	0.002	(0.093)	−0.012	(0.099)
Jobs3*Covid	−0.002	(0.079)	−0.087	(0.074)	0.007	(0.078)
Jobs2*Covid	0.002	(0.080)	0.077	(0.081)	−0.134	(0.088)
Cost*Covid	−0.001	(0.001)	−0.000	(0.000)	0.001	(0.002)
Asc3*Covid	0.461	(0.297)	0.512*	(0.264)	0.990**	(0.404)
Interactions with Status Quo Alternative (Asc3)						
Age	0.002	(0.004)	−0.009***	(0.003)	0.009**	(0.005)
Male	−0.111	(0.112)	−0.141	(0.109)	−0.309*	(0.165)
Third level education	0.138	(0.122)	0.092	(0.109)	−0.429***	(0.155)
Full time employed	0.198	(0.122)	−0.216*	(0.121)	−0.071	(0.184)
Unemployed	−0.008	(0.156)	0.066	(0.197)	0.744***	(0.253)
Married or cohabiting	−0.411***	(0.116)	0.188*	(0.114)	0.058	(0.127)
Marine sports enthusiast	0.163	(0.114)	0.214*	(0.114)	0.315*	(0.166)
Had heard of the Flemish Cap previously	−0.219	(0.141)	0.074	(0.131)	−1.002***	(0.262)
Age*Covid	−0.007	(0.005)	0.006	(0.004)	−0.016***	(0.006)
Male*Covid	0.225	(0.155)	−0.141	(0.141)	0.435**	(0.209)
Third level education*Covid	−0.504***	(0.161)	−0.088	(0.153)	−0.542***	(0.202)
Full time employed*Covid	−0.182	(0.173)	−0.231	(0.158)	−0.198	(0.235)
Unemployed*Covid	0.331	(0.203)	−0.373	(0.283)	−1.154***	(0.329)
Married or cohabiting*Covid	0.751***	(0.155)	−0.643***	(0.148)		
Marine sport enthusiast*Covid	−0.116	(0.152)	0.016	(0.151)	−0.007	(0.216)
Had heard of the Flemish Cap previously*Covid	−0.374*	(0.192)	−0.559***	(0.186)	1.312***	(0.312)
Log likelihood	−7222		−6989		−6099	
Wald Chiˆ2 statistic (37)	1783		1564		2967	
Pseudo R^2	0.15		0.13		0.30	
Observations	23,280		21,984		23,808	

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

these advantages are not necessarily critical to the hypothesis being tested. Therefore the first set of country-specific, joint period estimated, ML models are shown in Table 3 and the corresponding marginal willingness to pay estimates are shown in Table 4.

For the analysis, we restricted the samples used in each case to those respondents who did not serially choose the status quo option as a protest response.[10] The models include the choice attribute level dummies and interaction terms of the attribute level dummies and the cost variable, with the post Covid-19 sample (0/1) indicator. Interaction terms of several socio-demographic variables with the alternative specific constant, and in turn with the Covid-19 indicator are also included as controls. As is evident from Table 3 the base attribute coefficients are highly significant across the board for the Canadian model. For the Scotland model, only the lowest level for the area to be protected (Area2) is insignificant. In the case of Norway both the medium (Area3) and the lowest level for the area to be protected (Area2) are insignificant.

The highest levels of the marine litter, commercial fish health and area protected attributes shows the highest intensity of preferences across all countries, respectively. The relative magnitude of the jobs attribute levels would suggest that respondents in all countries have a higher preference for environmental protection rather than blue growth on the high-seas. It is also possible that respondents perceived the changes in economic activity presented by the jobs on the choice cards to be relatively low so may have put a lower value on this attribute. As expected, the coefficient on cost is negative and significant, suggesting that ceteris paribus, respondents prefer to pay lower amounts of additional taxation. The alternative specific constant for the status quo

[10] Protesters were determined by follow-on questions after the choice experiments for those who only chose the status quo option in the choice cards, asking why they had done so. Observations were removed if the reason for continuously choosing the status quo option was that they believed the government should pay from existing revenue, they did not believe any protection management scheme would be implemented or they objected to paying for marine ecosystem protection. It resulted in 31, 87 and 19 individuals being dropped from the approximately 1000 observations in each of the Canadian, Norwegian and Scottish samples, respectively. As recommended by Villanueva et al. (2017) further information on the status quo responses and the reasons for serially choosing the Status Quo option is provided in table S3 in the Supplementary Material to the paper. A frequency table displaying self-declared attendance to attributes in the pre and post samples is also provided.

Table 4
Marginal WTP (Canadian Dollars) based on multinomial logit model results.

Attribute level	Canada		Norway		Scotland	
	Pre Covid	Post Covid	Pre Covid	Post Covid	Pre Covid	Post Covid
Health3	83.36 (66.44, 103.99)	63.51 (50.32, 78.06)	67.59 (56.42, 79.76)	57.01 (46.76, 67.56)	72.68 (60.51, 87.31)	84.47 (71.58, 100.45)
Health2	61.66 (44.84, 81.53)	52.88 (39.29, 68.90)	55.27 (43.34, 69.39)	42.69 (32.02, 54.77)	55.11 (43.59, 68.80)	64.43 (52.70, 78.49)
Litter3	88.84 (71.16, 111.77)	81.86 (67.23, 100.15)	75.96 (64.41, 89.92)	77.28 (66.46, 90.41)	100.36 (86.25, 119.33)	109.05 (94.52, 128.87)
Litter2	59.36 (43.72, 77.37)	56.22 (43.36, 70.91)	49.14 (38.16, 61.72)	56.51 (46.06, 68.51)	78.24 (65.89, 94.18)	77.02 (65.07, 92.35)
Area4	37.51 (19.16, 57.15)	25.37 (10.78, 40.85)	36.02 (22.99, 49.50)	31.15 (19.21, 43.66)	35.72 (23.70, 48.67)	29.29 (18.71, 40.95)
Area3	31.21 (14.27, 50.40)	27.39 (13.42, 42.92)	6.09 (−7.33, 20.13)	6.46 (−5.86, 19.62)	21.08 (9.88, 33.18)	19.68 (9.26, 31.01)
Area2	29.32 (12.10, 46.74)	20.34 (6.35, 34.24)	−0.88 (−14.17, 12.12)	−0.66 (−12.97, 11.29)	7.72 (−3.85, 18.77)	7.32 (−3.50, 18.06)
Jobs3	36.46 (21.38, 52.63)	31.41 (18.80, 44.67)	22.33 (11.38, 33.74)	13.09 (3.49, 23.37)	20.92 (12.03, 31.04)	23.22 (14.95, 32.72)
Jobs2	25.33 (9.78, 41.41)	22.26 (9.33, 35.13)	19.78 (8.43, 32.03)	26.92 (16.33, 38.36)	31.88 (21.45, 43.51)	23.20 (13.67, 33.86)

95% Confidence interval in parenthesis. Exchange rates used to convert all results into Canadian dollars: 1 Norwegian Krone equals 0.14 CA dollars and 1 pound sterling equals 1.71 CA dollars.

alternative (ASC3) variable is negative and significant for Canada and Scotland but is insignificant in the Norwegian case. However, the net effect related to the ASC3 (accounting for the ASC3 interaction terms) is negative and significant across all models indicating that respondents in all countries are more likely, all else being equal, to choose a high-seas management plan for the Flemish Cap that is different from the current one in place.

Examining the Covid-19 interaction terms suggests that the crisis has had very little influence on people's preferences. No Covid-19 attribute interaction term is significant at the 5% level and only in the case of Scotland do we observe a statistical significance and positive Covid-ASC3 interaction term. The insignificant cost interaction term suggests that even 'price' sensitivity for marine environmental management has remained unchanged since the outbreak of the crisis. While it can be seen that individually the attribute interaction terms are insignificant at the 5% level we also examine whether the post crisis interaction variables, taken as a whole in each model, are significant by testing whether the interaction coefficients are simultaneously zero. The significance level of the χ^2 test in each case indicates that we fail to reject the hypothesis (H_0^1) of no difference in environmental preferences pre and post the Covid-19 crisis.[11]

To test the second hypothesis, the marginal WTP estimates are calculated for both the pre and post Covid-19 samples using the ML model results. Associated confidence intervals were calculated using Krinsky-Robb simulations with 10,000 replications (Krinsky and Robb, 1986). The results are shown in Table 4. All estimates have been converted to Canadian dollars to allow for easy comparison across countries. Scotland displays the highest marginal WTP values for all attributes across the countries and the magnitude of the results suggest that the health and litter attribute levels are even more highly valued in the post Covid-19 sample although the differences are not statistically significant. In contrast, Norway displays the lowest marginal WTP for the health and litter attributes across all countries.

The 95% confidence intervals suggest that the marginal WTP estimates for all attributes across all countries are not significantly different on average pre and post the Covid-19 crisis outbreak. Of course, in comparing any two groups, the confidence intervals may overlap and yet the means may still be significantly different from one another (see Austin and Hux, 2002 for a discussion on this point). Given the extent of the overlaps observed in the results here such a finding is unlikely in this case and hypothesis testing of the difference in the WTP estimates across the pre and post Covid-19 periods confirms no statistical differences.

Tables 5 to 7 present the separate pre and post Covid-19 mixed WTP space models for each of the three countries, respectively. The mean coefficients in the Canadian WTP space models are all highly significant in both the pre and post model cases. A similar result is evident in the Scottish case where bar the lowest level on the area dummy (Area2) in the pre and post Covid-19 models, all other mean coefficient values are significant at the 1% level. The WTP for any of the area dummies appears almost identical in the preCovid-19 Canadian model based on the magnitude of the coefficients. However, the standard deviation coefficient for the moderate area level dummy is large compared to the mean and also compared to the other area-level standard deviations.

In the Norwegian case, the majority of the mean coefficients are of the expected sign and significant. However, in the pre Covid-19 model, the Area2 WTP coefficient estimate and the mean of the log of the Jobs3 WTP coefficient are only significant at the 10% level. The mean of the log of the Jobs3 WTP coefficient is insignificant in the Norwegian post Covid-19 case. As was the case with the ML models the net effect related to the status quo option (accounting for the ASC3 interaction terms) was found to be negative and significant across all models. A decrease in the general WTP to avoid the status quo alternative in favour of a positively priced management plan was evident across the three countries although the difference from the pre Covid models was not statistically significant.

The SD coefficients are generally significant, indicating that there is heterogeneity in the respondents' preferences particularly for the highest level of each attribute associated with conservation and management of the deep sea area. However, in the majority of cases the relative size of the SD coefficients compared to the mean coefficients are low.[12] The relative size of the SD coefficients is particularly low in the case of the jobs attribute indicating that even if significant there is less variability around the mean effect when it comes to the creation of marine economy jobs in the area. Across all three countries, the SD associated with Jobs2 is statistically insignificant. The SD is also insignificant for a number of the other lower attribute level dummies suggesting relatively homogenous preferences in those instances. It is interesting to note an increase in the magnitude of the SD coefficients in the post Covid-19 Canadian model for all attributes except Area which implies the WTP for these attributes may have become more spread out around the mean following the crisis although there is less evidence of this in the case of the other countries.

[11] The pooled two period models rest on the assumption of no difference in variance between the two sample periods. This could be violated so in order to double check the findings, separate weighted ML models for each time period for each country were run instead of pooled ones. The results were virtually identical in terms of preference sign, magnitude and significance as suggested by the pooled models. In the interest of space, the results of these single period ML country models are not presented here but are available from the authors upon request. As we add complexity to the model specifications the mixed WTP space models are kept separate for the pre and post Covid-19 periods.

[12] Although not shown here, the standard deviations are substantially larger in the equivalent mixed preference space logit models relative to the means than in the WTP space models presented here. Similarly the WTP estimated from the equivalent preference space models are larger and have wider confidence intervals. This is a similar result to a number of other studies such as Train and Weeks (2005), Hole and Kolstad (2007) and Scarpa et al. (2008).

Table 5
Canadian mixed WTP space model for pre and post Covid-19 periods.

	Canada			
	Pre Covid-19		Post Covid-19	
	Mean	Standard deviation	Mean	Standard deviation
Health3	4.436***	0.364***	4.022***	0.529***
	(0.056)	(0.058)	(0.192)	(0.084)
Health2	4.189***	0.207***	3.863***	0.141
	(0.069)	(0.037)	(0.163)	(0.161)
Litter3	4.371***	0.662***	4.148***	0.772***
	(0.076)	(0.069)	(0.151)	(0.148)
Litter2	4.143***	0.060*	3.928***	0.216***
	(0.082)	(0.035)	(0.133)	(0.076)
Area4	30.618***	2.993*	28.601***	1.581
	(3.707)	(1.819)	(7.135)	(6.602)
Area3	30.845***	37.246***	26.900***	32.736***
	(6.111)	(5.804)	(6.983)	(6.522)
Area2	30.015***	2.366	25.090***	1.704
	(3.546)	(1.983)	(7.318)	(4.157)
Jobs3	2.787***	1.426***	3.514***	0.055
	(0.299)	(0.195)	(0.242)	(0.098)
Jobs2	3.147***	0.018	3.205***	0.001
	(0.121)	(0.107)	(0.256)	(0.133)
Cost	−4.889***	1.494***	−4.539***	1.060***
	(0.148)	(0.151)	(0.131)	(0.151)
Asc3	−654.10***	753.35***	−304.13***	544.22***
	(166.14)	(154.63)	(56.27)	(102.07)
Pseudo Log Likelihood	−3129		−3041	
Wald Chiˆ2 statistic (18)	20,203		5001	
Pseudo R^2	0.63		0.64	
Observations	11,688	11,688	11,592	11,592

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0$. The mean and standard deviation for health, litter, jobs and cost attributes are presented as the log of the WTP coefficients. Interaction terms of socio-demographic variables with the status quo ASC were also included in model and are reported as supplementary material in table S4.

Table 6
Norwegian mixed WTP space model for pre and post Covid-19 periods.

	Norway			
	Pre Covid-19		Post Covid-19	
	Mean	Standard deviation	Mean	Standard deviation
Health3	4.136***	0.021	4.053***	0.150**
	(0.075)	(0.108)	(0.070)	(0.061)
Health2	3.913***	0.148	3.811***	0.048
	(0.098)	(0.137)	(0.072)	(0.047)
Litter3	3.880***	0.892***	3.747***	1.064***
	(0.103)	(0.083)	(0.100)	(0.075)
Litter2	3.720***	0.156	3.746***	0.240***
	(0.097)	(0.121)	(0.070)	(0.086)
Area4	39.909***	46.772***	33.725***	63.221***
	(4.892)	(8.797)	(4.271)	(5.877)
Area3	11.129**	28.379***	12.460***	16.209
	(5.205)	(5.218)	(4.636)	(10.177)
Area2	7.729*	8.541	8.182***	2.777
	(4.081)	(7.236)	(2.082)	(2.137)
Jobs3	1.355*	1.865***	0.966	1.957***
	(0.716)	(0.358)	(0.797)	(0.409)
Jobs2	2.957***	0.030	3.140***	0.057
	(0.205)	(0.251)	(0.146)	(0.102)
Cost	−4.115***	1.029***	−3.995***	1.124***
	(0.118)	(0.089)	(0.099)	(0.110)
asc3	−97.869	357.381***	−49.981*	318.570***
	(75.481)	(46.446)	(29.912)	(33.681)
Pseudo Log Likelihood	−2758		−2848	
Wald Chiˆ2 statistic (18)	6260		13,815	
Pseudo R^2	0.65		0.64	
Observations	10,776	10,776	11,208	11,208

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The mean and standard deviation for health, litter, jobs and cost attributes are presented as the log of the WTP coefficients. Interaction terms of socio-demographic variables with the status quo ASC were also included in model and are reported as supplementary material in table S4.

Following Hole (2007) the attribute level in natural logarithm form are transformed to provide the mean and 95% confidence intervals of the WTP coefficients themselves. These are shown in Table 8. Similar to the basic ML WTP estimates, the highest WTP across all countries is associated with the highest level of management of marine litter followed by the achievement of the highest level of health for commercial fish stocks. Scotland displays the highest marginal WT*P* values for all attributes (except for Jobs3) across the three countries and the magnitude of the results suggest that the health and litter attribute levels are even more highly valued in the post Covid-19 Scottish sample although the differences are not statistically significant. In contrast, Norway displays the lowest marginal WTP for the health and litter attributes across all countries. Hypothesis testing of the difference in the means suggests that the marginal WTP estimates for all attributes across all countries are not significantly different on average pre and post the Covid-19 crisis outbreak. We, therefore, fail to reject the hypothesis (H_0^2) of no difference in mean WTP post the Covid-19 crisis. The relatively large confidence intervals should however be noted and the fact that the differences are still ‘economically’ meaningful, particularly for the health and litter attributes for Canada and Scotland.

Nonetheless, the empirical distributions of the individual level WTP coefficients could still be statistically different. To examie this possibility a Poe test is used. The Poe test does no*t* test for mean differences in WTP estimates as a z-test does but rather tests for the difference between marginal WTP distributions, i.e. it tests the null hypothesis that the difference in the two empirical distributions of the individual level marginal WTP values are equal to zero. The results of the Poe test are given in Table 9. Based on the P values in each case and across all countries the test fails to reject the null hypothesis that the difference in the two empirical distributions of the individual level marginal WTP values are equal to zero for the highest dummy level of each of the attributes. Some differences are observed however for a number of empirical distributions of the individual marginal WTP values for the lower dummy levels across the samples.

6. Discussion and conclusions

In this paper, use was made of a choice experiment conducted both before the Covid-19 pandemic and after the peak of the first wave of the pandemic across three separate countries to test for the stability of environmental preferences and WTP following the onslaught of a global crisis. The results suggest that while in general, the mean preferences are relatively stable, the pandemic would appear to have led to changes to preference heterogeneity as observed in the statistical difference across the periods in the empirical distributions of a number of individual-level WTP coefficients. While it is difficult to compare the results here to previous research on the stability of preferences given that no one previously has been in a position to test for such stability during such an immense global shock there have been numerous instances where environmental preferences and WTP have been found to remain stable over comparable time periods even if there was no shock in the intervening months (Bliem et al., 2012; Liebe et al., 2012). The results of Bliem et al. (2012) were characterized “by a remarkable stability” but in their case, no shock of any kind occurred in the period between the two DCEs.

Our a priori expectation that a person’s marginal WTP for the environmental attributes would decline due to the heightened uncertainty and concern for future income caused by the global pandemic, is not shown in our results. However, we believe there are several explanations for the robustness of mean preferences and mean WTP. One reason for the environmental preferences remaining relatively unchanged could be the awareness that human impact on natural environments may increase the risk of pandemics (Di Marco et al., 2020). The fact that human population growth is increasing the interaction between humans and animals, with the potential for increased exposure to pathogens, may have raised the awareness of the importance of protecting nature and increased its associated option value.

Furthermore, the experience of lockdown may impact the perception of the vulnerability of nature, as well as increasing the perceived value of ecosystem services delivered by nature, thus cancelling out any potential income effect. This could also explain the relatively large effect associated with the health attribute across the models. The importance of blue and green spaces for mental health for example is well documented and the lockdown may have increased that awareness amongst the general public (Shanahan et al., 2015). People may also have become more acutely aware that the next big challenges facing humanity are those related to climate change and the biodiversity crisis. The possible role of changing trust in governments, both in terms of their competence and their priorities could be another motivating factor for the results. Having seen how their governments dealt with the initial wave of the pandemic, respondents may have adjusted their levels of confidence in the ability/willingness of governments to use their tax contributions responsibly/effectively to deliver the changes postulated in the survey. This remains an interesting area for future research.

While not statistically different between periods, the majority of the WTP values do display the expected decrease in absolute terms across the crisis in the majority of cases. However, it can be seen that in the Scottish case the marginal values associated with the health and litter attributes, and the highest jobs level (Jobs3) show a slight increase.[13] Similarly, WTP for the highest litter level increases post Covid for Norway (albeit again not a statistically significant difference) suggesting that the pandemic has brought home even more for the maritime nations the importance of dealing with the marine litter crisis. It was also interesting to note that the potential blue growth opportunities on the Flemish Cap were the least valued of the attributes across all countries with much higher marginal WTP estimates observed for the highest levels of the environmental attributes in all three countries.

It had been expected that Canada might display higher marginal WTP values than Norway and Scotland, given it is the closest of the three to the Flemish Cap. However, Scotland was found to have the highest marginal values across all countries, with Canada having lower marginal WTP values than even Norway for some attributes in the post Covid-19 period. Distance-decay effects have been shown to be more prevalent for use values and less clear for non-use values (De Valck and Rolfe, 2018; Johnston et al., 2015). It should be noted though that due to range differences in the cost attribute used in the survey instrument between the countries the inter-country comparisons in terms of preference and WTP stability are the main focus of the analysis and a cautious view should be taken of any intra-country comparison of the results.

The study made use of independent samples across the three countries in the pre and post Covid-19 surveys. It would be interesting to test and compare the temporal stability of stated preferences and WTP

[13] This result may be due to similar levels of uncertainty with regard to future economic conditions being present in Scotland in both time periods. It may be the case that the presence of Brexit uncertainty at the time of the first survey had an influence on WTP at that point in time. A withdrawal agreement was finally in place by the time of the second survey but then there is uncertainty connected to the pandemic. If similar levels of uncertainty around future economic conditions are present in both time periods (but due to different reasons) we might expect to see even less variation in average preferences and in the distribution of WTP across the periods for Scotland compared to the other countries. The high salience in Scottish media of the various negotiations around fishing may also have had an influence on preferences for marine related attributes and the health of commercial fish stocks attribute in particular.

Table 7
Scottish mixed WTP space model for pre and post Covid-19 periods.

	Scotland			
	Pre Covid-19		Post Covid-19	
	Mean	Standard deviation	Mean	Standard deviation
Health3	4.679***	0.314	4.916***	0.339***
	(0.196)	(0.251)	(0.137)	(0.122)
Health2	4.323***	0.144	4.570***	0.020
	(0.162)	(0.132)	(0.128)	(0.359)
Litter3	4.888***	0.575***	5.141***	0.310***
	(0.146)	(0.075)	(0.137)	(0.073)
Litter2	4.699***	0.012	4.783***	0.013
	(0.134)	(0.079)	(0.162)	(0.146)
Area4	61.263***	120.622***	49.174***	125.678***
	(15.768)	(19.757)	(17.269)	(29.737)
Area3	37.533***	18.951	47.310***	17.807
	(9.649)	(16.037)	(9.414)	(13.440)
Area2	14.007	45.843***	1.612	13.145
	(11.457)	(13.283)	(8.694)	(10.634)
Jobs3	3.404***	0.130	3.129***	0.905**
	(0.294)	(0.805)	(0.700)	(0.383)
Jobs2	3.876***	0.218	3.849***	0.255
	(0.205)	(0.191)	(0.373)	(0.579)
Cost	−4.440***	0.575***	−4.536***	1.005***
	(0.137)	(0.124)	(0.148)	(0.201)
asc3	−267.14***	351.75***	−393.61***	575.94***
	(100.22)	(68.41)	(116.41)	(98.61)
Pseudo Log Likelihood	−2640		−2614	
Wald Chiˆ2 statistic (18)	3556		4812	
Pseudo R^2	0.69		0.70	
Observations	11,856	11,856	11,952	11,952

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0$. The mean and standard deviation for health, litter, jobs and cost attributes are presented as the log of the WTP coefficients. Interaction terms of socio-demographic variables with the status quo ASC were also included in model and are reported as supplementary material in table S4.

Table 8
Attribute WTP (Canadian Dollars) based on mixed WTP space model results.

	Pre Covid-19			Post Covid-19		
	Mean	95% Confidence Interval		Mean	95% Confidence Interval	
Canada						
Area4	30.62	(23.35	37.88)	28.60	(14.62	42.59)
Area3	30.85	(18.87	42.82)	26.90	(13.21	40.59)
Area2	30.02	(23.06	36.97)	25.09	(10.75	39.43)
Health3	90.22	(78.07	105.62)	64.19	(48.73	86.89)
Health2	67.39	(58.14	78.52)	48.08	(35.12	72.73)
Litter3	98.51	(78.32	126.19)	85.28	(52.89	149.60)
Litter2	63.10	(53.64	74.59)	52.00	(39.23	70.48)
Jobs3	44.87	(15.58	149.58)	33.63	(21.10	55.64)
Jobs2	23.27	(18.69	30.27)	24.66	(15.44	42.14)
Norway						
Area4	39.91	(30.32	49.50)	33.73	(25.35	42.10)
Area3	11.13	(0.93	21.33)	12.46	(3.37	21.55)
Area2	7.73	(−0.27	15.73)	8.18	(4.10	12.26)
Health3	62.57	(54.99	74.45)	58.22	(50.21	68.48)
Health2	50.60	(41.60	66.14)	45.25	(39.29	52.56)
Litter3	72.08	(51.63	103.34)	74.67	(53.06	107.37)
Litter2	41.77	(34.23	53.91)	43.59	(37.02	52.81)
Jobs3	22.07	(1.87	425.08)	17.83	(1.07	562.94)
Jobs2	19.25	(14.32	32.95)	23.14	(17.53	31.79)
Scotland						
Area4	61.26	(30.36	92.17)	49.17	(15.33	83.02)
Area3	37.53	(18.62	56.45)	47.31	(28.86	65.76)
Area2	14.007	(−8.45	36.46)	1.612	(−15.43	18.65)
Health3	113.10	(74.49	218.75)	144.53	(104.84	210.95)
Health2	76.20	(55.26	112.35)	96.56	(94.90	161.21)
Litter3	156.54	(109.23	229.25)	179.30	(132.48	247.69)
Litter2	109.85	(85.33	144.83)	119.47	(90.27	171.62)
Jobs3	30.34	(48.22	230.10)	34.42	(5.86	354.83)
Jobs2	49.39	(32.67	85.91)	48.50	(33.28	256.19)

Table 9
P values from Poe et al. (2005) test of differences between pre and post Covid-19 individual level WTP coefficient distributions.

Attribute level	Canada	Norway	Scotland
Health3	0.086	0.111	0.145
Health2	0.002*	0.028*	0.000*
Litter3	0.312	0.553	0.304
Litter2	0.009*	0.379	0.000
Area4	0.161	0.448	0.456
Area3	0.399	0.491	0.097
Area2	0.000*	0.417	0.207
Jobs3	0.558	0.390	0.513
Jobs2	0.000*	0.000*	0.465

* Indicates insignificant at 95% level.

values before and after the crisis when the same sample of respondents is offered the same sequence of choice sets as has been done previously in the test-retest literature (e.g. Brouwer et al., 2017; Schaafsma et al., 2014). Using the same sequence of choice sets the researcher could then also test if individuals' preferences remain consistent as well as stable during a global shock. Examining how individuals' choices are affected by actual changes in their employment status and household income due to the crisis would also be a useful area for future research.

While the second survey was carried out past the peak of the first wave of the pandemic in each country this was still only six months after the initial survey in November 2019. It is fair to say that respondents may not have realized the full extent of the pandemic that even in May 2021 is not fully clear. The limited time elapsed between the surveys may have influenced the "stability" of the results observed and a repeat of the survey now may reveal a greater difference in the preferences and willingness to pay for environmental protection. This remains an avenue for further research. There could also be seasonal differences here due to the dates of the data collection for the pre and post samples (winter versus summer) that may impact the results. It should be noted however that a number of recent survey-based studies have also found no significant variations in pro-environmental or climate change attitudes over a longer time period between the pre and post COVID-19 eras (Lucarelli et al., 2020; Evensen et al., 2021; Krosnick and MacInnis, 2020).

The environmental good under consideration in the DCE is also thought to be relatively unfamiliar to respondents. As seen in the summary statistics, 25% or less in each sample had heard of the Flemish Cap's deep-sea ecosystem and wildlife previously. While many may have heard of the Flemish Cap they would not presumably have been very aware of the ecosystems present in the area before receiving the background information in the survey instrument. It may be the case that mean preferences and WTP for such an 'unusual' good will remain stable as respondents may have strong views on how important such a good is to them. The differences observed in the preference heterogeneity across the periods could also be due to sampling effects. While the EB approach attempts to correct for this it only adjusts for the characteristics used in the weighting procedure. If the pandemic has led to a change in the people undertaking internet surveys, the effects observed may be due to sampling and not due to preference changes. Having said that the survey company employed to undertake the surveys maintains very large panels across all three countries that are unlike to have changed dramatically over the six months between both surveys.

As seen in the results, respondents were also more concerned with the existence values associated with the environmental attributes rather than the values present in the blue growth attribute which may be seen as having a more direct impact on the economy. If the value of the good lies mainly in its existence one might expect more stability in preferences (Rollins, 2001). It would be interesting to see how the results might differ if the environmental good in question was a familiar coastal ecosystem or the conservation of an iconic species or any good where use values may play a more important role. It could also be the case that, in line with the findings of Ji et al. (2020) in the revealed preference case, the study design here and the inclusion of an alternative specific constant in the models means that omitted variable bias is reduced which may lead to more stability in preferences. However, in interpreting the results of this study, it is important to bear in mind the limited sample sizes of the population samples across each country and the fact that the confidence intervals around the estimated parameters and mean WTP were relatively large.

Given that we accept the reasons for the identified preference stability, the relatively stable preferences found for all three countries under this extra-ordinary situation gives strong support to societal priorities regarding the conservation of deep-sea environments far removed from direct use or experience. We may conclude that even under extremely stressful conditions; mentally, economically and socially, human preferences regarding environmental conservation remain relatively robust. And though we can only allude to the underlying reasons for this robustness here, broad and increasing public awareness of human dependency on natural environments seems to be a plausible explanation. It may be that society has come to respect, and value the environment more than before the crisis, even when faced with greater financial insecurity. If this is indeed the case then the public might draw on the lessons from this crisis and be more willing to make the necessary choices to address the climate and biodiversity challenges ahead.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

This work has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 678760 (ATLAS). The authors also thank Ana García-Alegre Garralda, Matthew Gianni, Georgios Kazanidis, Ellen Kenchington, Lea-Anne Henry, Pablo Durán Muñoz, Keshav Prasad Paudel and J. Murray Roberts for their advice on survey development. 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 A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2021.107142.

References

Aanesen, M., Falk-Andersson, J., Vondolia, G.K., Borch, T., Navrud, S., Tinch, D., 2018. Valuing coastal recreation and the visual intrusion from commercial activities in Arctic Norway. Ocean Coast. Manag. 153, 157–167.
Ankamah-Yeboah, I., Bich Xuan, B., Hynes, S., Armstrong, C., Needham, K., 2021. Assessing public preferences for deep sea ecosystem conservation: a choice experiment in Norway and Scotland. J. Environ. Econ. Policy. https://doi.org/10.1080/21606544.2021.1924286.
Austin, P., Hux, J., 2002. A brief note on overlapping confidence intervals. J. Vasc. Surg. 36 (1), 194–195.
Bang, A., Khadakkar, S., 2020. Opinion: biodiversity conservation during a global crisis: consequences and the way forward. Proc. Natl. Acad. Sci. 117 (48), 29995–29999.
Bennett, J., Blamey, R., 2001. The Choice Modelling Approach to Environmental Valuation. Cheltenham, UK.
Berrens, R., Bohara, A., Silva, C., Brookshire, D., McKee, M., 2000. Contingent values for New Mexico instream flows: with tests of scope, group-size reminder and temporal reliability. J. Environ. Manag. 58 (1), 73–90.
Bliem, M., Getzner, M., 2012. Willingness-to-pay for river restoration: differences across time and scenarios. Environ. Econ. Policy Stud. 14 (3), 241–260.
Bliem, M., Getzner, M., Rodiga-Laßnig, P., 2012. Temporal stability of individual preferences for river restoration in Austria using a choice experiment. J. Environ. Manag. 103, 65–73.

Brouwer, R., 2006. Do stated preferences methods stand the test of time? A test of stability of contingent values and models for health risks when facing an extreme event. Ecol. Econ. 60, 399–406.

Brouwer, R., Dekker, T., Rolfe, J., Windle, J., 2010. Choice certainty and consistency in repeated choice experiments. Environ. Resour. Econ. 46 (1), 93–109.

Brouwer, R., Logar, I., Sheremet, O., 2017. Choice consistency and preference stability in test-retests of discrete choice experiment and open-ended willingness to pay elicitation formats. Environ. Resour. Econ. 68, 729–751.

Carson, R., Hanemann, W.M., Kopp, R., Krosnick, J., Mitchell, R., Presser, S., Rudd, P., Smith, V.K., Conaway, M., Martin, K., 1997. Temporal reliability of estimates from contingent valuation. Land Econ. 73, 151–163.

ChoiceMetrics, 2018. Ngene 1.2 User Manual and Reference Guide. ChoiceMetrics, Sydney, Australia.

Czajkowski, M., Barczak, A., Budzinski, W., Giergiczny, M., Hanley, N., 2016. Preference and WTP stability for public forest management. For. Policy Econ. 71, 11–22.

De Valck, J., Rolfe, J., 2018. Spatial heterogeneity in stated preference valuation: status, challenges and road ahead. Int. Rev. Environ. Resour. Econ. 11 (4), 355–422.

Di Marco, M., Baker, M., Daszak, P., De Barro, P., Eskew, E., Godde, C., Harwood Herrero, M., Hoskins, A., Johnson, E., Karesh, W., Machalaba, C., Navarro Garcia, J., Paini, D., Pirzl, R., Stafford Smith, M., Zambrana-Torrelio, C., Ferrier, S., 2020. Opinion: sustainable development must account for pandemic risk. Proc. Natl. Acad. Sci. 117 (8), 3888–3892.

ECDPC, 2020. European Centre for Disease Prevention and Control COVID-19 situation update worldwide. https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases (Last accessed 31/5/2020).

Evensen, D., Whitmarsh, L., Bartie, P., Devine-Wright, P., Dickie, J., Varley, A., Ryder, S., Mayer, A., 2021. Effect of "finite pool of worry" and COVID-19 on UK climate change perceptions. Proc. Natl. Acad. Sci. 118 (3), e2018936118.

Fetene, G., Olsen, S., Bonnichsen, O., 2014. Disentangling the pure time effect from site and preference heterogeneity effects in benefit transfer: an empirical investigation of transferability. Environ. Resour. Econ. 59 (4), 583–611.

GWI, 2020. Coronavirus research. In: Series 4: Media Consumption and Sport. GlobalWebIndex publication, London.

Hainmueller, J., 2012. Entropy balancing for causal effects: a multivariate reweighting method to produce balanced samples in observational studies. Polit. Anal. 20 (1), 25–46.

Hainmueller, J., Xu, Y., 2013. Ebalance: a Stata package for entropy balancing. J. Stat. Softw. 54 (7), 1–18.

Helm, D., 2020. The environmental impacts of the coronavirus. Environ. Resour. Econ. 76, 21–38.

Hensher, D., Greene, W., 2003. The mixed logit model: the state of practice. Transportation 30 (2), 133–176.

Hensher, D., Rose, J., Greene, W., 2005. Applied Choice Analysis: A Primer. Cambridge University Press.

Hoeffler, S., Ariely, D., 1999. Constructing stable preferences: a look into dimensions of experience and their impact on preference stability. J. Consum. Psychol. 8 (2), 113–139.

Hole, A.R., 2007. Fitting mixed logit models by using maximum simulated likelihood. Stata J. 7, 388–401.

Hoyos, D., 2010. The state of the art of environmental valuation with discrete choice experiments. Ecol. Econ. 69, 1595–1603.

Hynes, S., Ghermandi, A., Norton, D., Williams, H., 2018. Marine recreational ecosystem service value estimation: a meta-analysis with cultural considerations. Ecosyst. Serv. 31, 410–419.

Hynes, S., Ankamah-Yeboah, I., O'Neill, S., Needham, K., Bich Xuan, B., Armstrong, C., 2020. The impact of nature documentaries on public environmental preferences and willingness to pay: entropy balancing and the blue planet II effect. J. Environ. Plan. Manag. DOI. https://doi.org/10.1080/09640568.2020.1828840.

Ji, Y., Keiser, D., Kling, C., 2020. Temporal reliability of welfare estimates from revealed preferences. J. Assoc. Environ. Resour. Econ. 7 (4), 659–686.

Johnston, R., Jarvis, D., Wallmo, K., Lew, D., 2015. Multiscale spatial pattern in nonuse willingness to pay : applications to threatened and endangered marine species. Land Econ. 91 (4), 739–761.

Johnston, R., Boyle, K.J., Adamowicz, W., Bennett, J., Brouwer, R., Cameron, T.A., Hanemann, W.M., Hanley, N., Ryan, M., Scarpa, R., Tourangeau, R., Vossler, C.A., 2017. Contemporary guidance for stated preference studies. J. Assoc. Environ. Resour. Econ. 4, 319–405.

Jones, K., 2020. This Is how COVID-19 Has Changed Media Habits in each Generation. World Economic Forum Report.

Kazanidis, G., Orejas, C., Borja, A., Kenchington, E., Henry, L.A., Callery, O., Carreiro-Silva Hrönn Egilsdóttir, M., Giacomello, E., Grehan, A., Menot, L., Morato, T., Ragnarsson, S., Rueda, J., Stirling, D., Stratmann, T., van Oevelen, D., Palialexis, A., Johnson, D., Roberts, M., 2020. Assessing the environmental status of selected North Atlantic deep-sea ecosystems. Ecol. Indic. 119, 106624.

Krinsky, I., Robb, A., 1986. On approximating the statistical properties of Elasticities. Rev. Econ. Stat. 68, 715–719.

Krosnick, J., MacInnis, B., 2020. Climate Insights 2020: Overall Trends. Resources for the Future, Washington, DC.

Levin, J., Milgrom, P., 2004. Introduction to Choice Theory. Stanford University. Available at. https://web.stanford.edu/~jdlevin/Econ%20202/Choice%20Theory.pdf.

Lew, D., Wallmo, K., 2017. Temporal stability of stated preferences for endangered species protection from choice experiments. Ecol. Econ. 131, 87–97.

Liebe, U., Meyerhoff, J., Hartje, V., 2012. Test–retest reliability of choice experiments in environmental valuation. Environ. Resour. Econ. 53 (3), 389–407.

Loomis, J., 1989. Test-retest reliability of the contingent valuation method: a comparison of general population and visitor responses. Am. J. Agric. 71, 76–84.

Lucarelli, C., Mazzoli, C., Severini, S., 2020. Applying the theory of planned behavior to examine pro-environmental behavior: the moderating effect of COVID-19 beliefs. Sustainability 2020 (12), 10556.

McConnell, K., Strand, E., Valdes, S., 1998. Testing temporal reliability and carry-over effect: the role of correlated responses in test-retest reliability studies. Environ. Resour. Econ. 12 (3), 357–374.

McFadden, D., 1974. Conditional logit analysis of qualitative choice behavior. In: Zarembka, P. (Ed.), Frontiers in Econometrics. Academic Press, New York, pp. 105–142.

McFadden, D., Train, K., 2000. Mixed MNL models for discrete response. J. Appl. Econ. 15 (5), 447–470.

Meijer, E., Rouwendal, J., 2006. Measuring welfare effects in models with random coefficients. J. Appl. Econ. 21 (2), 227–244.

Mørbak, M., Olsen, S., 2014. A within sample investigation of test–retest reliability in choice experiment surveys with real economic incentives. Aust. J. Agric. Econ. 56, 1–18.

Morrison, M., Hatfield-Dodds, S., 2011. The success and failure of an inconvenient trust and the stern report in influencing Australian public support for greenhouse policy. Econ. Rec. 87 (277), 269–281.

Morrison, M., Bennett, J., Blamey, R., 1999. Valuing improved wetland quality using choice modelling. Water Resour. Res. 35, 2805–2814.

Morse, J., Gladkikh, T., Hackenburg, D., Gould, R., 2020. COVID-19 and human-nature relationships: Vermonters' activities in nature and associated nonmaterial values during the pandemic. PLoS One 15 (12), e0243697.

OECD, 2018. Data. Purchasing power parities (PPP) across countries. Available from: https://data.oecd.org/conversion/purchasing-power-parities-ppp.htm.

O'Hara, S., Toussaint, E., 2021. Food access in crisis: food security and COVID-19. Ecol. Econ. 180, 106859.

Poe, G., Giraud, K., Loomis, J., 2005. Computational methods for measuring the difference of empirical distributions. Am. J. Agric. 87, 353–365.

Rakotonarivo, O., Schaafsma, M., Hockley, N., 2017. A systematic review of the reliability and validity of discrete choice experiments in valuing non-market environmental goods. J. Environ. Manag. 183, 98e109.

Rollins, K., 2001. Measuring ecosystem values. In: Jensen, M., Bourgeron, P. (Eds.), Guidebook for Integrated Ecological Assessments. Springer-Verlag, New York, USA.

Scarpa, R., Thiene, M., Train, K., 2008. Utility in willingness to pay space: a tool to address confounding random scale effects in destination choice to the Alps. Am. J. Agric. 90, 94–1010.

Schaafsma, M., Brouwer, R., Liekens, I., Denocker, L., 2014. Temporal stability of preferences and willingness to pay for natural areas in choice experiments: a test–retest. Resour. Energy Econ. 38, 243–260.

Shanahan, D., Fuller, R., Bush, R., Lin, B., Gaston, K., 2015. The health benefits of urban nature: how much do we need? Bioscience 65, 476–485.

Shiller, R., 2019. Narrative Economics: How Stories Go Viral and Drive Major Economic Events. Princeton University Press.

Sillano, M., de Dios Ortúzar, J., 2005. Willingness-to-pay estimation with mixed logit models: some new evidence. Environ. Plan. A 37, 525–550.

Thurstone, L., 1927. The law of comparative judgement. Psychol. Rev. 34 (2), 273–286.

Train, K.E., Weeks, M., 2005. Discrete choice models in preference space and willingness-to-pay space. In: Scarpa, R., Alberini, A. (Eds.), Application of Simulation Methods in Environmental and Resource Economics. Springer, Dordrecht, pp. 1–16.

Tu, G., Abildtrup, J., Garcia, S., 2016. Preferences for urban green spaces and peri-urban forests: an analysis of stated residential choices. Landsc. Urban Plan. 148, 120–131.

Tversky, A., Kahneman, D., 1991. Loss aversion in riskless choice: a reference-dependent model. Q. J. Econ. 106 (4), 1039–1061.

Villanueva, A., Glenk, K., Rodríguez-Entrena, M., 2017. Protest responses and willingness to accept: ecosystem services providers' preferences towards incentive-based schemes. J. Agric. Econ. 68, 801–821.

Whitehead, J., Hoban, T., 1999. Testing for temporal reliability in contingent valuation with time for changes in factors affecting demand. Land Econ. 75 (3), 453–465.

Xuan, B., Ankamah-Yeboah, I., Hynes, S., Armstrong, C., Needham, K., 2021. Valuing high seas ecosystem conservation. Conserv Biol. https://doi.org/10.1111/cobi.13720.