

1 **The impact of nature documentaries on public environmental preferences and**
2 **willingness to pay: Entropy balancing and the Blue Planet II effect**

3
4 *“I personally can have enough of people leaning out of the television screen and saying ‘you lazy,*
5 *irresponsible, ignorant chap sitting there in your comfortable suburban home; why don’t you care for*
6 *this or subscribe to that or go out and do the other?’ I actually think the best way of taking the message*
7 *to the people is by showing them the pleasure, not necessarily by saying to them every time, ‘You’ve got*
8 *to do something about it,’ but by saying, ‘Look, isn’t this lovely?’ and the other bit follows”*

9 - *Sir David Attenborough*

10 *From a television interview with David Attenborough from early 1970s, reshown on the 2002 BBC documentary film ‘Life on*
11 *Air: David Attenborough’s 50 Years in Television’*

12
13 **1. Introduction**

14 Modelling the impact of a policy intervention or social factors on decision making is a common
15 goal in choice experiments. For example, researchers may be interested in determining the
16 influence of gender, or education level, or having previously been exposed to an environmental
17 awareness campaign on attribute and option preferences in a choice model. In these cases where
18 tastes may vary systematically with the observable variables or treatments, heterogeneity is
19 often captured by using interactions between the observable characteristics of the decision-
20 maker and the observable attributes of the alternatives in the chosen models. It has been argued
21 though that capturing heterogeneity systematically in this manner may be insufficient in the
22 presence of confounding influences or when tastes vary with unobservable variables or purely
23 randomly, and may result in inconsistent parameter estimates (Chamberlain, 1980). Tests by
24 Hess et al. (2013) also suggest that there is substantial scope for confounding in discrete choice
25 analysis and that when it occurs it leads to serious bias in parameter estimates and elasticities.
26 This paper proposes a strategy to control for these effects when the objective of the discrete
27 choice analysis is to determine the impact of a particular ‘treatment’ for one portion of the
28 population on choice and willingness to pay.

29 In particular, the ‘treatment’ analysed is having watched the BBC Blue Planet II (BP2)
30 documentary series and the research question of interest is what impact this may have had on
31 individuals’ choices and willingness to support marine conservation activity as observed
32 through the use of a choice experiment. In the discrete choice analysis, the preferences of the

33 Scottish public for the deep-sea environmental management of the Mingulay cold water reef
34 off the west coast of Scotland in the Sea of the Hebrides is assessed. These cold-water coral
35 reefs are known to act like islands in what is “normally flat, featureless and muddy
36 surroundings and harbour a distinct and rich ecosystem, providing niches and nursery grounds
37 for a variety of species, including commercial fish species” (Freiwald et al. 2004). While the
38 presentation of a data pre-processing method for estimating the impact of a particular treatment
39 on the choices made in discrete choice analysis is the main contribution of this paper, testing if
40 watching nature documentaries has a lasting effect on respondents’ environmental preferences
41 and willingness to pay (WTP) is in of itself an interesting line of research. If they can be shown
42 to influence preferences then they could be used as an effective policy tool to encourage
43 behavioural change to help tackle other environmental issues such as the looming climate and
44 biodiversity crises.

45 Sir David Attenborough’s second instalment of the Blue Planet series has been widely credited
46 for being responsible for generating a surge of interest in marine conservation efforts, in
47 reducing plastic pollution and in increasing recycling. When it first aired in October 2017, a
48 significant increase in on-line searches for conservation charities both during and after each
49 episode was observed (Hayns-Worthington, 2018)¹. A recent study of consumer behaviours
50 surrounding sustainable packaging in the UK and US also found an increase in internet searches
51 for “plastic recycling” on the back of the series (Globalwebindex, 2019). Other high-profile
52 television programs have also had an impact on public sentiment and environmental policy. Al
53 Gore’s ‘Inconvenient Truth’ film for example is known to have had a significant influence of
54 environmental behaviour and policy (Jacobsen, 2011) while celebrity chef and campaigner
55 Hugh Fearnley-Whittingstall’s documentaries on commercial fishing practices, for example,
56 were credited with having a major influence on the introduction of the discard ban under the
57 EU Common Fisheries Policy (Borges, 2015).

58 While there has been much focus on the increased interest in conservation from the BPII series,
59 we study whether it actually changes environmental preferences using a novel mechanism to
60 explain differences between those who have and have not seen the series. In particular, we
61 examine the impact of having seen the BPII series on preferences and willingness to pay (WTP)

¹ The eight episodes of the series ran from the 29th of October 2017 to the 1st of January 2018. Following its release the series was subsequently made available to download for UK based residents on the BBC iPlayer catch up service for a period of 7 months. It was also made available to purchase as a DVD box set from the BBC and was available to watch on Netflix from December 2018 to December 2019.

62 by including interaction terms between the BPII dummy and the observable attributes of the
63 alternatives in the choice models employed. One might suspect however that those who have
64 watched BPII may have different characteristics (perhaps from differing social classes,
65 education levels, etc) to those that have not, resulting in the non-random selection into the
66 subgroups of those who have versus have not watched the BPII series. Also, there may be
67 unobserved factors that simultaneously influence both watching the series and the choices
68 made. In these cases, there may be important subgroup differences between the groups’
69 covariates that, if not adequately accounted for through some form of adjustment to known
70 sample moments (e.g. mean, variance, or skewness), could result in the interaction terms
71 producing biased estimates and lead to inappropriate conclusions in relation to the effect of
72 having seen the BPII series on an individual’s preferences for marine environmental
73 management options. That is, the preferences of those that have not watched the BPII series
74 (the comparison group) may not represent the true counterfactual preferences of the group that
75 did watch BPPI (the treated group), had the latter group not watched BPII.

76 In this study, we therefore propose entropy balancing (EB) as a pre-processing technique to
77 achieve covariate balance between the two groups in the discrete choice analysis where the
78 objective is to estimate the effect of a treatment (having seen at least one episode of the BPII
79 series) on the choices made. EB is a multivariate reweighting method used to produce balanced
80 samples in observational studies and was first developed in the field of political science where
81 researchers are interested in estimating treatment effects in nonexperimental settings
82 (Hainmueller, 2012). After applying EB, the BPII viewers and reweighted BPII non-viewers
83 will have similar covariate distributions, mitigating self-selection bias from observed
84 confounders. Conditional Logit and Random Parameter Logit models are estimated with and
85 without weighting by the generated EB weights. To the best of the authors’ knowledge this is
86 the first study where the technique is applied in discrete choice analysis. We feel this approach
87 has obvious appeal for other DCE studies interested in making cross-group comparisons.

88 Meyerhoff (2006) argues that in order to analyse the relationship between attitudes and a
89 specific behaviour, it is crucial to distinguish at the outset between an attitude towards a target
90 and an attitude towards a behaviour. The author argues that the important difference between
91 these attitudes is that “they differ in their attitude object”. For example, an individual donates
92 money towards a marine conservation project. In this case, the project is the target of the
93 behaviour of donating and the individual probably has a positive attitude towards this target.
94 Simultaneously, it is assumed that the individual also has a positive attitude towards the

95 behaviour of giving money to the conservation effort, but Meyerhoff (2006) suggests that these
96 attitudes are not necessarily equally balanced. Individuals could have a positive attitude
97 towards marine conservation in general, but may have a negative attitude towards contributing
98 financially for such conservation. Therefore, an attitude towards a target may be an unreliable
99 predictor of a specific behaviour. We examine this issue by testing the hypotheses that, firstly,
100 having watched BPII influences the preferences of respondents for marine conservation
101 management options, and that secondly respondents that watched BPII have higher WTP for
102 marine conservation. A third hypothesis tested is that the WTP from the EB weighted models
103 are significantly different from unweighted models.

104

105 **2. Effect of Nature Documentaries on Environmental Perceptions and Behaviours**

106 The relationship between media and the environment has been studied from a wide range of
107 perspectives within the field of mass communication for many decades (Hobert et al., 2003).
108 Nature documentaries are now an increasingly used modality to communicate environmental
109 issues in order to create awareness, change behaviours or perhaps motivate increased viewers’
110 demand for environmental policy action. According to Östman (2013), media can play an
111 important role in engaging the public on environmental issues and asserts that fostering societal
112 awareness of their impact on the environment is a precondition to successful environmental
113 policy. Early empirical studies of media treatment effects on environmental behaviour typically
114 focused on public affairs (Atwater et al., 1985; McLeod et al., 1987; Brother et al., 1991), while
115 others focused on broad range of media communication content and consequences (Daley and
116 O’Neill, 1991; Meister, 2001).

117 In examining the relationships between television viewing and environmental concern,
118 Shanahan et al. (1997) showed that exposure to conservation messages on television is
119 associated with a general apprehension about the state of the environment. The authors found
120 however, that it was not consistently related to viewer’s perception of threats from specific
121 sources and frequent viewers were less willing to change their behaviour for the good of the
122 environment. Hynes et al. (2016) also reflect on the divergence between what the public
123 perceive to be major marine environmental threats compared to that of scientists. Hobert et al.
124 (2003) examined the differences between the direct effects of factual versus fictional-based
125 television programming on environmental attitudes and behaviour, with factual-based
126 television programming such as nature documentaries and current affairs being found to have

127 a statistically significant positive influence on individual's desire to recycle, purchase eco-
128 friendly products and to be more energy efficient in daily routines.

129 In Australia, Hofman and Hughes (2018) determined that nature documentaries with specific
130 environmental conservation messages can influence viewers' attitudes and bring about
131 immediate changes in behaviour. However, the authors note that post-viewing materials and
132 strategies were needed to insure that these behavioural changes continued in the long-term.
133 Elsewhere, Barbas et al. (2009) also found that nature documentaries about insects had a
134 positive effect on student's environmental sensitivity. The study also concluded that less
135 conventional documentary styles such as non-verbal films were more effective in the
136 development of environmental knowledge amongst the students, but the traditional nature
137 documentaries, such as BPPII, were effective in fostering positive environmental attitudes and
138 beliefs. An interesting question arising from the positive effects of nature documentary on
139 behavioural intentions observed in the literature is whether these intentions translate into policy
140 support and financial commitments.

141 In attempting to answer that question other research has questioned the role of nature
142 documentaries on pro-environmental behaviour and financial support to conservation efforts
143 (Meyerhoff, 2006; Arendt and Matthes, 2016). In an experiment where the treatment group
144 watched a nature documentary, and the control group watched an unrelated science
145 documentary, Arendt and Matthes (2016) found that viewing the nature documentary did not
146 result in a significant increase in 'connectedness to nature'. It was found however to increase
147 actual donations to animal and environmental conservation societies, but only for those who
148 were already observed to have had a strong pro-environmental attitude. In a similar finding to
149 Hofman and Hughes (2018) in relation to the lasting impact of viewing nature documentaries
150 on behaviour, Jacobsen (2011) found that while the purchase of voluntary carbon offsets
151 significantly increased in regions where Al Gore's 'Inconvenient Truth' documentary was
152 released compared with regions where the film was not released the effect did not last. The
153 authors found that carbon offset purchases went back to prior levels within two months. Janpol
154 and Dilts (2016) also examined the effect of watching a nature documentary on the natural
155 environment on post-viewing financial support. They found significant effects on

156 environmental perceptions and on the choice of charitable donations amongst the participants
157 in their experiment².

158 Following another Attenborough BBC documentary, Planet Earth II, Fernández-Bellon and
159 Kane (2019) analysed Twitter and Wikipedia big data activities and showed that nature
160 documentaries can generate awareness of unfamiliar animal species and that the viewers will
161 engage with the information provided at levels comparable to those achieved by other
162 environmental conservation initiatives such as world species awareness days. The analysis
163 however, suggested a lack of proactive engagement stemming from Planet Earth II through
164 charitable donations. According to the authors this latter effect was not unexpected given that
165 environmental awareness generated by the documentary is only one of many moderating
166 factors influencing the decision to donate and the effect may happen at a considerable lag. This
167 makes it difficult to establish a cause-and-effect relationship.

168 Conservation of natural resources and their financial requirements are often researched in the
169 field of economic valuation. However, the role the viewing of nature documentaries has on the
170 publics' environmental preferences and willingness to pay has generally been ignored in the
171 valuation literature. We aim to fill this gap by estimating choice models that test for the impact
172 of having seen the BPII series on both marine management preferences and willingness to pay
173 to support the delivery of deep-sea ecosystem services. The paper is also the first to examine
174 the use of EB in discrete choice analysis to increase the reliability of comparisons between
175 groups. We apply this method to study possible differences in preferences for those who have
176 and have not seen the BPII series, where we reweight those who have not seen the BPII series
177 to be similar to those who have seen the series in terms of their observable respondent
178 characteristics.

179

180 **3. Survey Design and Choice Experiment**

181 An online survey was carried out in January and February 2019 over a four week period. The
182 aim of the survey was to obtain information relating to the Scottish publics' preferences for
183 cold-water coral conservation and their associated ecosystem service benefits. The survey
184 attempted to also ascertain the ecosystem service benefit values that might be received by the

² It should be noted however that in this instance the donations were not the respondents' own money but was donated on their behalf by the researchers conducting the experiment.

185 Scottish public through the management of the Mingulay Reef complex found off the west
186 coast of Scotland at a depth of 100-200m, 8.7 miles east of the Island of Mingulay in the Sea
187 of the Hebrides (Henry et al. 2013), under two different management scenarios. With this in
188 mind, a choice experiment was included in the survey instrument in order to generate data for
189 the estimation of the public good benefit value of such conservation. Extensive discussions
190 with marine scientists on the EU ATLAS project who have in-depth knowledge of this
191 particular reef led to the choosing of the relevant attributes and levels that should be used in
192 the choice experiment. Focus group discussions were also used to refine the language,
193 descriptions and other questions asked in the survey instrument. While the scientists provided
194 the detail for the appropriate attributes and levels to be used, the focus groups ensured that the
195 descriptions were clearly understandable by the general public that would be responding to the
196 survey. The UK based market research company YouGov was employed to collect the data
197 using their established online panel of the general public. Pilot testing of the survey instruments
198 was conducted prior to the main survey.

199 In the final survey instrument, respondents were given some background information on the
200 cold-water coral reefs and the Mingulay Reef complex. They were then asked a series of
201 questions related to their attitudes towards Scotland's deep seas and marine wildlife and how
202 it was being managed as well as questions that retrieved respondent's direct experience with
203 Scottish waters either through recreation or by being involved in an industry associated with
204 the sea. Within the survey a series of 8 choice cards were presented to each respondent that
205 examined their preferences for a set of ecosystem service attributes associated with the
206 management of Mingulay Reef Complex. As is common in these types of surveys, the
207 questionnaire concluded with a number of socio-demographic questions related to age, gender,
208 marital status, occupation, working status, income, number of persons in household and
209 education. The surveys resulted in 1,025 complete observations.

210 To generate the choice cards used in the survey, a Bayesian efficient design was employed that
211 attempts to minimize the Bayesian Db-error criterion (Hess et al., 2008; Scarpa and Rose,
212 2008). A sequential experimental design where the choice cards were updated from the pilot to
213 the main survey was employed where the prior coefficients used in the design are updated.
214 Initially, prior coefficients for the pilot study were based on the results of similar surveys in
215 the literature. New prior coefficients estimates were generated based on the estimation of
216 choice models from the pilot study (n = 63). Such a sequential approach to choice card design
217 has been shown to deliver significant efficiency gains (Scarpa et al., 2007). The design for the

218 main survey was generated using the NGENE software and the value of the D-Error for the
219 main design was 0.55 (mean value).

220 For the choice experiment, respondents were first informed that: *“The Scottish Government are*
221 *responsible for delivering new plans on how best to manage Scotland’s deep seas and wildlife.*
222 *As part of this scientists are assessing the “health” or the environmental quality of the deep*
223 *sea, including the Mingulay Reef Complex, with regard to a number of characteristics”*
224 Respondents were then presented with a description of the 5 characteristics used in the choice
225 cards; the health of commercial fish stocks, the amount of marine litter, the size of area that is
226 protected, the possible expansion of the ocean economy in the area of the reef associated with
227 the creation of new marine related jobs and the price of each restoration option.

228 The health of commercial fish stocks was measured by the number of adult fish compared to
229 young fish in the population (scientists refer to this as the abundance ratio). The more adult
230 fish, the healthier the population. Respondents were told this and informed that the reef is an
231 important nursery area for young fish where they can mature into breeding adults and
232 eventually move out of the reef complex into the surrounding seas where they can be
233 commercially caught. The levels of the attribute were presented as high, medium or low in each
234 option of the choice cards. The level of marine litter was described as good, moderate or poor
235 and was based on the observed number of items of litter per square mile. Marine scientists
236 within the EU ATLAS project developing indicators of Good Environmental Status (GES) of
237 EU deep-sea waters as required under the Marine Strategy Framework Directive (MSFD)
238 advised on what the corresponding number of items of litter should be for each level of the
239 marine litter attribute. The size of protected area attribute was presented in the form of a
240 percentage of the Sea of Hebrides and as the corresponding multiple of the current management
241 area; either 1% of the Sea of the Hebrides (current management), 6% of the Sea of the Hebrides
242 (six times the size of current management), 10% of the Sea of the Hebrides (10 times the size
243 of current management) or 15% of the Sea of the Hebrides (15 times the size of “current
244 management).

245 - **Table 1 here**

246 The fourth attribute chosen was the possible expansion of the ocean economy in the area of the
247 reef through the creation of new marine related jobs. Additional jobs have tended to be the
248 most popular economic factor to be used in environmental valuation surveys, framed in the
249 concept of the non-use value of employment (Aanesen et al., 2018; Morrison et al. 1999;

250 Othman et al. 2004). Respondents were informed that in the Mingulay Reef Complex there is
251 potential to develop new industries such as fisheries, new forms of aquaculture, tourism and
252 marine renewable energy and that it was possible that these developments could provide
253 employment for local communities. This attribute was included to examine possible perceived
254 trade-offs between developing the area commercially and protecting the cold-water coral reef
255 and associated marine wildlife. Finally, the cost of each option (the price) was presented in the
256 form of an annual increase in personal income tax. The reef management attributes and levels
257 used to describe the choice alternatives are also shown in Table 1. While the description in the
258 choice cards for each attribute was kept simple for the sake of clarity, additional information
259 explaining each of the attributes was provided to respondents in the questionnaire. That
260 additional text is available in the full questionnaire that is supplied here as supplementary
261 material.

262 Following the presentation of the attributes, the respondent was then informed that “*different*
263 *levels of each of these can be delivered as part of the management plan: i.e. more or less jobs,*
264 *more or less marine litter, healthier fish stocks and a larger protected area. We would like you*
265 *to think about different “bundles” of these aspects of management and as a tax payer how*
266 *much you would be willing to pay for these different management aspects”. Furthermore, they*
267 *were told “Any changes from the status quo would need to be funded by the Scottish taxpayer.*
268 *This would take the form of an increase to annual personal income tax rates over a 10 year*
269 *period and ‘ring-fenced’ into a secure marine fund”. Respondents were also asked to imagine*
270 *themselves actually paying the amounts specified and to think about their own budget and*
271 *ability to pay when considering each option.*

272 An example choice card was then presented and described (Figure 1). Following that 8 choice
273 cards presented three management alternatives and respondents were asked to choose their
274 most preferred option on each card. The third option on each card was always the status quo
275 alternative and the attribute levels for this option did not vary across the 8 cards. In this case,
276 the status quo describes the situation (the attribute levels that would be achieved) in the future
277 if there was no further change from current management and is associated with no additional
278 financial cost to respondents. The first and second options on each choice card represented
279 management alternatives leading to improvements in the delivery of the ecosystem service
280 benefits, represented by the attributes, and were associated with a positive cost.

281 Following the choice experiment, a series of questions were asked to determine if the
282 respondents ignored any of the attributes informing their choices and to acquire an explanation
283 if respondents picked the status quo option on all choice occasions. Further questions were
284 asked related to the socio-demographic profile of respondents, their marine related past-times,
285 and, of particular interest to the analysis here, whether they had watched one or more episodes
286 of David Attenborough’s television series Blue Planet II.³

287

288 **4. Methodology**

289 The use of choice experiments in the valuation of ecosystem service benefits can provide
290 valuable information and social insights to assess environmental policy options and can act as
291 a bridge between environmental sciences, society, policy makers and planners (Perni and
292 Martínez-Paz, 2017; Birol and Cox, 2007). The basis for the analysis of the response data to a
293 choice experiment is the commonly applied McFadden’s (1973) random utility model
294 (RUM)⁴. The RUM model can be specified in different ways depending on the distribution of
295 the error term (Hynes et al., 2008). If the error terms are independently and identically drawn
296 from an extreme value distribution, the RUM model is specified as the Conditional Logit
297 (CL) (McFadden, 1974). Alternatively, the random parameter logit (RPL) overcomes the two
298 major limitations of the CL model, i.e. the independence of irrelevant alternatives (IIA)
299 property and the limited ability of the CL model to explicitly account for preference
300 heterogeneity (Train, 2003). The RPL allows the coefficients of observed variables to vary
301 randomly over people rather than being fixed for all individuals; thereby accounting for
302 preference heterogeneity. The utility of individual i from the alternative n in time t is
303 specified in the RPL model as:

304

$$305 \quad U_{int} = (\beta + k_i)x_{int} + \varepsilon_{int} \quad (1)$$

306

³ We did not record the number of episodes watched so cannot explore effects with respect to the level of exposure. This is a potential avenue for future research.

⁴ Although not applied here the latent class model is another popular alternative for analyzing stated preference choice data (Grilli and Curtis, 2020). For a more in-depth presentation of the RUM framework and the alternative choice models that can be applied the interested reader is directed to Train (2003) and Hensher et al. (2010).

307 where within the deterministic component of the model (V_{int}), the vector of coefficients β
 308 associated with the attributes denoted by x_{int} , vary across individuals, thus accommodating
 309 heterogeneous preferences in the sampled population. The error term ε_{int} captures the
 310 factors that affect utility but are not observed by the modeller. The error components of
 311 different alternatives within the RPL is also allowed to be correlated. The unknown
 312 parameters of the RPL model are distributed across the population according to a specified
 313 distribution function (Hensher and Greene, 2003). In this paper, the RPL has a fixed cost
 314 parameter but assumes normally distributed parameters for the other management attributes,
 315 with mean β and standard deviation σ . The conditional choice probability for respondent i
 316 choosing alternative n is given by:

317

$$318 \quad P_{int} = \Pr(y_i^t | \cdot) = \int_{\beta} \prod_{t=1}^{T_i} \frac{e^{V_{int}}}{\sum_{m=1}^M e^{V_{imt}}} f(\beta|\theta) d\beta, \quad (2)$$

319

320 Finally, the model is estimated by simulated maximum likelihood. The log-likelihood (LL)
 321 function for the model is given by $LL(\theta) = \sum_{i=1}^N \ln P_{int}$ where N is the size of the sample
 322 population. This expression cannot be solved analytically and simulation-based estimation of
 323 the model is used to evaluate P_{int} with a large number of draws from β (in this study we use
 324 300 Halton draws).

325 The simulated log likelihood of the RPL model is given by:

326

$$327 \quad LL(\theta) = \sum_{i=1}^N \ln \left[\frac{1}{R} \sum_{r=1}^R P_i(\beta^{in/\theta}) \right] \quad (3)$$

328

329 where R is the number of draws, $\beta^{in/\theta}$ is a vector of β s obtained in the r -th draw from the
 330 distribution $f(\beta|\theta)$ for individual i . In the RPL model, the parameters of β distribution (θ) are
 331 estimated, rather than a vector of β point values as is done in the basic CL model. Following
 332 McFadden and Train (2000), uncorrelated utility coefficients are assumed in the estimated
 333 RPL model.

334 The marginal utility estimates for changes in the level of each attribute from the choice
 335 models can be easily converted to the marginal willingness to pay for the particular change in

336 each attribute. These marginal values are derived by dividing a β parameter for a non-cost
337 attribute x in alternative n (x_n) by the β parameter for the cost attribute:

338

$$339 \text{ Marginal } WTP_{x_n} = \frac{\beta_{x_n}}{-\beta_{cost}} \quad (4)$$

340

341 In estimating the marginal effects using the RPL the expected measure requires integration
342 over taste distribution in the population which is computed by simulation from draws of the
343 estimated distributions for the random parameters (Scarpa and Thiene, 2005; Hynes et al.,
344 2008). In addition, the value (the compensating surplus) of a management option that leads to
345 specified changes in the cold water coral reef ecosystem service provision, as described by
346 the attribute levels, may be calculated using the standard utility difference expression
347 (Hanemann, 1984). Two management scenarios where the average WTP to move from the
348 state of the world given in the baseline (the status quo scenario) to the state of the world that
349 results with alternative levels of each attribute in the choice experiment is therefore
350 estimated.

351 The study was particularly interested in examining what influence, if any, having seen BBII
352 might have on attribute preferences and WTP. It has previously been pointed out that
353 differences in sociological, psychological and biological constructs, such as attitudes, values,
354 perceptions, normative beliefs, affects, lifestyles, etc. can have a profound influence on taste
355 heterogeneity (Vij and Krueger, 2017; Ben-Akiva et al., 2002) and it may be the case that there
356 are underlying factors driving individuals to watch BBII that would also influence choices
357 made and make it impossible for the analyst to disentangle the true effect of having seen BBII
358 on marine environmental preferences.

359 Ideally, one would have two identical groups, one of which was exposed to BPII and another
360 that was not. The difference in outcomes could then be attributed to their exposure to BPII.
361 One could achieve this by randomising individuals to watch/not watch BPII. As is usual in
362 observational studies this was not possible in this case. Therefore, in order to examine the
363 impact of having seen the BPII series on preferences and WTP, EB is used to reweight those
364 who have not seen the nature series to be similar to those individuals in the sample that have
365 seen any of the series, in terms of the mean, variance, and skewness of a range of observed
366 covariates. The approach assures that the two sets of respondents are exactly the same on these

367 three moments across the chosen variables. Thus, any observed differences in outcomes are not
 368 attributable to these covariates. Choosing covariates that might be considered important
 369 explanatory variables in explaining the respondent's environmental attitudes, perceptions, etc.
 370 should provide more assurance to the analyst that any observed impacts of having viewed BPII
 371 are meaningful.

372 The EB reweighting procedure employed in this paper is formally presented by Hainmueller
 373 (2012). In this analysis the population average treatment effect on the treated group is used.
 374 Assuming there is no unobserved confounding, the outcomes of the observed control group can
 375 be reweighted to represent the expected counterfactual outcome of the treated group. While
 376 there are a number of data pre-processing methods that could be used to reduce the imbalance
 377 in the covariate distributions (e.g. nearest neighbour matching, coarsened exact matching,
 378 propensity score matching) EB is used in this application as it has the advantage that it directly
 379 incorporates the information about the known sample moments for those who have not seen
 380 BPII and adjusts the weights such that the user obtains exact covariate balance for all moments
 381 included in the reweighting scheme (Hainmueller and Xu, 2013). The EB weights w_i are
 382 chosen by minimizing the entropy distance metric:

383

$$384 \quad \min_{w_i} H(w) = \sum_{\{i|D=0\}} w_i \log(w_i/q_i) \quad (5)$$

385 subject to balance and normalizing constraints

$$386 \quad \sum_{\{i|D=0\}} w_i c_{ri}(x_i) = m_r \text{ with } r \in 1, \dots, R$$

387 and

$$388 \quad \sum_{\{i|D=0\}} w_i = 1$$

389 and

$$390 \quad w_i \geq 0 \text{ for all } i \text{ such that } D = 0$$

391

392 where $q_i = 1/n_0$ is a base weight and $c_{ri}(x_i) = m_r$ describes a set of R balance constraints
 393 imposed on the covariate moments of the reweighted control group and D is the binary
 394 treatment indicator coded 1 or 0 if individual i has seen the BPII series or has not (the control
 395 condition), respectively. In this application the moment constraints include the mean, the
 396 variance, and the skewness. EB is less prone to giving extreme weights to individuals than

397 approaches such as Inverse Probability Weighting and is generally more efficient than
398 propensity score matching.

399 Once the covariate distributions are adjusted and the EB weights are fitted, the estimated
400 individual level weights are incorporated into the log likelihood function of the choice models
401 in order to examine the impact of having seen the BPII series on a person's environmental
402 preferences and WTP for marine ecosystem conservation. Thus, the simulated log likelihood
403 of the RPL model described in (3) is now given by:

404

405 $LL(\theta) = \sum_{i=1}^N w_i \ln \left[\frac{1}{R} \sum_{r=1}^R Pn(\beta^{in/\theta}) \right]$ where w_i is the balancing weight used for
406 individual i .

407

408 **5. Results**

409 Table 2 provides summary statistics for the sample of the 1,025 Scottish respondents to the
410 survey. The average age in the sample (adults aged 18 plus) is 49 while 44% were male and
411 52% had a third level qualification (including technical, professional or higher qualification).
412 Six per cent of the sample were active students, 28% were retired and 4% indicated that they
413 were currently unemployed. Six per cent of respondents were from the Highlands and Islands
414 region. Only 2% had visited the island of Mingulay while 12% indicated that they had visited
415 the nearest populated island Barra. Just under 25% of the sample had however visited the Outer
416 Hebrides at some point previously. Of particular interest to this study is the fact that there was
417 almost a 50/50 split in terms of those who had and had not watched BPII with 55% indicating
418 that they had seen at least one episode of the series.

419 - **Table 2 here**

420 Before proceeding to choice modelling results we first review the EB procedure used to pre-
421 process the choice data. All observations in the sample are used in the choice models, but these
422 observations are given different weights. Each respondent who has seen BPII is given a weight
423 of 1 because we are interested in the effect of having been exposed to the television series on
424 deep-sea management choice. Respondents who have not seen BPII are assigned varying
425 weights greater than zero that meet the EB conditions. The procedure effectively assigns more
426 weight to respondents who have not seen BPII, who have more comparable case conditions

427 and characteristics to respondents who have seen BPII, and less weight to respondents who
428 have not seen BPII whose features are more different. The entropy weights were generated
429 using the “ebalance” package in the statistical software package STATA (Hainmueller & Xu,
430 2013).

431 Respondents who have not seen BPII were weighted to meet the targets of balance on the three
432 moments (mean, variance, and skew) of the 9 independent variables shown in table 3. The EB
433 algorithms were restricted to a maximum number of 20 iterations and a maximum tolerated
434 deviation is set at .015 for the reweighted moments of the covariates. As pointed out by
435 MacDonald and Donnelly (2019) this maximum number of iterations and predefined tolerance
436 level encourages convergence and the optimization of covariate balance. Table 3 displays
437 descriptive statistics for the 9 covariates before and after matching the sub samples based on
438 EB. The balance table includes the means, variances, and skewness of covariates for both
439 treatment, and control pre and post weighting. As can be seen from the table the moments of
440 these variables across the 2 subsamples are already reasonably similar prior to reweighting
441 which should also aid the convergence and optimization process. In fact, the balancing
442 algorithms only required 13 iterations to fully converge.

443 Also evident in Table 3, before reweighting, the treated and control groups differ slightly in
444 terms of their covariate distributions, suggesting perhaps some degree of self-selection.
445 However, a simple logit model where 'watches BPII or not' is the dependent variable and the
446 nine independent variables are the regressors would suggest that only age and being aware of
447 information given on Scottish marine environment at start of survey have a significant
448 influence on the decision to watch BPII or not. The pseudo R^2 of this model is also low at 0.026
449 (see logit model results in table A1 of the appendix). This is further indication that the initial
450 level of imbalance between treatment and control groups is low. A ‘leave-covariates-out’
451 (LCO) approach (Cerulli, 2019) was also employed to assess the sensitivity of the results to
452 unobserved confounders. The entropy balancing procedure was rerun a further eight times,
453 excluding one of the nine independent variables each time. The results of this analysis show
454 little variation in the resulting effect estimates. The effect estimate in each case range from
455 0.01586 to 0.01984 and hence the main choice model estimates are likely to be relatively
456 insensitive to unobserved confounders, since a potential omitted confounder would have to
457 exert a greater influence than all of the observed confounders to overturn the findings. This
458 provides some reassurance that the assumption of no unobserved confounders is not too
459 restrictive in this case.

460 - **Table 3 here**

461 The EB procedure produces an almost perfect balance between the groups across all observed
462 covariates. The means of the covariates in the reweighted control group (those who did not
463 watch BPII) perfectly match the means in the treatment group (those who did watch BPII). The
464 only slight imbalance occurs for the variance and skew of the income and age variables,
465 although their means are well-balanced so we do not anticipate this will introduce significant
466 bias. The individual level EB weights generated in the pre-processing step are stored for use in
467 the subsequent discrete choice analysis where they enter the log-likelihood function of the
468 chosen models as outlined in the methodology section.

469 For the analysis, we restricted the sample to those respondents who did not serially choose the
470 status quo option as a protest response; this left a usable sample size of 994 respondents. The
471 models include dummies for the choice attributes and BPII interaction terms with the attribute
472 level dummies as well as the interaction of the status quo option with age, gender and being
473 from the highland and islands region. The results from the alternative CL models with and
474 without the EB weighting are presented in Table 4⁵.

475 Results for the unweighted and reweighted sample are quite similar, although it should be noted
476 that the reweighted results relate to a hypothetical population containing the treated units with
477 and without having watched BPII. While there are slight differences in the magnitude of
478 coefficient estimates across the weighted versus unweighted versions of the model there are no
479 statistical differences observed. This was not a surprising result given how closely the sub
480 samples were even without using the EB procedure.

481 All of the choice attribute level coefficients are significant at the 1% level. For all attributes,
482 the level against which estimates are compared in all models is the lowest level in each case
483 (attributes and all associated levels were summarized in table 1). As shown in table 4, the
484 magnitude and signs of the attribute coefficients in the CL models are broadly in line with
485 expectations. In particular, respondents show a stronger preference for higher levels of healthy
486 fish stock, lower levels of marine litter, more ocean economy job opportunities and a larger
487 area protected. In the latter case though, the medium level (10% of the Sea of Hebrides around
488 the reef complex protected) has a marginally lower coefficient than the 6% protection level.
489 The 15% protection area is still the most preferred, however. As expected, the coefficient on

⁵ Separate CL models for the subsamples who watched BPII, who did not watch it (unweighted), who did not watch it with EB weights, and a model for entire sample excluding BPII interaction terms is also provided for comparison in the appendix (table A2).

490 cost is negative and significant, suggesting that ceteris paribus, respondents prefer to pay lower
491 amounts of additional taxation. The alternative specific constant for the status quo alternative
492 is negative and significant indicating that respondents are more likely all else being equal to
493 choose a management option that is different from the status quo option.

494 The attribute level dummies were also interacted with a binary variable that indicates whether
495 a person watched even one episode of the BPII series and these interaction terms were included
496 in all models. Examining the results of the weighted CL model, which thanks to the EB pre-
497 processing procedure is closer to an experimental data setting, one can see that those who have
498 seen BPII display statistically higher preferences for management options that achieve the
499 highest level of fish stock health, higher levels of area protected and lower levels of marine
500 litter compared to those who have not seen any of the series. The BPII watchers do not appear
501 to have any statistically different preferences when it comes to the creation of additional ocean
502 economy jobs however. Interestingly though, they do display higher sensitivity to the price of
503 a management option than those who have not seen the series, as is evident from the significant
504 and negative sign on the cost interaction term. The results also highlight that a respondent who
505 is male or older is not statistically more or less likely to choose the status quo option but being
506 from the Highlands and Islands is a negative and significant predictor of choosing the status
507 quo option.

508 - **Table 4 here**

509 Table 5 presents the results from the RPL model for the weighted choice data⁶. A Hausman
510 test showed that the CL model does not hold to the restrictive substitution patterns implied by
511 the IIA assumption. This suggests the need for an alternative specification such as the RPL
512 model that relaxes this assumption and also accounts for the panel nature of the data and allows
513 for unobserved heterogeneity in tastes and preferences. The parameters for the cost attribute,
514 the alternative specific constant for the status quo alternative and all interaction terms are
515 specified as fixed. The fixed cost attribute facilitates the calculation of welfare effects and
516 reduces the possibility of retrieving extreme welfare estimates.

517 As is evident from Table 5 both the means and the standard deviations are significant for all
518 random parameters. The mean coefficients for the attribute level dummies are all of the
519 expected sign and also show the same pattern as in the CL case. As with the CL model the

⁶ As in the CL case no statistical differences were found in the coefficient estimates across the weighted versus unweighted versions of the RPL model so to focus the analysis only the weighted results are shown here. The unweighted RPL model results are available from the authors upon request.

520 highest level of the marine litter attribute has the largest coefficient value indicating a strong
521 preference for management options that achieve this outcome. There is however a wide
522 distribution in the preferences for the management attributes as seen in the magnitude and
523 significance of the standard deviation coefficients. The largest difference between mean and
524 standard deviation coefficient is observed for the highest level of the area protected and may
525 reflect the fact that some respondents believe that too large an area under protection may be
526 detrimental to other users of the marine space.

527 - **Table 5 here**

528 In the case of the non-random BPII interaction terms, a similar pattern to the CL results with
529 significant taste preference differences is observed for those who have seen BPII; the one
530 change from the CL results being that a management option with the medium level for size of
531 area protected is now the only area level to be statistically more likely to be chosen by those
532 who have seen BPII. The highest level of the marine litter attribute in the interaction terms once
533 again has the largest coefficient value indicating a strong preference for management options
534 that achieve this outcome for those individuals who have seen the BPII series. This may reflect
535 the fact that the final episode of the series focused on how plastic is having a devastating effect
536 on the ocean and sea creatures and was credited with being a catalyst for changes in attitudes
537 toward how society uses plastic.

538 In Table 6 and 7, the marginal WTP per person per year estimates calculated based on both the
539 EB weighted CL model and EB weighted RPL model are presented for both those who had and
540 had not seen BPII along with their 95% confidence intervals. The marginal values were
541 estimated using the Krinsky and Robb (1986) procedure. As was the case for CL and RPL
542 models it follows through that there were no statistical differences in the marginal WTP values
543 derived from the weighted versus unweighted versions of the models so once more the focus
544 is on the EB weighted results. The estimates produced by the CL and RPL models across both
545 subgroups are similar. The highest estimated marginal WTP figure is for a high level (Good)
546 for marine litter in both the CL and RPL models (£54.68 and £46.85 for those who have not
547 and who had seen BPII respectively, in the case of the RPL model results) followed by the
548 highest possible level for health of fish stocks (£41.23 and £35.66 for those who have not and
549 who had seen BPII respectively, in the case of the RPL model results). The lowest level of the
550 ocean economy jobs created attribute (+20 jobs) is associated with the lowest marginal WTP
551 in both models. The results of a Poe test (Poe et al. 2005) however fails to reject the null

552 hypothesis that the difference in the two empirical distributions of the individual level marginal
553 WTP values, across those who have and have not seen BPII, are equal to zero and thus indicates
554 no statistical difference in the marginal WTP estimates across the groups.

555 - **Table 6 and table 7 here**

556 The results in Table 8 present the estimates of the compensating surplus (CS) associated with
557 two possible management scenarios, based on the results of the EB weighted RPL model. The
558 first is a cold-water coral reef conservation management option and is associated with the
559 highest levels of the attributes health of fish stocks, marine litter and area to be protected, but
560 the status quo level for blue growth opportunities, i.e. no new ocean economy jobs are created.
561 We also estimate the compensating surplus associated with a management plan that is more
562 focused on blue growth with 40+ ocean economy jobs created in the area, but the plan only
563 achieves the medium levels of all the other attributes. As was the case for the marginal WTP
564 per person per year estimates, and as can be seen from the results presented in table 8, no
565 statistical differences in the estimated welfare impact of alternative management options are
566 observed between those who have seen and have not seen BPII. This can be seen in the
567 overlapping confidence intervals and once again confirmed with a Poe test.

568 - **Table 8 here**

569 The welfare impact for scenario 1 (full restoration to the highest possible level of all attributes)
570 is significantly larger than for the medium level restoration of scenario 2 based on the results
571 of the CL model (£70.70 versus £51.89). The difference is not as great in absolute terms (or
572 statistically) when the RPL results are used to estimate the scenario welfare effects. Although
573 not reported here, the estimated compensating surplus measures are higher from the CL model
574 compared to the RPL model (not unexpected given the observed magnitude of the coefficient
575 estimates in Tables 3 and 4). However, the estimates are not significantly different between the
576 models.

577

578 **6. Discussion and Conclusions**

579 This paper presented the results of a discrete choice experiment that was employed to estimate
580 the willingness to pay of the Scottish public to conserve the Mingulay cold water reef complex
581 and analysed how respondents make trade-offs between blue growth potential and ecosystem
582 service delivery. The impact that having watched the BBC Blue Planet II documentary series

583 may have had on individuals' preferences and willingness to support marine conservation
584 activity was also examined. To test this impact we first had to control for the possibility of
585 confounding covariates using EB, a multivariate reweighting method to produce balanced
586 samples in observational studies. It may be the case that those who have watched BPII have
587 different characteristics (education levels, environmental awareness, etc) from those that have
588 not, resulting in the non-random selection into the subgroups of those who have versus have
589 not watched the BPII series. The EB procedure allows the researcher to control for the
590 differences in characteristics across subgroups through the subsequent use of the generated
591 individual EB weights in the choice models.

592 The EB reweighting approach has desirable appeal in discrete choice modelling when the
593 researcher is concerned with estimating differences in preferences between a group of interest
594 (treatment group) and a counterfactual comparison group (control). In a randomized
595 experiment, respondents are randomly assigned to treatment or control groups. Conceptually,
596 this means that the only difference between the groups is whether or not they receive the
597 treatment. Therefore, any difference in outcomes must be due to the treatment and not to any
598 other pre-existing differences in the respondents. With observational data however, such as that
599 generated from a choice experiment, the treated and control groups may have very different
600 distributions of the confounding covariates that can lead to biased model estimates. The goal
601 in pre-processing the response choice data using the EB approach is to adjust the covariate
602 distribution of the control group data by reweighting the observations such that it becomes
603 more similar to the covariate distribution in the treatment group (Abadie and Imbens, 2011;
604 Hainmueller, 2012).

605 In this study, no significant differences in the magnitude of coefficient estimates were found
606 across the weighted versus unweighted versions of the choice models. This was not a surprising
607 result given how closely the sub-samples matched on the covariates even without using the EB
608 procedure. Nevertheless, the study demonstrates how entropy weighting can be used as a robust
609 estimator to examine the effect of a campaign or programme on preferences in a discrete choice
610 setting. In the weighted RPL model all attributes were significant and of the expected sign but
611 based on the magnitude and significance of the standard deviations there was evidence of
612 substantial unobserved preference heterogeneity in preferences across all attributes. The results
613 also demonstrated a difference in the observed preferences for management option outcomes
614 between those who had and had not seen the BPII series, particularly in relation to marine litter
615 and the health of fish stocks.

616 The fact that those who have seen BPPII were found to display higher sensitivity to the price of
617 a management option as indicated by the significant and negative interaction term $\text{Cost} \times \text{BPPII}$
618 in all model specifications suggest that those who have seen the series are not willing to pay as
619 much for deep-sea management as those who have not seen the television series (the larger
620 coefficient of the price coefficient in the denominator in equation (4) in effect cancels out the
621 higher attribute coefficient values in the numerator). So, while the weighted models suggest an
622 influence of watching BBPII on an individual's preferences for better management of marine
623 litter, for moderate increases in the size of the protected area and for the highest level for
624 healthy fish stocks they are not found to be willing to pay a premium for these outcomes
625 compared to the average person who did not watch BPPII.

626 This result; no statistical differences between the two group in terms of marginal WTP
627 estimates and welfare impacts of alternative management options may seem counter-intuitive
628 at first but there are a number of possible reasons for this result. Firstly, it may be that those
629 who have watched the series already pay into some form of conservation fund (or were
630 persuaded to on the back of having seen the series) and thus are taking that into account in their
631 choices. Secondly, it may be the case that those who watch nature documentaries are more
632 likely to seriously consider what such deep-sea management may involve and thus may be
633 more 'thoughtful' in their responses in terms of what they can truly afford to pay in support.
634 Finally, and in line with the findings of Meyerhoff (2006), it may be the case that well-designed
635 documentaries with targeted conservation messages have the potential to influence the viewer's
636 attitudes but post-viewing strategies may be needed to further action in the form of WTP. Also,
637 given the 13 month time gap between the first complete airing of the series and the
638 administration of the survey, it may be the case that the initial spike in observed enthusiasm
639 for donating to ocean conservation had decreased; a phenomena noted elsewhere in the
640 literature (Jacobsen, 2011; Hofman and Hughes, 2018).

641 While the use of the EB procedure allows us, to some extent, to get closer to saying what the
642 effect of BPPII watching has on the demand for potential marine conservation outcomes it is
643 important to keep in mind that the underlying choice data is still observational rather than
644 experimental. There could still be other unobserved factors that may have a confounding effect
645 on the analysis that are not being controlled for in the balancing of the chosen covariates
646 although the results of the LCO analysis would suggest that this is not a major concern in this
647 case. Balancing on covariates that are likely to have a key influence on both the treatment and
648 decision making over choices is important for confidence in results. Also, while the EB

649 approach could be extremely useful where the only goal of the modelling exercise is to analyse
650 the effect of some treatment on choices made if the initial level of imbalance in the covariates
651 is high, then the reweighted model results may not be appropriate to draw general conclusions
652 about preferences in the population. Having said this Hainmueller (2012) points out that one
653 of the key advantages of EB is that it retains valuable information in the pre-processed data by
654 allowing the unit weights to vary smoothly across units; “it reweights units appropriately to
655 achieve balance, but at the same time keeps the weights as close as possible to the base weights
656 to prevent loss of information and thereby retains efficiency for the subsequent analysis”.

657 The EB approach offers researchers a useful and flexible method for estimating the impact of
658 a particular treatment on the choices made in discrete choice analysis. While the effect of the
659 EB approach here was limited due to the close balance already observed in the covariates in
660 both sub-samples prior to the rebalancing it could have much greater influence in situations
661 where the sub-samples of interest display greater differences. Furthermore, the procedure could
662 have other uses in discrete choice analysis and environmental valuation more generally. It is a
663 procedure that could be used to reweight an entire survey of valuation observations to known
664 characteristics of some target population. This could be particularly useful for on-line samples
665 which are often not representative for certain age-groups or social classes. It could also be
666 useful in a benefit transfer situation where a national level sample, for example, could be
667 reweighted to be representative of a subsample of interest (perhaps a region with different
668 population characteristics) on known moments of the characteristics of that subsample. This
669 would be similar to how Hynes et al. (2010) used a spatial microsimulation modelling
670 framework in the transfer of a value function from an existing study to a policy study of interest.
671 In this setting the EB approach would be a far less complex procedure to undertake and
672 implement.

673 The paper started with a quote from a young Sir David Attenborough in which the broadcaster
674 was espousing the view that demonstrating the value of nature to the public is more beneficial
675 than lecturing them on what they should be doing to prevent damages. Although it would take
676 another decade for the first mention of the idea of ecosystem services (Ehrlich and Ehrlich,
677 1981), forty years on ‘ecosystem services’ now constitute a key conceptual framework for
678 discussing ecological, economic and social interactions in many areas of policy and has done
679 what Attenborough hoped; shifting the conversation from the negative impacts of humans on
680 the environment to the positive benefits society receives from a healthy environment. As
681 Kronenberg (2014) points out, the concept of ecosystem services refocuses the conversation

682 by suggesting that destroying the environment runs counter to societies' interests. The results
683 presented in this paper show that Sir David Attenborough's BPII series has not only highlighted
684 the importance of the ecosystem services provided by the marine environment but may also
685 have had an impact on how the public form their preferences for the services that marine
686 ecosystems such as cold water corals deliver, and their choices on how they should be managed
687 in the future.

688

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789

790

791 **Figure 1 Sample choice card**

SCENARIO 1		Option A	Option B	Option C (current management)
Health of commercial fish stocks		Low: 40% of commercial stocks at healthy stock levels	Moderate: 50% of commercial stocks at healthy stock levels	Low: 40% of commercial stocks at healthy stock levels
Density of Marine litter		Poor (5 to 8 items of litter per mile ²)	Moderate (2 to 4 items of litter per mile ²)	Poor (5 to 8 items of litter per mile ²)
Size of protected area		10% of the Sea of the Hebrides	1% of the Sea of the Hebrides	1% of the Sea of the Hebrides
Marine economy jobs created from sea based commercial activities in the area		No employment change	+ 40 jobs	No employment change
Additional costs (per person per year)	£	£ 5	£ 20	£ 0
Your choice for scenario 1 (please tick A, B or C)		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

792

793 **Table 1 Attributes and Levels Description**

Attribute Definition	Scotland – Levels
Health: % of commercial stocks at healthy stock levels.	High (>80%) Moderate (40 – 80%) Low (<40%)
Litter: Density of marine litter measured as number of items of litter per square mile	Good (0 to 1) Moderate (2 to 4) Poor (5 to 8)
Area: size of protected area.	15% of the Sea of the Hebrides (15 times the size of current management) 10% of the Sea of the Hebrides (10 times the size of current management) 6% of the Sea of the Hebrides (6 times the size of current management) 1% of the Sea of the Hebrides (current management)
Jobs: number of marine economy jobs created from sea based commercial activities in the area	+ 40 + 20 No employment change
Additional costs: Unit currency per person per year	£0 (for status quo option only), £5, £10, £20, £30, £40, £60

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797 **Table 2. Summary Statistics**

Variable*	Mean or Proportion	Std. Dev.
Age	49.59	16.88
Male	0.440	0.497
Number of persons in household	6.323	1.218
Third level education	0.518	0.500
Full time employed	0.380	0.486
Part time employed	0.133	0.339
Currently a student	0.064	0.246
Retired	0.281	0.450
Unemployed	0.044	0.205
Resident of Highlands and Islands	0.063	0.244
Have visited island of Mingulay	0.023	0.151
Have visited island of Barra	0.119	0.324
Have visited elsewhere in the Outer Hebrides	0.238	0.426
Respondent or member of household employed in sea related industry	0.089	0.285
Marine sports enthusiast	0.384	0.487
Have seen Blue Planet II Series	0.549	0.497

798 * Bar Age and Number of persons in household all other variables are expressed as proportions

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800 **Table 3. Entropy Balancing Outcomes**

	Before: Without Weighting						After: With Weighting		
	<i>Treatment: Have seen Blue Planet II</i>			<i>Control before EB : Have not seen Blue Planet II</i>			<i>Control after EB: Have not seen Blue Planet II</i>		
	Mean	Variance	Skewness	Mean	Variance	Skewness	Mean	Variance	Skewness
Third level education	0.540	0.248	-0.160	0.491	0.250	0.035	0.540	0.248	-0.160
Part time employed	0.128	0.112	2.228	0.139	0.119	2.093	0.128	0.112	2.228
Unemployed	0.041	0.039	4.639	0.048	0.045	4.249	0.041	0.039	4.639
Male	0.448	0.247	0.211	0.431	0.245	0.280	0.448	0.247	0.211
Income level/1000	22.5	198.2	2.329	20.6	156.6	2.166	22.5	206.8	2.456
Resident of Highlands and Islands	0.068	0.063	3.448	0.058	0.055	3.765	0.067	0.063	3.448
Age	51.0	285.0	-0.151	47.9	279.1	-0.026	51.0	270.7	-0.208
Marine sports enthusiast	0.385	0.237	0.471	0.383	0.236	0.481	0.385	0.237	0.471
Aware of information given on Scottish marine environment at start of survey	0.425	0.244	0.306	0.582	0.243	-0.334	0.425	0.244	0.304

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806 **Table 4. Conditional Logit Models**

	Attribute level	Unweighted CL	Weighted CL
Health of fish stocks	High: > 80% of commercial stocks have healthy stock levels	0.611***(.054)	0.606***(.049)
	Moderate: 40 to 80% of commercial stocks have healthy stock levels	0.359***(.056)	0.334***(.051)
Marine litter	Good (0 to 1 item of litter per mile ²)	0.723***(.062)	0.736***(.057)
	Moderate (2 to 4 items of litter per mile ²)	0.353***(.057)	0.398***(.053)
Size of area protected	15% of the Sea of the Hebrides (15 times the size of "current management)	0.348***(.072)	0.389***(.066)
	10% of the Sea of the Hebrides (10 times the size of current management)	0.332***(.064)	0.364***(.059)
	6% of the Sea of the Hebrides (six times the size of current management)	0.366***(.063)	0.373***(.057)
Blue Growth (ocean economy jobs created in area)	+40 Jobs	0.472***(.051)	0.449***(.047)
	+20 jobs	0.227***(.055)	0.277***(.050)
Cost		-0.015***(.002)	-0.014***(.002)
Alternative Specific Constant for Status Quo Option (ASC3)		-0.576***(.122)	-0.474***(.119)
<i>Blue Planet (BPIL) Interactions</i>			
Health of fish stocks*BPIL	High: > 80% of commercial stocks have healthy stock levels	0.157*(.069)	0.157*(.067)
	Moderate: 40 to 80% of commercial stocks have healthy stock levels	0.084 (.073)	0.106 (.070)
Marine litter*BPIL	Good (0 to 1 item of litter per mile ²)	0.232**(.081)	0.215**(.078)
	Moderate (2 to 4 items of litter per mile ²)	0.217**(.075)	0.169*(.071)
Size of area protected*BPIL	15% of the Sea of the Hebrides (15 times the size of "current management)	0.245**(.094)	0.200*(.090)
	10% of the Sea of the Hebrides (10 times the size of current management)	0.225**(.082)	0.189*(.078)
	6% of the Sea of the Hebrides (six times the size of current management)	0.145 (.081)	0.133 (.077)
Blue Growth (ocean economy jobs created in area)*BPIL	+40 Jobs	0.076 (.067)	0.096 (.064)
	+20 jobs	0.127 (.071)	0.073 (.068)
Cost*BPIL		-0.007***(.002)	-0.009***(.002)
<i>Other Interactions with ASC3</i>			
Age*ASC3		0.0051*(.002)	0.003 (.002)
Male*ASC3		0.141*(.069)	0.078 (.067)
Highlands and Islands resident*ASC3		-0.851***(.186)	-0.867*** (.176)
Log Likelihood		-7701	-8408
Likelihood Ratio Chi ² (24)		2515	2796
Observations		7952	7952

Standard errors in parentheses, ***indicates significant at 1%, ** 5% and * 10%

Table 5. Random Parameters Logit estimated using entropy balancing weights

	Attribute level	Mean of coefficient	Standard deviation of coefficient
Health of fish stocks	High: > 80% of commercial stocks have healthy stock levels	0.872***(0.091)	1.135***(0.069)
	Moderate: 40 to 80% of commercial stocks have healthy stock levels	0.411***(0.076)	0.587***(0.092)
Marine litter	Good (0 to 1 item of litter per mile ²)	1.157***(0.104)	1.544***(0.078)
	Moderate (2 to 4 items of litter per mile ²)	0.616***(0.078)	0.719***(0.075)
Size of area protected	15% of the Sea of the Hebrides (15 times the size of "current management)	0.459***(0.106)	1.186***(0.107)
	10% of the Sea of the Hebrides (10 times the size of current management)	0.514***(0.084)	0.428***(0.107)
	6% of the Sea of the Hebrides (six times the size of current management)	0.525***(0.081)	0.459***(0.106)
Blue Growth (ocean economy jobs created in area)	+40 Jobs	0.678***(0.082)	1.086***(0.069)
	+20 jobs	0.460***(0.089)	1.125***(0.083)
<i>Non-random parameters in utility functions</i>			
Cost		-0.021***(0.002)	
Alternative Specific Constant for Status Quo Option (ASC3)		-0.329** (0.153)	
<u>Blue Planet (BP11)</u>			
<u>Interactions</u>			
Health of fish stocks*BP11	High: > 80% of commercial stocks have healthy stock levels	0.234* (0.126)	
	Moderate: 40 to 80% of commercial stocks have healthy stock levels	0.162 (0.104)	
Marine litter*BP11	Good (0 to 1 item of litter per mile ²)	0.297** (0.141)	
	Moderate (2 to 4 items of litter per mile ²)	0.234** (0.105)	
Size of area protected*BP11	15% of the Sea of the Hebrides (15 times the size of "current management)	0.121 (0.146)	
	10% of the Sea of the Hebrides (10 times the size of current management)	0.256** (0.112)	
	6% of the Sea of the Hebrides (six times the size of current management)	0.168 (0.109)	
Blue Growth (ocean economy jobs created in area)*BP11	+40 Jobs	0.133 (0.110)	
	+20 jobs	0.082 (0.120)	
Cost*BP11		-0.010*** (0.003)	
<u>Other Interactions with ASC3</u>			
Age*ASC3		0.003(0.003)	
Male*ASC3		0.052(0.089)	
Highlands and Islands resident*ASC3		-0.855***(0.213)	
Log likelihood	-7041		
Likelihood Ration chi ² (?)	3853		
Observations	7952		

807 Figures in parenthesis indicate the values of the standard errors. ***indicates significant at 1%, ** 5% and * 10%.

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809 **Table 6. Marginal WTP based on EB weighted Conditional Logit model results (£ Sterling)**

	Attribute level	Those who have not seen Blue Planet	Those who have seen Blue Planet
Health of fish stocks	High: > 80% of commercial stocks have healthy stock levels	44.35*** (5.11)	55.85*** (7.72)
	Moderate: 40 to 80% of commercial stocks have healthy stock levels	24.40*** (4.34)	32.16*** (5.39)
Marine litter	Good (0 to 1 item of litter per mile ²)	53.85*** (5.21)	69.58*** (9.43)
	Moderate (2 to 4 items of litter per mile ²)	29.08*** (4.26)	41.42*** (6.24)
Size of area protected	15% of the Sea of the Hebrides (15 times the size of "current management)	28.47*** (4.29)	43.09*** (7.31)
	10% of the Sea of the Hebrides (10 times the size of current management)	26.60*** (4.42)	40.41*** (6.61)
	6% of the Sea of the Hebrides (six times the size of current management)	27.31*** (4.85)	37.04*** (6.19)
Blue Growth (ocean economy jobs created in area)	+40 Jobs	32.86*** (4.61)	39.86*** (5.99)
	+20 jobs	20.28*** (4.11)	25.65*** (4.74)

810 Figures in parenthesis indicate the values of the standard errors. ***indicates significant at 1%.

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813 **Table 7. Marginal WTP based on EB weighted Random Parameter Logit model results (£ Sterling)**
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	Attribute level	Those who have not seen Blue Planet	Those who have seen Blue Planet
Health of fish stocks	High: > 80% of commercial stocks have healthy stock levels	41.23*** (5.14)	35.66*** (3.05)
	Moderate: 40 to 80% of commercial stocks have healthy stock levels	19.45*** (4.01)	18.47*** (2.64)
Marine litter	Good (0 to 1 item of litter per mile ²)	54.68*** (5.67)	46.85*** (3.53)
	Moderate (2 to 4 items of litter per mile ²)	29.12*** (3.98)	27.40*** (2.52)
Size of area protected	15% of the Sea of the Hebrides (15 times the size of "current management)	21.70*** (4.80)	18.71*** (3.31)
	10% of the Sea of the Hebrides (10 times the size of current management)	24.31*** (4.06)	24.85*** (2.76)
	6% of the Sea of the Hebrides (six times the size of current management)	24.84*** (3.99)	22.35*** (2.69)
Blue Growth (ocean economy jobs created in area)	+40 Jobs	32.07*** (5.02)	26.17*** (3.00)
	+20 jobs	21.75*** (4.62)	17.46*** (2.94)

815 Figures in parenthesis indicate the values of the standard errors. ***indicates significant at 1%.

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821 **Table 8. Attribute levels and compensating surplus value estimates for two policy**
 822 **scenarios (£ Sterling per person per year) based on EB weight RPL results**

Management Plan	Attribute levels	Welfare Impact of average person (95%CI)	Welfare Impact who have not seen Blue Planet (95%CI)	Welfare Impact who have seen Blue Planet (95%CI)
Marine Conservation Management Option	Health of fish stocks: High Marine litter: Good			
	15% of the Sea of the Hebrides No new ocean economy jobs created in area	107.11***(96.32, 117.90)	117.61*** (97.39, 137.84)	101.22*** (89.72, 112.72)
Blue Growth Management Option	Health of fish stocks: Moderate Marine litter: Moderate 10% of the Sea of the Hebrides +40 ocean economy jobs created in area	71.50*** (62.03, 80.96)	72.88*** (56.98, 88.77)	70.72*** (60.36, 81.08)

823 Figures in parenthesis indicate 95% confidence intervals. ***indicates significant at 1%, ** indicates significant at 5%.

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826 Appendix 1

827 **Table A1. Logit model of whether or not a person has watched any of the Blue Planet II**
 828 **series**

	Coefficient	Standard Error
Third level education	0.128	-0.131
Part time employed	-0.0241	-0.194
Unemployed	0.0679	-0.319
Male	-0.0331	-0.134
Income level/1000	0.00923	-0.0052
Resident of Highlands and Islands	-0.0249	-0.266
Age	0.00989**	-0.00394
Marine sports enthusiast	-0.023	-0.132
Aware of information given on Scottish marine environment at start of survey	-0.603***	-0.13
Constant	-0.227	-0.274
LogLikelihood		-687
LR chi2(9)		37*
Pseudo R2		0.0263

829 ***indicates significant at 1%, ** indicates significant at 5%.

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831 **Table A2. Separate conditional logit models for portion of sample who watched BPII,**
832 **who did not watch it, who did not watch it with EB weights, and model for entire**
833 **sample excluding BPII interaction terms.**

		BPII watchers	BPII non- watchers (un- weighted)	BPII non- watchers (weighted)	Full sample
Health of fish stocks	High: > 80% of commercial stocks have healthy stock levels	0.733*** (0.051)	0.641*** (0.052)	0.655*** (0.057)	0.695*** (0.038)
	Moderate: 40 to 80% of commercial stocks have healthy stock levels	0.414*** (0.052)	0.361*** (0.053)	0.396*** (0.058)	0.404*** (0.039)
Marine litter	Good (0 to 1 item of litter per mile ²)	0.921*** (0.059)	0.774*** (0.06)	0.771*** (0.065)	0.848*** (0.044)
	Moderate (2 to 4 items of litter per mile ²)	0.534*** (0.054)	0.434*** (0.056)	0.401*** (0.061)	0.472*** (0.041)
Size of area protected	15% of the Sea of the Hebrides (15 times the size of "current management)	0.519*** (0.048)	0.478*** (0.049)	0.511*** (0.054)	0.512*** (0.036)
	10% of the Sea of the Hebrides (10 times the size of current management)	0.325*** (0.051)	0.303*** (0.051)	0.263*** (0.057)	0.296*** (0.038)
	6% of the Sea of the Hebrides (six times the size of current management)	0.554*** (0.068)	0.430*** (0.069)	0.402*** (0.076)	0.480*** (0.051)
Blue Growth (ocean economy jobs created in area)	+40 Jobs	0.518*** (0.059)	0.404*** (0.061)	0.383*** (0.067)	0.455*** (0.045)
	+20 jobs	0.471*** (0.059)	0.410*** (0.06)	0.416*** (0.066)	0.444*** (0.044)
Cost		-0.022*** (0.002)	-0.014*** (0.002)	-0.016*** (0.002)	-0.019*** (0.001)
Alternative Specific Constant for Status Quo Option (ASC3)		-0.863*** (0.177)	-0.119 (0.162)	-0.295 (0.17)	-0.534*** (0.121)
Age*ASC3		0.00645* (0.003)	0.00053 (0.003)	0.00405 (0.003)	0.00432* (-0.003)
Male*ASC3		0.306** (0.098)	-0.125 (0.092)	-0.0219 (0.098)	0.137* (0.069)
Highlands and Islands resident*ASC3		-0.963*** (0.274)	-0.778*** (0.231)	-0.736** (0.256)	-0.848*** (0.186)
Observations		13296	10560	10560	23856

834 Standard errors in parentheses, ***indicates significant at 1%, ** 5% and * 10%.