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Nature-based solutions for climate change mitigation: Assessing the Scottish Public's preferences for saltmarsh carbon storage

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ABSTRACT

The saltmarsh carbon storage potential is a key topic in blue carbon research and climate policy. Ecosystem service valuations provide valuable information to policymakers for habitat management and climate change mitigation policies. Yet, only few saltmarsh valuation studies have included the carbon storage service in the UK context. This paper investigates how the public values saltmarsh ecosystem services, focussing on the carbon storage service. We used a choice experiment to elicit the willingness to pay (WTP) of a representative sample of the Scottish public to support interventions that would maintain or improve the provision of these services. Furthermore, we tested the effect of information on individuals' preferences and WTP with a split sample approach where one group received a treatment in the form of additional information. We found that (i) all attributes had a significant influence on individuals' choices; (ii) both groups had, on average, a positive marginal WTP for all presented ecosystem services; (iii) the treated sample had, on average, no significantly different marginal WTP for carbon storage than the control group. This paper adds to the limited literature on the saltmarsh carbon storage ecosystem service and demonstrates a developed nation's public's openness to nature-based climate change mitigation solutions.

1. Introduction

In 2018, the IPCC published the *IPCC Special Report on Global Warming of 1.5 °C*, which clearly warned that while limiting global warming to 1.5 °C was still possible, it would be out of our reach unless we strongly increased our mitigation ambitions to significantly reduce greenhouse gas emission by 2030 (IPCC, 2018). The IPCC's results were highly publicised and on 28th April 2019, a climate emergency was declared in Scotland by the First Minister, Nicola Sturgeon, during a speech at her party's conference. The announcement was followed by the passing of the Climate Change (Emissions Reduction Targets) (Scotland) Act in September, 2019, which establishes the Scottish Government's commitment to reach net-zero emissions by 2045 as opposed to the Climate Change (Scotland) Act 2009's, 80% emissions reduction target by 2050. This requires reductions across all sectors and the exploration of nature-based emission reduction solutions.

Saltmarshes as blue carbon ecosystems can be a part of these nature-based emission reduction solutions and can thereby contribute to climate change mitigation. The habitat sequesters carbon dioxide (CO_2) from the atmosphere, which is one of the climate gases responsible for the enhanced greenhouse gas effect and store it for centuries or even millennia if the habitat remains undisturbed. Saltmarshes are more efficient carbon stores than terrestrial forests since they (i) sequester carbon at a higher rate compared area by area than forests, and (ii) the regular submersion by the tides creates soil conditions that are conducive to long-term carbon storage (McLeod et al., 2011). In addition to sequestering CO_2 from the atmosphere, saltmarshes also accumulate their carbon stock through allochthonous carbon in vegetation and suspended sediment from surrounding ecosystems that is trapped by saltmarsh vegetation when the marsh is flooded during high tide (Howard et al., 2017).

Unfortunately, saltmarshes are under significant pressures and globally in decline. The most significant threats for these habitats include land claim for agriculture and infrastructure, coastal erosion, and sea-level rise (Beaumont et al., 2014). Global estimates indicate that 50% of the total saltmarsh extent is already lost or degraded (Barbier

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et al., 2011). In the Scottish context, it is less clear whether saltmarshes are currently declining or accreting. A clear downward trend in saltmarsh area has been identified by Beaumont et al. (2014),[1] however, according to a more recent study by Ladd et al. (2019), saltmarshes are currently accreting in five out of six UK regions; none of the study regions were in Scotland though. According to a study commissioned by Scotland's Nature Agency, NatureScot,[2] the extent of Scottish saltmarshes is 5840 ha (Haynes, 2016).[3] A natural shift or migration of saltmarshes inland without active management is assessed as unlikely in highly developed areas due to obstacles, such as infrastructure, which emphasises the requirement for a supporting policy (Doody, 2013; Greenberg et al., 2014).

Economic valuation studies provide important evidence for policy in terms of possible costs and monetary benefits of such policies. This paper presents a valuation of Scottish saltmarshes' ecosystem services (ES) with a choice experiment approach and a focus on the carbon storage service. It addresses the question of whether there is a preference for possible management interventions to improve the carbon storage ES and if there are trade-offs or complementarity with other ES. Moreover, it also aims to identify and characterise different groups within the population according to their preferences regarding saltmarsh management.

Choice Experiments have been widely used in environmental economics and other fields, such as transportation and health economics, and are considered a reliable tool to value ES (Champ et al., 2017). However, in the blue carbon context, their use is still limited (Himes-Cornell et al., 2018). There is a growing number of studies on valuing saltmarsh ES, yet, compared to other blue carbon ecosystems, such as mangroves and seagrass, the number of studies on saltmarshes is still quite sparse. Himes-Cornell et al., 2018 conducted a systematic review of blue carbon ecosystem valuation studies that were published globally in the 10 years prior to the review. They identified only 15 saltmarsh studies (70 for mangroves, 32 for seagrass) and it needs to be highlighted that not all of these studies included a valuation of the carbon storage ES; only seven of the studies valued this ES, mostly in the form of the social cost of carbon (SCC) or benefit/value transfer (Barbier et al., 2011; Beaumont et al., 2014; Feagin et al., 2010; Flores, 2012; Reddy et al., 2016; Russell and Greening, 2015; Schmidt et al., 2014). We could not identify a study that used a choice experiment as valuation method. This is also reflected in more recently published studies that were not included in Himes-Cornell et al.'s (2018) review.[4]

Mazzocco et al. (2022) and Bertram et al. (2021), for example, valued the carbon storage ES provided by saltmarshes, however, we are not aware of studies using a choice experiment approach. On the other hand, we could identify studies that used choice experiments to value other saltmarsh ES, such as the studies by Rendón et al. (2022) and Grilli et al. (2022). A choice experiment study by Kim et al. (2022) explicitly highlighted the carbon sequestration and storage benefits of blue carbon ecosystems but only included the extent of saltmarshes as an attribute rather than individual ecosystem services. Rendón et al. (2022) additionally included a Latent Class Analysis, which provided insightful information on the characteristics of choice experiment participants with similar preferences. Boeri et al. (2020) and Morardet et al. (2015) also used this method to gain a better understanding of participants' preferences in their respective studies on bird biodiversity in UK coastal ecosystems and the Vistre river restoration project.

The above presented impression of the saltmarsh carbon valuation literature also extends to the UK context. There are few UK studies that value the carbon storage ES of saltmarshes and to the best of our knowledge no studies that use willingness to pay (WTP) to value this ES. The review by Himes-Cornell et al. (2018) identified only one study on saltmarsh that was conducted in the UK (Beaumont et al., 2014). Additional UK case studies exist and since the publication of the review, further studies have been conducted; however, while these studies investigate a variety of services, only a few include a valuation of the carbon storage service (Lockwood and Drakeford, 2021; Luisetti et al., 2011; Luisetti et al., 2014; Watson et al., 2020). Furthermore, two of these studies have the same leading author and seem to be at least partially based on the same data (Luisetti et al., 2011; Luisetti et al., 2014).

The two studies led by Luisetti (Luisetti et al., 2011; Luisetti et al., 2014) are the only studies of the identified UK case studies that include a Discrete Choice Experiment (DCE). In Luisetti et al.'s (2011) paper, the DCE is part of a more extensive study on the Humber and Blackwater estuaries alongside other methods to value ES, such as market value and benefit transfer. Yet, in both of these studies, the carbon valuation is not part of the choice experiment but was conducted separately, once with the damage cost avoided method (Luisetti et al., 2011) and once with the UK Department of Energy & Climate Change's (DECC) prices for non-traded carbon (Luisetti et al., 2014). The other UK studies also used the carbon price approach with the DECC's non-traded carbon price, in which the carbon price is set based on its marginal abatement costs (Beaumont et al., 2014; Lockwood and Drakeford, 2021; Watson et al., 2020). Lockwood and Drakeford (2021) additionally included the SCC in the valuation exercise for comparison. The carbon ES has therefore not been included in saltmarsh DCE studies in the UK or, to the best of our knowledge, in other countries. This presents a research gap since DCE valuation studies (i) provide important information on trade-offs and enable a comparison between the different saltmarsh ES and their values; (ii) can aid the design of socially optimal policies by determining from which benefits of an ecosystem the public derive the most value (Birol and Cox, 2007); and (iii) also take cultural contexts into account which can affect ecosystem values (Klenert et al., 2018).

In their review of the saltmarsh valuation literature, Himes-Cornell et al., 2018 further critiqued that a valuation is rarely conducted for more than a few selected services and that predominantly provisioning services are valued (based on the TEEB[5] classification). Particularly the first point of critique is also reflected by several of the identified UK case studies (Beaumont et al., 2014; Lockwood and Drakeford, 2021) and presents a further although less significant research gap. Our DCE included four benefits provided by ES spread across three ecosystem service categories: (i) regulating services in the form of climate regulation (carbon storage) and moderation of extreme events (flood protection); (ii) supporting services (biodiversity); and (iii) cultural services (opportunities for recreation and tourism). Original primary data was collected for this study. While we focus on the carbon storage ecosystem service in this paper, there is potential to conduct further analysis for the DCE data and to cover the other included ES in more detail.

Considering the identified research gaps, our paper thus presents an

[1] Beaumont et al. (2014) present a table of the extent of UK coastal margin habitats that includes Scottish saltmarsh extent. Accordingly, Scottish saltmarsh declined from 6900 ha in 1945 to 6000 ha in 2000 and is projected to decline to 5190 ha by 2060.

[2] At the time when the study was conducted, NatureScot was known as Scottish Natural Heritage (SNH). The agency has since conducted a rebrand.

[3] The study only systematically included saltmarshes larger than 3 ha in extent or over 500 m in linear extent. A selection of 25 small sites under 3 ha in extent and of 10 perched saltmarshes were also assessed in the survey, but not all were included in the final result since no saltmarsh was recorded upon closer inspection (Haynes, 2016, 8–11).

[4] We identified these studies in a scoping review of the literature. To conduct the literature search, we used the University of St Andrews library resources, databases such as Scopus and Web of Science, and the google search function. We used queries with different combinations of search terms, such as the query ("salt marsh" OR "saltmarsh") AND ("valu*" OR "valuation") AND ("carbon") Note that this is one example of the search queries used.

[5] TEEB (The Economics of Ecosystems and Biodiversity project) (2010) provides a classification system for ecosystem services which is what is referred to here.

Table 1
Attributes and their levels.

Attribute	Definition	Levels
Biodiversity	number of bird species breeding on saltmarshes Coding in analysis: dummy	3 levels: 15% decrease (BaU) (reference level); no change; 15% increase
Flood Defence	measured in the amount of coastline that would be protected by saltmarshes Coding in analysis: dummy	3 levels: 14km decrease (BaU) (reference level); no change; 14km increase
Carbon Storage	measured in the amount of carbon that could additionally be stored or released and was represented by the equivalent number of annual car emissions Coding in analysis: quadratic[13]	6 levels: **release** of carbon equivalent to the annual emissions of 10,000 cars (BaU) (reference level); no change; and additional carbon **stored** equivalent to the annual emissions of 4,000; 10,000; 16,000; and 20,000 cars
Recreation	measured in recreational infrastructure Coding in analysis: dummy	3 levels: no infrastructure (BaU, since this is the case for most Scottish saltmarshes) (reference level); the construction of boardwalks and bridges over creeks; the construction of boardwalks, bridges over creeks, and of bird hides;
Payment/Price	one-time increase in annual income tax for the next 10 years Coding in analysis: continuous	6 levels: £25, £50, £100, £150, £200, £300; £0 (BaU)

[a] The quadratic specification was chosen since Likelihood Ratio tests indicated this was the best fit over a linear continuous coding or a dummy coding of the attribute.

original approach and a significant contribution to the saltmarsh blue carbon valuation literature as it values the carbon storage ES with a DCE. Moreover, using the DCE method allowed us to conduct a Latent Class Analysis (LCA), which provides insightful information on the preferences of different groups in the population regarding saltmarsh ecosystem services and their respective characteristics. This information helps to characterise the group of the population that has no preference for policy action to improve the state of saltmarshes and thus enables better targeting of awareness raising interventions. Moreover, this study further contributes to the literature by widening the pool of studies that consider a variety of ES categories and by increasing the available database of studies based on new data.

In addition, we further test the hypothesis that additional information on the carbon storage service of saltmarshes has a positive effect on participants' WTP. The potential effect of information on respondent's WTP is well established in the academic literature (Czajkowski et al., 2016; Munro and Hanley, 2001) and there are studies that demonstrate that better information can influence behaviour (Jessoe and Rapson, 2014; LaRiviere et al., 2014). This effect on behaviour is not always linked with an increase in respondents' WTP but can be reflected in a reduced variance of the estimate for average WTP, which suggests that respondents are able to make more informed choices with increased information (Boyle, 1989). However, there are also studies that found there to be no significant effect of the provision of information on respondent's behaviour (Boyle et al., 1990). In addition to these findings in the literature, our hypothesis is derived from the combination of two factors: (i) there is currently a favourable political climate in Scotland concerning nature-based solutions for climate change mitigation and a climate emergency has been declared, and (ii) the carbon storage ecosystem service of saltmarshes is not yet widely known in the Scottish public. Testing for this effect for the carbon storage service of saltmarshes will deliver valuable information for policymakers whether information campaigns could increase the public's acceptance and WTP for blue carbon climate change mitigation policies. In addition to the contributions to the saltmarsh ecosystem services valuation literature, this paper is, therefore, a valuable and timely contribution to the current blue carbon policy development process in Scotland.

2. Methods

2.1. Discrete choice experiment

DCEs are a survey based stated preference valuation method that overcome the absence of a market for indirect and non-use benefits by creating a hypothetical market to determine their value (Hanley and Barbier, 2009). In this paper, the hypothetical market is created by presenting and describing the potential changes in saltmarshes' provision of ES through management policies. Respondents were asked to make a choice between alternative saltmarsh management scenarios that were described with several attributes that took different levels. These scenarios were grouped together on choice cards. Each choice card included the business-as-usual scenario, which described what would happen if no saltmarsh management policy was introduced; the other scenarios included on the choice cards varied regarding the levels each attribute took and how these levels were combined. Respondents were presented with six choice cards with different scenario combinations and were hence asked to make several choices.

2.2. The survey instrument, experimental design, and operationalisation

Before drafting the survey instrument, we used two focus groups and one one-on-one interview to narrow down the possible attributes for the DCE scenarios,[6] to provide information on the questions that needed to be included in the survey instrument, and to test first choice card drafts (Hensher et al., 2015). Overall, the two focus groups had six participants, and were implemented with members of the general public living close to saltmarshes and who were familiar with these ecosystems. Based on the results of these focus groups and the interview, we included five different attributes in our DCE, which are presented in their final version in Table 1: (i) Biodiversity, (ii) Flood Defence, (iii) Carbon Storage, (iv) Recreational Infrastructure, and (v) Price to determine respondent's WTP for a marginal increase in the benefits provided by the other attributes.

The survey was structured in four different parts (Supplementary Material). The first section was the baseline assessment of knowledge and information text on saltmarshes and their ES. This was followed by information and instructions for the choice cards and the choice cards themselves. We placed debrief questions and questions concerning respondents' environmental ideation[7] directly after the choice cards and finished the questionnaire with a demographics section.

We explained in the survey that Scottish saltmarshes are currently in decline (Beaumont et al., 2014) and provided information on each of the included attributes. Respondents were asked to make six consecutive and independent choices. They were asked to choose between two unlabelled management options and a 'Business as Usual' (BaU) option as illustrated below in Fig. 1. The BaU option always took the value £0 and was unchanging while the management options showed hypothetical outcomes of managing Scottish saltmarshes with the associated increase in income tax. Respondents were asked to choose the option they preferred on each choice card.

Since we aimed to test the hypothesis that increased information on the carbon attribute increased respondent's WTP, we used a split sample approach and administered a treatment in the form of a longer and more detailed information text on the carbon attribute to one half of the sample to test this hypothesis. Respondents were randomly allocated to the treatment and control groups.

A challenge for determining the value of ES with this method is hypothetical bias (Hanley and Barbier, 2009): because of the hypothetical nature of the survey, respondents may overstate the price they would be willing to pay. However, there are measures that can be taken to contain this issue. Champ et al. (2017) list several methods that have been used in the past to enhance validity, including cheap-talk and creating consequentiality, which are the methods we used to reduce hypothetical bias and to ensure internal validity. This included asking respondents to consider their budget when making their choices and creating consequentiality in the choice of the payment vehicle and by providing information on how the survey outcome will be shared with the government. An increase in income tax was chosen as payment vehicle as it is a tested vehicle with high consequentiality (Johnston et al., 2017; Mariel et al., 2021).

The information on how attributes would change under alternative policy interventions, and without intervention, was derived from the literature. The projected decrease in carbon storage of the BaU scenario was estimated from Beaumont et al.'s (2014) projection of saltmarsh area loss for Scotland and the associated carbon loss calculated from the average carbon storage value per hectare.[8] The biodiversity levels were calculated with information from Fuller (2010) regarding the number of breeding bird species on Scottish saltmarshes. From Fuller's current number of breeding bird species on Scottish saltmarshes we used the conservative value of a decrease or increase by two bird species breeding on Scottish saltmarshes, which was expressed in percentage values. Regarding the flood defence value, we used Burrows et al.'s (2014) estimate that 3% of the Scottish coastline is currently protected by saltmarshes and transformed this into the total number of kilometres of the Scottish coastline that is currently protected by saltmarshes. In consultation with saltmarsh scientists and taking Beaumont et al.'s (2014) projected saltmarsh area loss into account, we determined a conservative estimate of coastline that could lose or gain protection. In the choice cards the changes in these attributes were presented to respondents with colour-coded symbols and concise supporting text as is demonstrated in Fig. 1. Concerning the initial price range, we consulted similar previous studies (Bauer et al., 2004; Birol and Cox, 2007; Perni and Martínez-Paz, 2017; Petrolia et al., 2014; Remoundou et al., 2015) and decided on a range from £25 - £150.

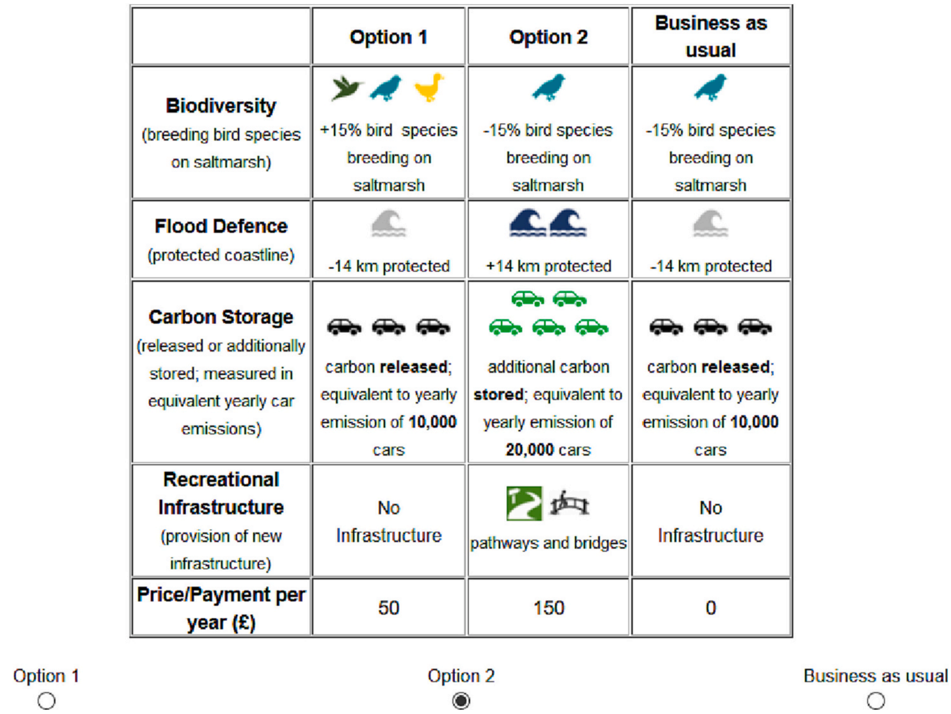
Once completed, the DCE survey was tested face-to-face in a pilot with 22 participants. From the pilot we gained an understanding of: (i) the overall content validity of the survey instrument including the understandability of the terminology and instructions for the choice scenarios; the attribute and level depiction on the choice cards; the information text on the included saltmarsh ES and whether they provided enough information for the participants to make an informed decision; and the suitability of the payment range, (ii) the prior estimates for the utility parameters to be used in the final experimental design (priors), (iii) acceptability of the length of the survey. Overall, the pilot feedback was positive regarding the length, structure, and content of the survey, but a few adjustments were made to (i) improve the understandability of the choice cards and the information text, (ii) create a stronger connection to Scottish policy, (iii) increase precision in the wording of the questions and the information text. After the pilot study we increased this price range (£25 - £300) due to feedback we received from respondents and since the BaU option was only selected twice over 22 × 6 choices. The final attributes used are listed in Table 1.

The experimental design was determined with the statistical softwares SAS and Ngene. The %mktruns autocall macro of the SAS software provided a list of reasonable sizes for the experimental design. We picked the smallest design with 0 violations of orthogonality and balance, which was 36 choice situations. Of these 36 choice situations 2 were on a choice card together, which left 18 choice cards. The choice cards were assembled using a D-efficient design in Ngene that minimised the D-error for the MNL model. We generated 18 choice sets divided into 3 blocks with 6 choice cards each to prevent respondent fatigue and used

[6] The data collection employed in this study was scrutinised and approved by the University of St Andrews, School of Geography and Sustainable Development's Teaching and Research Ethics Committee; Approval Code: GG 14206.

[7] The idea of environmental ideation is based on Dunlap and Van Liere's (1978) New Environmental Paradigm (NEP scale), which is comprised of 12 likert scale items that can measure pro-environmental orientation. Dunlap et al. (2000) updated and improved the scale. We used 5 items from the updated scale and added three items on actions that are broadly considered pro-environmental behaviour (e.g., recycling) and two items specific to the context of the survey.

[8] The carbon decrease in the BaU scenario is based on the best available information at the time the DCE was designed. As pointed out in the introduction, the study by Ladd et al. (2019) has since been published and indicates that saltmarshes are currently accreting in 5 out of six study regions in the UK.



	Option 1	Option 2	Business as usual
Biodiversity (breeding bird species on saltmarsh)	+15% bird species breeding on saltmarsh	-15% bird species breeding on saltmarsh	-15% bird species breeding on saltmarsh
Flood Defence (protected coastline)	-14 km protected	+14 km protected	-14 km protected
Carbon Storage (released or additionally stored; measured in equivalent yearly car emissions)	carbon **released**; equivalent to yearly emission of **10,000** cars	additional carbon **stored**; equivalent to yearly emission of **20,000** cars	carbon **released**; equivalent to yearly emission of **10,000** cars
Recreational Infrastructure (provision of new infrastructure)	No Infrastructure	pathways and bridges	No Infrastructure
Price/Payment per year (£)	50	150	0

Fig. 1. Example choice card.

the parameter estimates of the pilot survey as priors to generate the final design (Choice Metrics, 2018). Participants were randomly assigned one of the 3 blocks by the survey software Qualtrics. An example choice card is shown in Fig. 1.

2.3. Analytical framework and preference analysis (the model)

DCEs are based on the Random Utility Model (McFadden, 1973) which assumes that utility can be broken down into an observable part, which is the sum of the utility provided by each of the k attributes, and a random unobservable part, or error part (Bateman et al., 2002). As participants are expected to have heterogeneous preferences for some attributes such as the recreation and flood defence attributes, we use a mixed logit model. The mixed logit model can be estimated in preference space and WTP space; in WTP space the estimated parameters represent the WTP distribution parameters rather than the preference coefficients. This is achieved by changing the utility function, which is specified in preference space as presented in (1):

$$U_{nj} = \boldsymbol{\beta}_n^{'} \boldsymbol{X}_{nj} + \varepsilon_{nj} \tag{1}$$

where $\boldsymbol{X}_{nj}$ is a vector of k attributes describing alternative j presented to respondent n and $\boldsymbol{\beta}_n$ is the vector of k preference parameters. ε_{nj} represents the random unobservable part of the utility provided by alternative j to respondent n. The corresponding probability of individual n choosing alternative j over other alternatives g, $g \in [1, G]$ on a choice card, in preference space, is defined as presented in (2):

$$P(j|\boldsymbol{\beta}_n) = \frac{exp\left(\alpha_{nj} + \boldsymbol{\beta}_n^{'} \boldsymbol{X}_{nj}\right)}{\sum_{g=1}^{G} exp\left(\alpha_{ng} + \boldsymbol{\beta}_n^{'} \boldsymbol{X}_{ng}\right)} \tag{2}$$

where α_{nj} (or α_{ng}) is an alternative-specific constant associated with alternative j (or g). It shows, independent of the results for the other attributes, the utility individuals get simply from either leaving or staying in the status quo (Hanley and Barbier, 2009).

In WTP space the utility function is adjusted so that the cost coefficient multiplies the rest of the utility function as presented in (3):

$$U_{nj} = \beta_n^{'m}\left(X_{nj}^{m} + \boldsymbol{\beta}_n^{'-m} \boldsymbol{X}_{nj}^{-m}\right) + \varepsilon_{nj} \tag{3}$$

where X_{nj}^{m} is the monetary attribute and $\boldsymbol{X}_{nj}^{-m}$ a vector of all other attributes, β_n is the parameter for the monetary attribute and $\boldsymbol{\beta}_n^{-m}$ is the vector of marginal WTPs for all other attributes. While in preference space the WTP would be estimated as the ratio of the attribute preference coefficient to the monetary coefficient, the model based on this utility function (3) produces $\boldsymbol{\beta}_n^{-m}$ that are direct estimates of marginal WTP measures (Hess and Palma, 2019; Train and Weeks, 2005). This approach has been found to produce more realistic WTP measures (Train and Weeks, 2005) than calculating the WTP as the ratio of the attribute preference coefficient to the monetary coefficient. The probability function for the mixed logit model in WTP space is specified as described by Louviere et al. (2000) and presented in (4):

$$P\left(j|\boldsymbol{\beta}_n^{-m}, \beta_n^{m}\right) = \frac{exp\left(\beta_n^{'m}\left(\alpha_{nj} + \boldsymbol{X}_{nj}^{m} + \boldsymbol{\beta}_n^{'-m} \boldsymbol{X}_{nj}^{-m}\right)\right)}{\sum_{g=1}^{G} exp\left(\beta_n^{'m}\left(\alpha_{ng} + \boldsymbol{X}_{ng}^{m} + \boldsymbol{\beta}_n^{'-m} \boldsymbol{X}_{ng}^{-m}\right)\right)} \tag{4}$$

$\boldsymbol{X}_{nj}$ (or $\boldsymbol{X}_{ng}$) is a vector of k attributes describing alternative j (or g) presented to respondent n and $\boldsymbol{\beta}_{nj}$ (or $\boldsymbol{\beta}_{ng}$) is a vector of k utility parameters associated with the k attributes of alternative j (or g), each parameter being randomly distributed across individuals, and represent the weight of each attribute in utility. The alternative specific constant was coded to take the value of 1 in both management options and 0 in the BaU option. All attribute parameters were treated as random parameters and normally distributed, except for the parameter associated with the payment attribute, which was defined as lognormally distributed. The data of the mixed logit models was analysed in R (version 4.1.2) with version 0.2.7 of the apollo package published by Hess and Palma (2019).

To determine underlying classes across both subsamples for our data, we conducted a Latent Class Analysis (LCA). In STATA, the LCA is conducted as a latent class conditional logit (LCL) model. It is based on the conditional logit model but instead of assuming IID, the LCL incorporates a "discrete representation of unobserved preference heterogeneity across decision makers" (Yoo, 2020, 407), which allows the decision makers to be allocated to C distinct classes where each class c "makes choices consistent with its own clogit [conditional logit] model with utility coefficient βc" (Yoo, 2020, 407). Under the latent class model, the probability of individual n choosing alternative j is:

$$P(j|\boldsymbol{B},\boldsymbol{\Theta}) = \sum_{c=1}^{C} \pi_{nc}(\boldsymbol{\Theta}) \frac{exp\left(\alpha_{c,j} + \beta_c^{'}\boldsymbol{X}_{nj}\right)}{\sum_{g=1}^{G} exp\left(\alpha_{c,g} + \beta_c^{'}\boldsymbol{X}_{ng}\right)} \tag{5}$$

with, $\boldsymbol{B} = (\boldsymbol{\beta}_1, \boldsymbol{\beta}_2, \ldots, \boldsymbol{\beta}_C)$ a collection of the C utility coefficient vectors (one for each class $c \in [1, C]$), and $\pi_{nc}(\boldsymbol{\Theta})$ the probability that decision maker n belongs to class c, which is represented by (6):

$$\pi_{nc}(\boldsymbol{\Theta}) = \frac{exp\left(z_n^{'}\boldsymbol{\theta}_c\right)}{1 + \sum_{l=1}^{C-1} exp\left(z_n^{'}\boldsymbol{\theta}_l\right)} \tag{6}$$

where $\boldsymbol{z}_n$ is a vector of individual n's characteristics; $\boldsymbol{\theta}_c$ is a vector of membership coefficients for class c, with $\boldsymbol{\theta}_C$ set to $\boldsymbol{0}$ for the reference class; and $\boldsymbol{\Theta} = (\boldsymbol{\theta}_1, \boldsymbol{\theta}_2, \ldots, \boldsymbol{\theta}_{C-1})$ represents the $C-1$ membership coefficient vectors (Yoo, 2020, 407–408).

2.4. The study sample

The survey was distributed through a market research company. We aimed for a study sample of $n = 300$ complete responses for each version of the survey as we were advised by the company that distributed the survey that $n = 600$ participants was realistically the maximum number of participants with sufficient response quality for our specified region and quotas. Within the $n = 300$ we aimed for representativeness of the Scottish population in terms of sex and age; to achieve this, we set hard quotas. A further soft quota was set for household income. For the survey with shorter information on carbon storage, we achieved 313 completed responses with an even distribution across the quotas. For the survey with longer information, we achieved 307 completed responses and had to relax the male, age 18–24 quota. The missing complete responses were distributed evenly across the other quotas. Overall, 527 participants started the survey with shorter information and 698 started the survey with longer information. 214 and 391 responses were respectively screened out due to the set quotas or response quality concerns. We included three "red herring" questions to test whether respondents read the provided information text; respondents were screened out if they replied incorrectly to two out of the three questions. Moreover, respondents were screened out due to speeding concerns. The descriptive statistics of the respondents presented in Table 2 demonstrate the representativeness of the sample in terms of age and sex and provides an overview of respondents' other characteristics.

The survey being distributed online may have led to some selection bias since it excluded potential respondents that do not have internet access. The Scottish Government reports in its 2018 Household Survey that 87% of the Scottish population had internet access in 2018 (Scottish Government, 2020). They also report that while gaps narrowed in recent years, older adults and households with lower incomes were still less likely to have internet access. Accordingly, there was the potential that our sample could be biased towards younger adults and against adults from lower income households and from deprived areas. We steered against the first effect by including quotas for age to still reach a representative sample. However, it was not possible to adjust for the second effect. Moreover, respondents were selected from an opt-in panel, which may limit generalisability and thereby external validity. However, we weighed these issues against the ability to procure such a large, stratified sample.

We conducted balancing tests (Appendix Table 1) to check whether the random allocation to the treated and control groups worked. The tests were conducted as Chi-square tests of the variables that may have influenced participants' decisions, between the two groups. There is no indication that the randomisation of the untreated and treated samples was not successful.

3. Results

3.1. The effect of information

We analysed our data with the mixed logit model in preference and WTP space. The results are presented in Table 3. Overall, the results show positive and significant coefficients for all ES attributes (maintenance or increase in biodiversity and flood defence, provision of recreational facilities) which suggests that all attributes influence participants' preferences and WTP. The coefficients for the payment attribute are significant and as expected negative, which indicates that the payment factor worked as a deterrent for respondents when they made their choices.

In order to measure the effect of information on the preferences and WTP for a marginal increase in saltmarsh carbon storage, we let the carbon attribute interact with treatment (i.e. the carbon attribute was split into the two subsamples by treatment). A Wald test shows that there is no statistically significant difference between the carbon coefficient means of the two subsamples in preference space ($p > 0.05$). This result was also confirmed in WTP space ($p > 0.05$).

In addition, we also conducted the Wald test for the standard deviation of the carbon attribute preference coefficients to determine whether there is a significant difference in the heterogeneity of preferences between the subsamples. While the null hypothesis could not be rejected in preference space ($p > 0.05$), it could be rejected ($p < 0.05$) in WTP space. The results thus provide some indication that participants allocated to the treated subsample (i.e. more information) make more coherent choices than the respondents that received no treatment (i.e. less information). This allows for the interpretation that the increased information decreased the heterogeneity of participants' choices as they were better able to more consistently develop their preferences and make decisions.[9]

Further, to confirm these results on the effect of the treatment on choices regarding the carbon attribute, we also fit the mixed logit model in preference space without any interactions with treatment (Table 4). A Likelihood Ratio test indicates that the model in which the carbon attribute is not interacted with the treatment variable, fits the data better ($p > 0.05$), which is in line with the previous Wald test conducted in preference space. In WTP space, the Likelihood Ratio test also indicates that the model in which the carbon attribute is not interacted with the treatment variable is the better fit for the data ($p > 0.05$), which is not in line with the previous Wald test conducted in WTP space. This may indicate that the significant difference in standard deviation between the two subsamples alone (i.e. the means were not significantly different) was not significant enough for an overall better fit of the model.

Since there is no significant difference in the mean values of preferences and WTP both in preference and WTP space, we continue the analysis of participants' average WTP with the model where the carbon attribute does not interact with treatment (Table 4).

3.2. Participants' WTP

The results suggest that respondents, on average, preferred change over the status quo and support the management of saltmarshes for their

[9] We are aware of the ongoing discussion regarding the adjustment for scale heterogeneity. Scale heterogeneity is the "variance of a variance term or the standard deviation of utility over different choice situations" (Greene and Hensher, 2010, 413). However, working in WTP space avoids this issue of scale heterogeneity between the two datasets (Davis et al., 2019).

Table 2
Descriptive statistics.[a]

	Treated Sample	Control Group	Scottish Pop. 18+		Treated Sample	Control Group
n	307	313	4,409,302	n	307	313
Age (%)				**Children (%)**		
18–24	8.14	10.54	10.71	None	36.16	42.17
25–34	17.26	16.61	16.86	1	21.50	19.17
35–44	15.64	15.34	15.09	2	25.73	23.96
45–54	18.24	18.85	17.67	3	11.40	9.90
55–64	17.59	16.29	16.40	4 or more	5.21	4.47
65 and over	23.13	22.36	23.27	Prefer not to say	–	0.32
Sex (%)				**Taxpayer (%)**		
Female	53.75	52.08	51.88	Yes	70.36	72.84
Male	46.25	47.92	48.12	No	29.64	27.16
Education (%)				**Annual household Income (%)**		
High School	28.99	30.67		£ 0–12,500	16.29	13.42
College	22.80	21.09		£ 12,501–20,000	12.70	16.61
Bachelor	25.41	26.84		£ 20,001-30,000	18.89	18.21
Master	10.75	9.90		£ 30,001-40,000	18.24	21.41
PhD or higher	3.58	3.83		£ 40,001-50,000	11.07	12.46
Technical	7.17	4.15		£ over 50,000	17.59	14.06
Prefer not to say	1.30	3.51		Prefer not to say	5.21	3.83
Marital Status (%)				**Employment (%)**		
Single	30.29	32.91		Full-time	31.60	34.82
Married or Civil Partnership	48.86	46.96		Part-time	9.45	15.34
Divorced	10.10	9.58		Self employed	7.49	7.67
Widowed	6.84	4.15		Student	5.86	6.07
Other	0.65	–		Retired	28.01	20.45
Prefer not to say	3.26	6.39		Homemaker	7.49	6.39
				Not Employed	5.21	3.51
Election Participation (%)				Other	3.26	4.47
Yes	88.27	90.42		Prefer not to say	1.63	1.28
No	10.75	8.31				
Prefer not to say	0.98	1.28				

[a] The percentages regarding the age and sex distribution of the Scottish population 18+ were calculated from the National Records of Scotland 2018 Mid-Year Population Estimates, which were the latest available at the time the survey was conceptualised (National Records of Scotland, 2019).

ES. This is indicated by the positive mean preference and WTP coefficients of the alternative specific constant.[10]

Due to the coding in the data analysis, the carbon attribute WTP coefficients represent a marginal increase of the carbon storage service equivalent to the emissions of 1000 cars/year in yearly payments for a time span of 10 years; and because of the quadratic form of the variable, participants' marginal WTP depends on the value of the increase in carbon storage. It can be calculated as, for a given value of carbon storage X_C (Mariel et al., 2021):

$$mWTP_C(X_C) = \beta_C + 2\beta_{C\hat{2}}X_C.$$

While the WTP to achieve a specific level is:

$$WTP_C(X_C) = \beta_C X_C + \beta_{C\hat{2}}X_C^2$$

with β_C and $\beta_{C\hat{}2}$ the parameters associated with, respectively, the carbon attribute and the square of the carbon attribute, contained in vector $\boldsymbol{\beta}^{-m}$, in eq. (4).

The carbon attribute had 6 levels, one of which was the status quo (i.e. release of stored carbon equivalent to the release of the annual emissions of 10,000 cars) at no cost. The WTP for the other levels can be calculated relative to the status quo level. Maintaining the current carbon storage level of saltmarshes thus requires preventing the release of carbon equivalent to the annual emissions of 10,000 cars and is valued at £ 89.50/year; the average WTP to achieve an increase of carbon storage equivalent to the annual emission of 4,000, 10,000, 16,000, and 20,000 cars are presented in Table 5. We can see (Table 5) that the marginal WTP for carbon storage decreases for higher levels of carbon storage, with a maximum WTP for an increase of carbon stored equivalent to the annual emissions of 10,000 cars.

Furthermore, it is worth noting (Table 4) that for both the flood protection and the biodiversity attributes, a higher mean WTP was shown for an increase of the service rather than for just maintaining it (i.e., preventing a decline, which was the BaU option). This is not the case for the recreation attribute; respondents have a positive mean WTP for increasing access to marsh with bridges and boardwalks but show a lower mean WTP for adding the same infrastructure with additional bird hides. This suggests that the majority of respondents have a low interest in bird hides but would like improved access to saltmarshes.

3.3. Latent class analysis

To conduct the LCA, we first had to reduce the individually specific variables that influence class membership probability through a k-means cluster analysis; without this summarisation, the LCA model struggled to converge due to the high number of individually specific variables. An overview of the variables is provided in Table 6. We identified three groups within these variables: (i) demographic variables, (ii) variables regarding participants' familiarity and existing knowledge about saltmarshes, and (iii) variables that provide information regarding participants' personal experiences and attitudes. We summarised the first group (demographic characteristics) and a subset (i.e. environmental attitude variables) of the third group of our explanatory variables with this method. For the second group, the

[10] The alternative specific constant was coded to take the value of 1 in both management options and 0 in the BaU option.

Table 3
Mixed logit model with interaction treatment - carbon in preference and WTP space.

	Preference Space	WTP space
Number of observations	10,536	10,536
Number of parameters	24	24
Log likelihood	−2727.66	−2868.32
AIC	5503.33	5784.64
BIC	5651.26	5932.58

Choice	**Mean (St. error)**	**Standard deviation (St. error)**	**Mean (St. error)**	**Standard deviation (St. error)**
Maintaining current biodiversity level	0.607***	−0.110	71.100***	−21.538
	(0.074)	(0.424)	(12.153)	(27.728)
Increasing biodiversity level	1.040***	−0.200	177.974***	−37.040**
	(0.090)	(0.322)	(12.368)	(14.654)
Maintaining current flood defence level	0.516***	−0.012	74.314***	51.272***
	(0.073)	(0.206)	(10.432)	(10.748)
Increasing flood defence level	1.116***	0.710***	201.704***	−78.516***
	(0.097)	(0.141)	(12.445)	(15.608)
Increase in carbon storage (in emissions eq. of 1,000 cars) (short information)	0.082***	0.044***	13.370***	7.021***
	(0.011)	(0.010)	(1.743)	(0.955)
(Increase in carbon storage)ˆ2 (short information)	−0.002***	−0.002	−0.353***	−0.072
	(0.001)	(0.001)	(0.118)	(0.051)
Marginal increase in carbon storage (in emissions eq. of 1,000 cars) (long information)	0.060***	0.031***	11.680***	3.765***
	(0.010)	(0.008)	(1.298)	(0.713)
(Increase in carbon storage)ˆ2 (long information)	−0.001	0.000	−0.324***	0.061
	(0.001)	(0.002)	(0.090)	(0.074)
Providing bridges and boardwalks	0.570***	0.229	82.335***	−7.240
	(0.079)	(0.237)	(10.898)	(20.567)
Providing bridges, boardwalks, and bird hides	0.342***	0.311	53.807***	−70.420***
	(0.075)	(0.233)	(9.917)	(10.610)
asc (alternative specific constant)	3.337***	2.738***	641.883***	673.331***
	(0.326)	(0.303)	(49.604)	(50.590)
Increase in income tax for 10 years	−0.047***	0.982	−0.020***	0.049
	(0.014)	(0.763)	(0.007)	(0.031)

The sign of the estimated standard deviations is irrelevant: interpret them as being positive.
***, ** and * indicate 1,5 and 10% significance levels respectively.

cluster analysis did not reach a stable result that was suitable to be used in further analysis and those individually specific variables were thus used for the LCA in an unaggregated form.

The cluster analysis of respondents based on the demographic characteristics led to the identification of 2 clusters: one cluster of respondents who tend to (i) be older, (ii) be educated to High School or Bachelor level, (iii) be or were married, (iv) have children, (v) have a higher household income, (vi) pay income tax, (vii) be retired or homemakers, and (vii) have participated in the last election; while the other cluster is composed of respondents who tend to (i) be younger, (ii) be not married, (iii) not have children, (iv) have a lower household income, (v) be students or not employed, and (vi) not have voted in the last election. Regarding the clustering of respondents according to their environmental preferences, we also identified 2 clusters: one cluster of respondents who tend to (i) scale high on the NEP scale, (ii) be more likely to support policy with a focus on the environment, (iii) be more likely to support moving infrastructure to enable the coastline to adapt to sea-level rise, (iv) be more likely to recycle and donate to conservation organisations, and (v) to be more likely to eat organic food; while the other cluster is composed of participants that tend to (i) score lower on the NEP scale, (ii) be less likely to support moving infrastructure, (iii) be less likely to recycle and donate to conservation organisations, and (iv) be less likely to eat organic food. Whether respondents belonged to one or the other of these two types of clusters was used as an explanatory variable for the class membership in the LCA.

We determined through class enumeration (LCA models with 2 to 4 classes) that the model with three classes is the best fit for our DCE data. We used the AIC, CAIC, and BIC fit statistics (Table 7) and checked the posterior class probability (i.e. how likely is it that a participant ends up in a particular class when we take their sequence of choices into account). For the three-class model, this probability was 95.85% for class 1, for class 2 it was 90.15%, and for class 3 97.44%. We then also had a look at the results of the most promising class model to check whether they seemed reasonable. The LCL model is estimated in preference space.[11] The results are presented in Table 8.

3.3.1. *Class 1 – Improvement of all attributes: the Ideologists*

Class 1 is the largest class (64.5%), and respondents have statistically significant positive preference coefficients ($p < 0.05$) for all attributes including the ASC, except for the payment attribute. The payment attribute is negative as expected but its effect on choices is only significant at the 90% confidence level. This indicates a strong preference of the management scenarios over the status quo. Consistent with the strong preference for change, the coefficients for an increase in biodiversity and flood protection are larger than the coefficients that represent only maintaining those services at the current level, and are the largest of the 3 classes. The observed preferences and low significance of the payment attribute suggest members of this class followed an ideological inclination, paying lower attention to the payment attribute than

[11] While the survey was only sent out to Scottish residents, 107 participants were located outside of Scotland in England and Northern Ireland when the survey was undertaken. We conducted a robustness test to check whether the results change when participants who were located outside of Scotland are excluded. The test showed that our results are overall robust; excluding the participants located outside of Scotland did not significantly change the class allocation. The only significant change in the robustness test occurs for level 1 of the recreational attribute (providing bridges and boardwalks), which changes from being significant at the 95% level ($p = 0.049$) to not being significant.

Table 4
Mixed logit model in preference and WTP space.

	Preference Space		WTP Space	
Number of observations		10,536		10,536
Number of parameters		20		20
Log likelihood		−2730.56		−2872.68
AIC		5501.12		5785.36
BIC		5624.4		5908.64

Choice	**Mean (St. error)**	**Standard deviation (St. error)**	**Mean (St. error)**	**Standard deviation (St. error)**
Maintaining current biodiversity level	0.601***	−0.092	70.302 ***	−29.018 ***
	(0.073)	(0.411)	(10.335)	(8.696)
Increasing biodiversity level	1.049***	−0.196	177.912 ***	−5.805
	(0.091)	(0.367)	(11.669)	(15.502)
Maintaining current flood defence level	0.512***	−0.003	73.231***	−59.112***
	(0.073)	(0.206)	(9.923)	(11.164)
Increasing flood defence level	1.125***	0.710***	199.607***	−77.996***
	(0.098)	(0.145)	(12.422)	(10.760)
Increase in carbon storage (in emissions eq. of 1,000 cars)	0.072***	−0.039***	12.340 ***	5.157 ***
	(0.009)	(0.007)	(1.016)	(0.660)
(Increase in carbon storage)^2	−0.002***	0.001	−0.339***	0.001
	(0.001)	(0.002)	(0.070)	(0.044)
Providing bridges and boardwalks	0.571***	0.164	81.912 ***	29.090**
	(0.079)	(0.429)	(11.125)	(11.856)
Providing bridges, boardwalks, and bird hides	0.343***	0.325	54.227 ***	−67.874***
	(0.075)	(0.218)	(9.130)	(10.705)
asc (alternative specific constant)	3.392***	2.832***	656.472 ***	683.845 ***
	(0.334)	(0.343)	(45.765)	(48.303)
Increase in income tax for 10 years	−0.035***	0.527*	−0.023**	0.062
	(0.008)	(0.292)	(0.009)	(0.046)

The sign of the estimated standard deviations is irrelevant: interpret them as being positive.
***, ** and * indicate 1,5 and 10% significance levels respectively.

Table 5
Marginal WTP for the different levels of the carbon attribute.

Carbon Attribute Level with corresponding % change in total carbon stored in Scottish saltmarshes	Marginal WTP (in £, for an increase of 1,000 cars equivalent in C storage)	Average WTP (in £, per year for 10 years)
BaU: *release* of carbon currently stored equivalent to the annual emissions of 10,000 cars (−2.5%)	12.34	–
Maintaining current levels of carbon storage (±0%)	5.56	89.50
Increase of carbon stored equivalent to the annual emissions of 4,000 cars (+1%)	2.85	106.32
Increase of carbon stored equivalent to the annual emissions of 10,000 cars (+2.5%)	−1.22	111.20
Increase of carbon stored equivalent to the annual emissions of 16,000 cars (+4%)	−5.29	91.68
Increase of carbon stored equivalent to the annual emissions of 20,000 cars (+5%)	−8.00	65.10

the average effect estimated in the Mixed logit model. This interpretation is supported by the characteristics of participants that were sorted into this class. Respondents were more likely to be allocated to this class if they belonged to the cluster with high scores for the environmental attitude statements. Respondents of this class were thus more likely to have a favourable attitude towards the environment. Moreover, respondents were more likely to be allocated to class 1 if they scored high on the discounting scale and were thus more likely to give something up that was beneficial to them in the present to benefit more from it in the future. Although statistically not as robust ($p = 0.082$), respondents were also more likely to have a previous knowledge of saltmarshes' value for recreation.

3.3.2. Class 2 – Improvement of carbon storage: the Rationalists and Prioritisers

Class 2 is the second largest class (26.5%). Respondents have statistically significant positive preference coefficients only for the ASC, the carbon attribute, the provision of bridges and boardwalks as recreational infrastructure and the payment attribute, which is negative as expected. Respondents allocated to this class thus prefer the management options over the status quo, but the payment acts as a deterrent. This indicates that members allocated to this class behaved rationally regarding the payment attribute, exhibiting a more cautious attitude with preferences for change decreasing when prices increase. An interpretation for this could be that since members of this class only showed an interest in the marginal increase of the carbon attribute, the payment associated with the management options were frequently considered too high; or that the carbon attribute was prioritised over other attributes due to limited means to pay for change as opposed to members of class 1 who preferred change with less weight given to costs. Yet, the demographics variable, which includes income, was not significant for determining class allocation, which supports the notion that members of this class exhibited more rational behaviour rather than being limited by a higher budget constraint. Similarly to the mixed logit model, respondents from class 2 display decreasing marginal utility of increased carbon storage, as indicated by the negative coefficient associated with the square of the carbon storage attribute. Respondents were more likely to be allocated to class 2, if they scored high on the discounting scale (higher levels of patience) ($p = 0.048$); however, they were less likely to do so relative to class 1. They were also more likely to be allocated to this class if they had a previous knowledge of saltmarshes' value for flood protection ($p = 0.006$). This may imply that these participants were more familiar with saltmarshes due to proximity; however, distance to the coast was included as a variable in the LCA and was found to not be a significant factor in class allocation. Nevertheless, this knowledge implies a greater familiarity with saltmarshes.

Table 6
The three individually specific variables groups that influence class membership probability.

1. Demographic variables

	N	%		N	%
Sex			Pay income tax		
Male	292	47.10	Yes	444	71.61
Female	328	52.90	No	176	28.39
Age			Marital Status		
18–24	58	9.35	Single	196	31.61
25–34	105	16.94	Married/Civil Partnership	297	47.90
35–44	96	15.48	Divorced	61	9.84
45–54	115	18.55	Widowed	34	5.48
55–64	105	16.94	Other	30	4.84
65+	141	22.74	Prefer not to say	2	0.32
Children	376	60.65	Participated in the last election		
Yes	243	39.19	Yes	554	89.35
No	1	0.16	No	59	9.52
Prefer not to say			Prefer not to say	7	1.13
Income (£/year)			Employment		
£ 0–12,500	92	14.84	Employed (incl. Self-employed)	330	53.23
£ 12,501–20,000	91	14.68	Homemaker	43	6.94
£20,001-30,000	115	18.55	Seeking opportunities	27	4.35
£30,001-40,000	123	19.84	Student	37	5.97
£40,001-50,000	73	11.77	Retired	150	24.19
£50,000+	98	15.81	Other	24	3.87
Prefer not to say	28	4.52	Prefer not to say	9	1.45
Education					
High School Qualifications	185	29.84			
College Qualifications (e.g. HNC/HND)	136	21.94			
Bachelor's Degree	162	26.13			
Master's Degree	64	10.32			
PhD or higher	23	3.71			
Technical Qualifications (e.g. apprenticeship, etc.)	35	5.65			
Prefer not to say	15	2.42			

2. Variables that provide information regarding participants' familiarity and existing knowledge about saltmarshes

	N	%		N	%
Have heard about saltmarshes			Have been to a saltmarsh		
Yes	326	52.58	Yes	205	33.06
No	294	47.42	No	415	66.94

	N	Min.	Max.	Mean	Std. Dev.
Know about saltmarsh biodiversity	620	1	5	4.12	0.75
Know about saltmarsh carbon storage	620	1	5	3.78	0.78
Know about saltmarsh flood protection	620	1	5	3.75	0.79
Know about saltmarsh recreational value	620	1	5	3.45	0.81

3. Variables that provide information regarding participants' personal experiences and attitudes

	N	Min.	Max.	Mean	Std. Dev.
NEP scale					
We are approaching the limit of the number of people the earth can support	620	0	5	3.75	1.01
When humans interfere with nature it often produces disastrous consequences	620	0	5	4.14	0.86
Humans are severely abusing the environment	620	0	5	4.29	0.797
Plants and animals have as much right as humans to exist	620	0	5	4.32	0.79
If things continue on their present course, we will soon experience a major ecological catastrophe	620	0	5	4.12	0.89
Support a political focus on the environment	620	0	5	4.17	0.86
Donate to conservation associations	620	0	5	2.41	1.13
Practice recycling	620	0	5	4.49	0.84
Should consider moving infrastructure so the coastline can naturally adapt to sea-level rise	620	0	5	3.66	0.91
Buy organic products	620	0	5	2.79	1.03
Risk scale (1 very risk averse to 11 very risk taker)	620	1	11	6.19	2.47
Discount scale (1 very impatient to 11 very patient)	620	1	11	7.57	1.96

	N	%
Have been affected by flooding		
Yes	36	5.81
No	584	94.19

Table 7
LCA fit statistics.

Classes	AIC	CAIC	BIC
2	5762.773	5941.954	5908.954
3	5484.92	**5788.984**	**5732.984**
4	**5460.348**	5889.296	5810.296

3.3.3. Class 3 – Business as Usual

Class 3 is the smallest class (9.0%). The ASC coefficient is significant ($p < 0.05$); however, it is negative which indicates that respondents prefer the status quo over the management scenarios. Furthermore, the coefficient for maintaining current flood protection levels is negative and significant but at a low level of confidence. The payment coefficient is not significant since the BaU option comes at no cost. Relative to members of classes 1 and 2, respondents were more likely to be allocated to this class if they scored lower for the environmental attitude variable and the discounting scale (more impatient) and if they scored lower on the previous knowledge questions for the recreation and flood protection services of saltmarshes. Moreover, they were less likely, to have previously heard of saltmarshes before taking the survey.

4. Discussion

Overall, we found that participants preferred change over the status quo but that the payment acts as a deterrent. It is difficult to compare our WTP results for the carbon storage service with the valuation results of other studies. All the studies that value the saltmarsh carbon storage ecosystem service in the UK use different valuation methods. Even Luisetti et al. (2011) and Luisetti et al. (2014) who include a DCE approach, value the carbon storage service separately with a differing method. Our WTP results are presented per respondent and had to be transformed into a medium that is comprehensible to respondents (i.e. car emissions) while other studies determine value by ha or by tC. To illustrate the difficulty to compare the estimates, we calculated the average WTP per respondent for an increase of 1 tC storage in saltmarshes, which would be £ 0.01; converted to CO_2e it would be even less with 0.003 £/tCO_2e.[12] However, the carbon price, which is based on marginal abatement costs (BEIS, 2021) would not be paid by a single person. The 2020 carbon price, which was the year the DCE was carried out, was set as 241 £/tCO_2e with a 50% sensitivity range (BEIS, 2021). A further factor that makes a comparison difficult is the dynamic nature of the carbon price. Luisetti et al. (2011) use a carbon price based on the SCC, which has since been declared as not fit for use for determining the carbon price (BEIS, 2021). Luisetti et al. (2014) and Beaumont et al. (2014) used the DECC's (2011) non-traded carbon price that replaced the SCC. Yet, this carbon price has since also been updated and increased (BEIS, 2021). Additionally, independent from the method that was used in valuation studies, the determined values are also not fixed. Quite the contrary, it can be expected that natural capital and ecosystem services values will increase in the future since the habitat decline causes them to become more stressed and scarcer in the future; while the supply diminishes, the demand will remain or even increase leading to rising prices. This creates a compelling argument for conservation which can supplement the ethical rationales for conservation (Costanza et al., 1997; Grunewald and Bastian, 2015).

However, one limitation of the stated preference method is summarised by Costanza et al. (1997) and pertains to potentially ill-informed individuals whose preferences may not sufficiently incorporate aspects such as ecological sustainability and social fairness. Costanza et al. (1997) explain that if these aspects were taken into account, market prices and surveys of WTP would very likely yield higher values of ecosystem services. We mitigated the effect of ill-informed respondents by providing information on the habitat and the different ecosystem services. The other factors Costanza et al. (1997) name, such as the social fairness of respondents' preferences are inherent to the method and difficult to mitigate. Nevertheless, as the authors also state, these factors are more likely to cause an undervaluation and thus conservative valuation estimates rather than an overvaluation of ecosystem services.

The treatment in the form of additional information did not influence WTP but participants who received the additional information made more consistent choices. Boyle (1989) reports comparable results regarding the effect of information on preferences for a contingent valuation study on the trout fishery in Wisconsin; he finds that "gross changes in a minimal commodity description can significantly alter value statements and small refinements in a specific commodity description do not alter estimated means" (Boyle, 1989, 61). He cautions against simply applying the findings to other contexts since these results were derived from a distinct application (i.e. trout fishery in Wisconsin). He also stresses that researchers need to be careful to provide complete information on the commodity that is to be valued to the respondents allocated to the control group. Consequently, the additional information provided to the treated group would be a refinement of the information the control group receives. This matches our approach of providing additional information as a treatment to one subsample and we can confirm Boyle's (1989) general results. That Boyle's (1989) appeal to be cautious about transferring results to other contexts is warranted is confirmed by Shapansky et al. (2008) who found that different levels of information and involvement in the valuation assessment did not reliably decrease the error variance.

There are also limitations to our approach. Our study was focused specifically on saltmarshes, but there is a wide range of different coastal, terrestrial, and marine habitats that can provide similar ecosystem services (e.g. seagrasses, sand dunes, etc.) and as Himes-Cornell et al. (2018) caution, there are differences how communities value services provided by their local ecosystems; further studies across different ecosystems are thus necessary to determine whether our findings regarding the effect of information can be generalised for environmental management in Scotland. Moreover, it could be the case that the additional information provided to the treated group had no effect on average WTP since it was too in depth and that the information provided to the control group was perceived as sufficient to make a well-informed choice; hence, there could be a saturation threshold for information where additional new information no longer influences average WTP estimates (Needham et al., 2018). This effect has been previously reported by Munro and Hanley (2001) and Bergstrom et al. (1989).

The results of the LCA also revealed another interesting point regarding information. The members of class 3 who preferred the status quo over change, were less likely to have previously heard of saltmarshes before taking the survey. A greater familiarity with saltmarshes thus appears to be connected to a WTP for change. This observation is in line with previous observations made in the literature. Accordingly, people tend to be more knowledgeable about things they care about and familiarity with the subject of the study can influence participants' WTP (Czajkowski et al., 2015; Needham et al., 2018).

Overall, the study demonstrates that there is support and WTP for a whole-ecosystem approach. A focus on a single ES in saltmarsh management may thus lead to a loss of support from the public and losing out on potential funding for the improvement of other ES. Accounting for the multiple ecosystem services that can be provided through saltmarsh conservation can help fund saltmarsh management projects, contributing both to the net-zero targets and the delivery of other benefits. This finding is also reflected in the wider literature (Reed et al., 2022) and presents an interesting insight for policy makers beyond the Scottish context. It demonstrates that policies singling out carbon may not be the best long-term approach, even though they seem to be a good strategy to work towards domestic and international goals of reducing carbon

[12] The calculations are based on the £ 12.34 marginal WTP value at the Status quo level of carbon storage, see Table 5.

Table 8
Latent class model with 3 latent classes.

Latent Class model	Class 1 (64.5%)			Class 2 (26.5%)			Class 3 (9.0%)		
3 classes	Estimate	Std. Err.	p-val(0)	Estimate	Std. Err.	p-val(0)	Estimate	Std. Err.	p-val(0)
Preferences									
Maintaining current biodiversity level	0.726***	0.097	0.000	0.045	0.153	0.767	0.550	0.368	0.135
Increasing biodiversity level	1.260***	0.129	0.000	0.156	0.183	0.394	−0.419	0.480	0.383
Maintaining current flood defence level	0.520***	0.079	0.000	0.050	0.152	0.741	−0.879*	0.455	0.053
Increasing flood defence level	1.276***	0.133	0.000	0.268	0.194	0.168	0.076	0.406	0.852
Increase in carbon storage (in emissions eq. of 1,000 cars)	0.060***	0.010	0.000	0.042***	0.014	0.003	−0.018	0.028	0.512
(Increase in carbon storage)^2	−0.001	0.001	0.453	−0.002**	0.001	0.037	0.0002	0.002	0.908
Providing bridges and boardwalks	0.478***	0.088	0.000	0.302**	0.153	0.049	−0.083	0.436	0.850
Providing bridges, boardwalks, and bird hides	0.282***	0.083	0.001	−0.007	0.167	0.965	0.366	0.414	0.376
asc (alternative specific constant)	0.853***	0.240	0.000	2.143***	0.258	0.000	−1.877***	0.573	0.001
payment	−0.002*	0.001	0.076	−0.013***	0.001	0.000	−0.002	0.002	0.264
Class membership							Reference Class		
Demographics (clustered)	0.359	0.342	0.294	0.141	0.371	0.703	–	–	–
Have heard about saltmarshes	0.158	0.369	0.669	−0.010	0.395	0.979	–	–	–
Have been to a saltmarsh	−0.295	0.425	0.487	−0.741*	0.444	0.096	–	–	–
Knowledge Question: Biodiversity	0.199	0.231	0.391	0.092	0.253	0.715	–	–	–
Knowledge Question: Flood Protection	0.350	0.251	0.164	0.749***	0.273	0.006	–	–	–
Knowledge Question: Carbon Storage	0.303	0.266	0.254	−0.101	0.280	0.718	–	–	–
Knowledge Question: Recreation	0.400*	0.230	0.082	0.084	0.245	0.731	–	–	–
Environmental Attitude (clustered)	−1.493***	0.371	0.000	−0.606	0.406	0.136	–	–	–
Have been affected by flooding	−1.482	1.182	0.210	−2.148*	1.173	0.067	–	–	–
Risk Scale	−0.075	0.076	0.325	−0.084	0.081	0.296	–	–	–
Discount Scale	0.336***	0.090	0.000	0.188**	0.095	0.048	–	–	–
Distance to Coast	−0.004	0.017	0.798	−0.021	0.020	0.290	–	–	–

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

emissions. The UK, for example, takes a pioneering role in developing carbon codes to finance ecosystem restoration. A UK saltmarsh code is currently under development to sit alongside the already existing Woodland and Peatland carbon codes. However, their presentation of co-benefits that can be achieved through the carbon code, such as reducing coastal erosion, mitigating storm surge flooding, and the value saltmarshes provide for biodiversity, is a step in the right direction and may incentivise funders beyond those who have an interest only in carbon storage (Forest Carbon, 2023; UKCEH, 2023).

Costanza et al. (2017) included a table with different uses for ecosystem service valuation ranging from raising awareness to specific policy analyses. This highlights the value and importance of valuation studies for policy. Our study can be of use for policy in several ways; (i) it can be allocated to two of the uses the authors included in the table (i.e. (a) the 'Raising Awareness and Interest' category and (b) the Payment for Ecosystem Services' category) and (ii) it contributes to the understanding of the effect information can have on public preferences. Especially the latter contribution as well as the determination of participant's WTP for saltmarsh ecosystem services are valuable to policy.

5. Conclusion

Our results show that there is support within the Scottish public to manage saltmarshes for their carbon storage benefit and to realise their potential as a nature-based solution for climate change mitigation; information campaigns have the potential to support this process since they can help the public make more informed decisions. Additionally, although we focused on the carbon ecosystem service, the results of our study also revealed that there is considerable support and WTP for the management of the other saltmarsh ecosystem services we included in the experiment (i.e. biodiversity, flood defence, recreation). The flood protection ecosystem service in particular can provide additional benefits for climate change adaptation. The need for holistic approaches instead of singling out particular services has also been confirmed in the funding context (Reed et al., 2022). We conclude thus that management of saltmarshes should go beyond the carbon storage service and the potential for climate change mitigation and take all ecosystem services into account in a whole-ecosystem approach to realise a wide range of benefits including both benefits for climate change mitigation and climate change adaptation.

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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.

Data availability

The data was collected under strict ethics guidelines that only allow for data publication in an aggregated form. The raw data collected for this project can hence not be made freely available.

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Appendix A. Appendix

Table A1 Balancing Tests to test whether the random sampling was successful.

Variable Name	Variable Descriptor	Chi-2 test result	Variable Name	Variable Descriptor	Chi-2 test result
Sex	q26	$p = 0.677$	Heard about saltmarshes	q5	$P = 0.819$
Age	q27	$p = 0.942$	Have visited a saltmarsh	q6	$P = 0.531$
Education	q28	$p = 0.397$	NEP scale item 1	q22_1	$P = 0.165$
Marital Status	q29	$p = 0.108$	NEP scale item 2	q22_2	$P = 0.920$
Children	q30	$p = 0.620$	NEP scale item 3	q22_3	$P = 0.738$
Income	q31	$p = 0.491$	NEP scale item 4	q22_4	$P = 0.700$
Employment	q32	$p = 0.231$	NEP scale item 5	q22_5	$P = 0.945$
Taxpayer	q18	$p = 0.493$	NEP scale item 6	q22_6	$P = 0.396$
Election Participation	q34	$p = 0.556$	NEP scale item 7	q22_7	$P = 0.419$
Likert-scale: knowledge biodiversity	q14_1	$p = 0.976$	Recycling	q23_1	$P = 0.155$
Likert-scale: knowledge flood protection	q14_3	$p = 0.815$	Donations	q23_2	$P = 0.617$
Likert-scale: knowledge carbon storage	q14_4	$p = 0.485$	Buy organic products	q23_3	P = 0.231
Likert-scale: knowledge recreation	q14_5	$p = 0.660$	Risk scale	q24	$P = 0.179$
Affected by flooding in the past	q13	$p = 0.724$	Discounting scale	q25	$P = 0.394$

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2023.107863.

References

Barbier, E.B., et al., 2011. The value of estuarine and coastal ecosystem services. Ecol. Monogr. 81 (2), 169–193. https://doi.org/10.1890/10-1510.1.

Bateman, I.J., et al., 2002. Economic Valuation with Stated Preference Techniques: A Manual. Edward Elgar, Cheltenham.

Bauer, D.M., et al., 2004. Public preferences for compensatory mitigation of salt marsh losses: a contingent choice of alternatives. Conserv. Biol. 18 (2), 401–411. https://doi.org/10.1111/j.1523-1739.2004.00367.x.

Beaumont, N.J., et al., 2014. The value of carbon sequestration and storage in coastal habitats. Estuar. Coast. Shelf Sci. 137 (1), 32–40. https://doi.org/10.1016/j.ecss.2013.11.022.

BEIS, 2021. Policy paper - Valuation of greenhouse gas emissions: for policy appraisal and evaluation. [online]. Available at: https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation [Accessed 22 June 2022].

Bergstrom, J.C., et al., 1989. Information effects in Contingent markets. Am. J. Agric. Econ. 71 (3), 685–691. https://doi.org/10.2307/1242024.

Bertram, C., et al., 2021. The blue carbon wealth of nations. Nat. Clim. Chang. 11 (8), 704–709. https://doi.org/10.1038/s41558-021-01089-4.

Birol, E., Cox, V., 2007. Using choice experiments to design wetland management programmes: the case of Severn estuary wetland, UK. J. Environ. Plan. Manag. 50 (3), 363–380. https://doi.org/10.1080/09640560701261661.

Boeri, M., et al., 2020. Public preferences for multiple dimensions of bird biodiversity at the coast: insights for the cultural ecosystem services framework. Estuar. Coast. Shelf Sci. 235, 106571 https://doi.org/10.1016/j.ecss.2019.106571.

Boyle, K.J., 1989. Commodity specification and the framing of contingent-valuation questions. Land Econ. 65 (1), 57–63. https://doi.org/10.2307/3146264.

Boyle, K.J., et al., 1990. Species substitution and question sequencing in Contingent Valuation surveys evaluating the hunting of several types of wildlife. Leis. Sci. 12 (1), 103–118. https://doi.org/10.1080/01490409009513092.

Burrows, M., et al., 2014. Assessment of Carbon Budgets and Potential Blue Carbon Stores in Scotland's Coastal and Marine Environment. Project Report. Scottish Natural Heritage Commissioned Report No. 761 [pdf] SNH. Available at: https://www.nature.scot/snh-commissioned-report-761-assessment-carbon-budgets-and-potential-blue-carbon-stores-scotlands [Accessed 19 April 2020].

Champ, P.A., et al., 2017. A Primer on Nonmarket Valuation, 2nd ed. Springer, Dordrecht.

Choice Metrics, 2018. Ngene User Manual and Reference Guide [pdf] Choice Metrics. Available at: http://www.choice-metrics.com/download.html#manual [Accessed 11 August 2021].

Climate Change (Emissions Reduction Targets) (Scotland) Act 2019, 2019 [online] Available at: https://www.legislation.gov.uk/asp/2019/15/contents/enacted> [Accessed 05 August 2022].

Climate Change (Scotland) Act 2009, 2009 [online] Available at: https://www.legislation.gov.uk/asp/2009/12/contents> [Accessed 05 August 2022].

Costanza, R., et al., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253–260. https://doi.org/10.1038/387253a0.

Costanza, R., et al., 2017. Twenty years of ecosystem services: how far have we come and how far do we still need to go? Ecosyst. Serv. 28 (A), 1–16. https://doi.org/10.1016/j.ecoser.2017.09.008.

Czajkowski, M., et al., 2015. The effects of experience on preferences: theory and empirics for environmental public goods. Am. J. Agric. Econ. 97 (1), 333–351.

Czajkowski, M., et al., 2016. Controlling for the effect of Information in a public goods discrete choice model. Environ. Resour. Econ. 63 (3), 523–544. https://doi.org/10.1007/s10640-014-9847-z.

Davis, K.J., et al., 2019. Scale heterogeneity and its implications for discrete choice analysis. Land Econ. 95 (3), 353–368. https://doi.org/10.3368/le.95.3.353.

DECC, 2011. A Brief Guide to the Carbon Valuation Methodology for UK Policy Appraisal [online] Available at: https://www.gov.uk/government/publications/carbon-valuation-methodology-for-uk-policy-appraisal [Accessed 22 June 2022].

Doody, J.P., 2013. Coastal squeeze and managed realignment in Southeast England, does it tell us anything about the future? Ocean Coast. Manag. 79, 34–41. https://doi.org/10.1016/j.ocecoaman.2012.05.008.

Dunlap, R.E., Van Liere, K.D., 1978. The "new environmental paradigm": a proposed measuring instrument and preliminary results. J. Environ. Educ. 9, 10–19. https://doi.org/10.1080/00958964.1978.10801875.

Dunlap, R.E., et al., 2000. Measuring endorsement of the new ecological paradigm: a revised NEP scale. J. Soc. Issues 56 (3), 425–442. https://doi.org/10.1111/0022-4537.00176.

Feagin, R.A., et al., 2010. Salt marsh zonal migration and ecosystem service change in response to global sea level rise: a case study from an urban region. Ecol. Soc. 15 (4), 1–15.

Flores, L.P., 2012. Ecosystem Service Valuation: Opportunities for Increased Protection and Conservation in Clallam County, WA. Master's thesis. The Evergreen State College, Olympia, Washington, USA [online] Available at: https://archives.evergreen.edu/mastersthesess/Accession86-10MES/Flores_L-thesis2012.pdf [Accessed 20 January 2023].

Forest Carbon, 2023. Blue Carbon in UK Waters [online] Available at: <https://www.forestcarbon.co.uk/news/blue-carbon-uk-waters#:~:text=The%20Saltmarsh%20Code,funding%20into%20coastal%20ecosystem%20restoration> [Accessed 09 February 2023].

Fuller, R.J., 2010. Bird Habitats in Britain, Digital ed. T & AD Poyser, London.

The distribution and conservation of birds of coastal salt marshes. In: Greenberg, R., Maslo, B., Lockwood, J.L., et al. (Eds.), 2014. Coastal Conservation. Cambridge University Press, Cambridge, pp. 180–242.

Greene, W.H., Hensher, D.A., 2010. Does scale heterogeneity across individuals matter? An empirical assessment of alternative logit models. Transportation 37 (3), 413–428. https://doi.org/10.1007/s11116-010-9259-z.

Grilli, G., et al., 2022. The role of choice experiments in natural capital accounting approaches: fast track versus simulated exchange value in the Deben estuary saltmarshes. J. Environ. Plan. Manag. 65 (7), 1281–1300. https://doi.org/10.1080/09640568.2021.1957794.

Development and Fundamentals of the ES Approach. In: Grunewald, K., Bastian, O., Grunewald, K., Bastian, O. (Eds.), 2015. Ecosystem Services: Concept, Methods and Case Studies. Springer, Berlin, pp. 13–34.

Hanley, N., Barbier, E.B., 2009. Pricing Nature - Cost-Benefit Analysis and Environmental Policy. Edward Elgar, Cheltenham.

Haynes, T.A., 2016. Scottish Saltmarsh Survey National Report. Scottish Natural Heritage Commissioned Report No. 786.

Hensher, D.A., et al., 2015. Applied Choice Analysis, 2nd ed. Cambridge University Press, Cambridge.

Hess, S., Palma, D., 2019. Apollo: a flexible, powerful and customisable freeware package for choice model estimation and application. J. Choice Model. 32, 1–26. https://doi.org/10.1016/j.jocm.2019.100170.

Himes-Cornell, A., et al., 2018. Valuing ecosystem services from blue forests: a systematic review of the valuation of salt marshes, sea grass beds and mangrove forests. Ecosyst. Serv. 30 (A), 36–48. https://doi.org/10.1016/j.ecoser.2018.01.006.

Howard, J., et al., 2017. Clarifying the role of coastal and Marine Systems in Climate Mitigation. Front. Ecol. Environ. 15 (1), 42–50. https://doi.org/10.1002/fee.1451.

IPCC, 2018. Global Warming of 1.5°C: Proposed Outline of the Special Report in 2018 on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change Sustainable Development, and Efforts to Eradicate Poverty [online] Available at: https://www.ipcc.ch/sr15/ [Accessed 19 April 2020].

Jessoe, L., Rapson, D., 2014. Knowledge is (less) power: experimental evidence from residential energy use. Am. Econ. Rev. 104 (4), 1417–1438. https://doi.org/10.1257/aer.104.4.1417.

Johnston, R.J., et al., 2017. Contemporary guidance for stated preference studies. J. Assoc. Environ. Resour. Econ. 4 (2), 319–405. https://doi.org/10.1086/691697.

Kim, J.H., et al., 2022. Public perceptions of blue carbon in South Korea: findings from a choice experiment. Mar. Policy 144, 105236. https://doi.org/10.1016/j.marpol.2022.105236.

Klenert, D., et al., 2018. Making carbon pricing work for citizens. Nat. Clim. Chang. 8, 669–677. https://doi.org/10.1038/s41558-018-0201-2.

Ladd, C.J.T., et al., 2019. Sediment supply explains long-term and large-scale patterns in salt marsh lateral expansion and Erosion. Geophys. Res. Lett. 46 (20), 11178–11187. https://doi.org/10.1029/2019GL083315.

LaRiviere, J., et al., 2014. The value of familiarity: effects of knowledge and objective signals on willingness to pay for a public good. J. Environ. Econ. Manag. 68 (2), 376–389. https://doi.org/10.1016/j.jeem.2014.07.004.

Lockwood, B., Drakeford, B.M., 2021. The value of carbon sequestration by saltmarsh in Chichester harbour, United Kingdom. J. Environ. Econ. Policy 1–15. https://doi.org/10.1080/21606544.2020.1868345.

Louviere, J.J., et al., 2000. Stated Choice Methods: Analysis and Applications. Cambridge University Press, Cambridge.

Luisetti, T., et al., 2011. Coastal and marine ecosystem services valuation for policy and management: managed realignment case studies in England. Ocean Coast. Manag. 54 (3), 212–224. https://doi.org/10.1016/j.ocecoaman.2010.11.003.

Luisetti, T., et al., 2014. Coastal zone ecosystem services: from science to values and decision making; a case study. Sci. Total Environ. 493, 682–693. https://doi.org/10.1016/j.scitotenv.2014.05.099.

Mariel, P., et al., 2021. Environmental Valuation with Discrete Choice Experiments: Guidance on Design, Implementation and Data Analysis. Springer Nature, Cham.

Mazzocco, V., et al., 2022. Economic value of salt marshes under Uncertainty of sea level rise: a case study of the Narragansett Bay. Coast. Manag. 50 (4), 306–324. https://doi.org/10.1080/08920753.2022.2078174.

Conditional logit analysis of qualitative choice behaviour, 1974. In: McFadden, D., Zarembka, P. (Eds.), 1973. Frontiers in Econometrics. Academic Press, New York, pp. 105–142.

McLeod, E., et al., 2011. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. Front. Ecol. Environ. 9 (10), 552–560. https://doi.org/10.1890/110004.

Morardet, S., et al., 2015. What do people want for the Vistre River? Using choice experiment to support an ordinary stream restoration project. In: 11th International Conference of the European Society for Ecological Economics, June 2015. University of Leeds [online]. Available at: https://hal.inrae.fr/hal-02602514 [Accessed 20 January 2023].

Information, uncertainty, and contingent valuation, 2011. In: Munro, A., Hanley, N.D., Bateman, I.J., Willis, K.G. (Eds.), 2001. Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU, and Developing Countries. Oxford University Press, Oxford, pp. 258–274.

National Records of Scotland, 2019. Mid-2018 population estimates Scotland. [Excel data sheet] National Records of Scotland. Available at. https://webarchive.nrscotland.gov.uk/20210313160229/https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-estimates/mid-year-population-estimates/mid-2018> [Accessed 13 January 2023].

Needham, K., et al., 2018. What is the causal impact of information and knowledge in stated preference studies? Resour. Energy Econ. 54, 69–89. https://doi.org/10.1016/j.reseneeco.2018.09.001.

Perni, A., Martínez-Paz, J.M., 2017. Measuring conflicts in the management of anthropized ecosystems: evidence from a choice experiment in a human-created Mediterranean wetland. J. Environ. Manag. 203 (1), 40–50. https://doi.org/10.1016/j.jenvman.2017.07.049.

Petrolia, D.R., et al., 2014. America's wetland? A National Survey of willingness to pay for restoration of Louisiana's coastal wetlands. Mar. Resour. Econ. 29 (1), 17–37. https://doi.org/10.2139/ssrn.2054867.

Reddy, S.M., et al., 2016. Evaluating the role of coastal habitats and sea-level rise in hurricane risk mitigation: an ecological economic assessment method and application to a business decision. Integr. Environ. Assess. Manag. 12 (2), 328–344. https://doi.org/10.1002/ieam.1678.

Reed, M.S., et al., 2022. Integrating ecosystem markets to co-ordinate landscape-scale public benefits from nature. PLoS ONE 17 (1), 1–27. https://doi.org/10.1371/journal.pone.0258334.

Remoundou, K., et al., 2015. Valuing climate change mitigation: a choice experiment on a coastal and marine ecosystem. Ecosyst. Serv. 11, 87–94. https://doi.org/10.1016/j.ecoser.2014.11.003.

Rendón, O., et al., 2022. Heterogeneity of values for coastal flood risk management with nature-based solutions. J. Environ. Manag. 304, 1–10. https://doi.org/10.1016/j.jenvman.2021.114212.

Russell, M., Greening, H., 2015. Estimating benefits in a recovering estuary: Tampa Bay, Florida. Estuar. Coasts 38 (1), S9–S18. https://doi.org/10.1007/s12237-013-9662-8.

Schmidt, J.P., et al., 2014. Integrating ecosystem services and local government finances into land use planning: a case study from coastal Georgia. Landsc. Urban Plan. 122, 56–67. https://doi.org/10.1016/j.landurbplan.2013.11.008.

Scottish Government, 2020. Scotland's People Annual Report: Scottish Household Survey. [pdf] Scottish Government. Available at. https://www.gov.scot/publications/scotlands-people-annual-report-results-2018-scottish-household-survey/pages/7/ [Accessed 31 July 2020].

Shapansky, B., et al., 2008. Assessing information provision and respondent involvement effects on preferences. Ecol. Econ. 65 (3), 626–635. https://doi.org/10.1016/j.ecolecon.2007.08.012.

TEEB, 2010. Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB. Earthscan, London and Washington.

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

UKCEH, 2023. UK Saltmarsh Code [online] Available at: https://www.ceh.ac.uk/our-science/projects/uk-saltmarsh-code [Accessed 09 February 2023].

Watson, S.C.L., et al., 2020. Assessing the natural capital value of water quality and climate regulation in temperate marine systems using a EUNIS biotope classification approach. Sci. Total Environ. 744, 1–11. https://doi.org/10.1016/j.scitotenv.2020.140688.

Yoo, H.I., 2020. lclogit2: an enhanced command to fit latent class conditional logit models. Stata J. 20 (2), 405–425. https://doi.org/10.1177/1536867X20931003.