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Hynes, Stephen; Ankamah-Yeboah, Isaac; O'Neill, Stephen; Needham, Katherine; Xuan, Bui Bich; Armstrong, Claire; (2020) The impact of nature documentaries on public environmental preferences and willingness to pay: entropy balancing and the blue planet II effect. *Journal of Environmental Planning and Management*, 64 (8). pp. 1428-1456. ISSN 0964-0568 DOI: <https://doi.org/10.1080/09640568.2020.1828840>

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DOI: <https://doi.org/10.1080/09640568.2020.1828840>

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

43 - *Sir David Attenborough*

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

46

47 **1. Introduction**

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

63 In particular, the ‘treatment’ analysed is having watched the BBC Blue Planet II (BPII)
64 documentary series and the research question of interest is what impact this may have had on
65 individuals’ choices and willingness to support marine conservation activity as observed
66 through the use of a choice experiment. In the discrete choice analysis, the preferences of the
67 Scottish public for the deep-sea environmental management of the Mingulay cold water reef
68 off the west coast of Scotland in the Sea of the Hebrides is assessed. These cold-water coral
69 reefs are known to act like islands in what is “normally flat, featureless and muddy

70 surroundings and harbour a distinct and rich ecosystem, providing niches and nursery grounds
71 for a variety of species, including commercial fish species” (Freiwald et al. 2004). While the
72 presentation of a data pre-processing method for estimating the impact of a particular treatment
73 on the choices made in discrete choice analysis is the main contribution of this paper, testing if
74 watching nature documentaries has a lasting effect on respondents’ environmental preferences
75 and willingness to pay (WTP) is in of itself an interesting line of research. If they can be shown
76 to influence preferences then they could be used as an effective policy tool to encourage
77 behavioural change to help tackle other environmental issues such as the looming climate and
78 biodiversity crises.

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

92 While there has been much focus on the increased interest in conservation from the BPII series,
93 we study whether it actually changes environmental preferences using a novel mechanism to
94 explain differences between those who have and have not seen the series. In particular, we
95 examine the impact of having seen the BPII series on preferences and willingness to pay (WTP)
96 by including interaction terms between the BPII dummy and the observable attributes of the
97 alternatives in the choice models employed. One might suspect however that those who have
98 watched BPII may have different characteristics (perhaps from differing social classes,

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.

99 education levels, etc.) to those that have not, resulting in the non-random selection into the
100 subgroups of those who have versus have not watched the BPII series. Also, there may be
101 unobserved factors that simultaneously influence both watching the series and the choices
102 made. In these cases, there may be important subgroup differences between the groups’
103 covariates that, if not adequately accounted for through some form of adjustment to known
104 sample moments (e.g. mean, variance, or skewness), could result in the interaction terms
105 producing biased estimates and lead to inappropriate conclusions in relation to the effect of
106 having seen the BPII series on an individual’s preferences for marine environmental
107 management options. That is, the preferences of those that have not watched the BPII series
108 (the comparison group) may not represent the true counterfactual preferences of the group that
109 did watch BPPI (the treated group), had the latter group not watched BPII.

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

122 Meyerhoff (2006) argues that in order to analyse the relationship between attitudes and a
123 specific behaviour, it is crucial to distinguish at the outset between an attitude towards a target
124 and an attitude towards a behaviour. The author argues that the important difference between
125 these attitudes is that “they differ in their attitude object”. For example, an individual donates
126 money towards a marine conservation project. In this case, the project is the target of the
127 behaviour of donating and the individual probably has a positive attitude towards this target.
128 Simultaneously, it is assumed that the individual also has a positive attitude towards the
129 behaviour of giving money to the conservation effort, but Meyerhoff (2006) suggests that these
130 attitudes are not necessarily equally balanced. Individuals could have a positive attitude
131 towards marine conservation in general, but may have a negative attitude towards contributing

132 financially for such conservation. Therefore, an attitude towards a target may be an unreliable
133 predictor of a specific behaviour. We examine this issue by testing the hypotheses that, firstly,
134 having watched BPII influences the preferences of respondents for marine conservation
135 management options, and that secondly respondents that watched BPII have higher WTP for
136 marine conservation. A third hypothesis tested is that the WTP from the EB weighted models
137 are significantly different from unweighted models.

138

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

140 The relationship between media and the environment has been studied from a wide range of
141 perspectives within the field of mass communication for many decades (Holbert et al., 2003).
142 Nature documentaries are now an increasingly used modality to communicate environmental
143 issues in order to create awareness, change behaviours or perhaps motivate increased viewers'
144 demand for environmental policy action. According to Östman (2013), media can play an
145 important role in engaging the public on environmental issues and asserts that fostering societal
146 awareness of their impact on the environment is a precondition to successful environmental
147 policy. Early empirical studies of media treatment effects on environmental behaviour typically
148 focused on public affairs (Atwater et al., 1985; McLeod et al., 1987; Brother et al., 1991), while
149 others focused on broad range of media communication content and consequences (Daley and
150 O'Neill, 1991; Meister, 2001).

151 In examining the relationships between television viewing and environmental concern,
152 Shanahan et al. (1997) showed that exposure to conservation messages on television is
153 associated with a general apprehension about the state of the environment. The authors found
154 however, that it was not consistently related to viewer's perception of threats from specific
155 sources and frequent viewers were less willing to change their behaviour for the good of the
156 environment. Hynes et al. (2014) also reflect on the divergence between what the public
157 perceive to be major marine environmental threats compared to that of scientists. Holbert et
158 al. (2003) examined the differences between the direct effects of factual versus fictional-based
159 television programming on environmental attitudes and behaviour, with factual-based
160 television programming such as nature documentaries and current affairs being found to have
161 a statistically significant positive influence on individual's desire to recycle, purchase eco-
162 friendly products and to be more energy efficient in daily routines.

163 In Australia, Hofman and Hughes (2018) determined that nature documentaries with specific
164 environmental conservation messages can influence viewers' attitudes and bring about
165 immediate changes in behaviour. However, the authors note that post-viewing materials and
166 strategies were needed to ensure that these behavioural changes continued in the long-term.
167 Elsewhere, Barbas et al. (2009) also found that nature documentaries about insects had a
168 positive effect on student's environmental sensitivity. The study also concluded that less
169 conventional documentary styles such as non-verbal films were more effective in the
170 development of environmental knowledge amongst the students, but the traditional nature
171 documentaries, such as BPII, were effective in fostering positive environmental attitudes and
172 beliefs. An interesting question arising from the positive effects of nature documentary on
173 behavioural intentions observed in the literature is whether these intentions translate into policy
174 support and financial commitments.

175 In attempting to answer that question other research has questioned the role of nature
176 documentaries on pro-environmental behaviour and financial support to conservation efforts
177 (Meyerhoff, 2006; Arendt and Matthes, 2016). In an experiment where the treatment group
178 watched a nature documentary, and the control group watched an unrelated science
179 documentary, Arendt and Matthes (2016) found that viewing the nature documentary did not
180 result in a significant increase in 'connectedness to nature'. It was found however to increase
181 actual donations to animal and environmental conservation societies, but only for those who
182 were already observed to have had a strong pro-environmental attitude. In a similar finding to
183 Hofman and Hughes (2018) in relation to the lasting impact of viewing nature documentaries
184 on behaviour, Jacobsen (2011) found that while the purchase of voluntary carbon offsets
185 significantly increased in regions where Al Gore's 'Inconvenient Truth' documentary was
186 released compared with regions where the film was not released the effect did not last. The
187 authors found that carbon offset purchases went back to prior levels within two months. Janpol
188 and Dilts (2016) also examined the effect of watching a nature documentary on the natural
189 environment on post-viewing financial support. They found significant effects on
190 environmental perceptions and on the choice of charitable donations amongst the participants
191 in their experiment².

192 Following another Attenborough BBC documentary, Planet Earth II, Fernández-Bellon and
193 Kane (2019) analysed Twitter and Wikipedia big data activities and showed that nature

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.

194 documentaries can generate awareness of unfamiliar animal species and that the viewers will
195 engage with the information provided at levels comparable to those achieved by other
196 environmental conservation initiatives such as world species awareness days. The analysis
197 however, suggested a lack of proactive engagement stemming from Planet Earth II through
198 charitable donations. According to the authors this latter effect was not unexpected given that
199 environmental awareness generated by the documentary is only one of many moderating
200 factors influencing the decision to donate and the effect may happen at a considerable lag. This
201 makes it difficult to establish a cause-and-effect relationship.

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

213

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

215 An online survey was carried out in January and February 2019 over a four week period. The
216 aim of the survey was to obtain information relating to the Scottish publics' preferences for
217 cold-water coral conservation and their associated ecosystem service benefits. The survey
218 attempted to also ascertain the ecosystem service benefit values that might be received by the
219 Scottish public through the management of the Mingulay Reef complex found off the west
220 coast of Scotland at a depth of 100-200m, 8.7 miles east of the Island of Mingulay in the Sea
221 of the Hebrides (Henry et al. 2013), under two different management scenarios. With this in
222 mind, a choice experiment was included in the survey instrument in order to generate data for
223 the estimation of the public good benefit value of such conservation. Extensive discussions
224 with marine scientists on the EU ATLAS project who have in-depth knowledge of this
225 particular reef led to the choosing of the relevant attributes and levels that should be used in

226 the choice experiment. Focus group discussions were also used to refine the language,
227 descriptions and other questions asked in the survey instrument. While the scientists provided
228 the detail for the appropriate attributes and levels to be used the focus groups ensured that the
229 descriptions were clearly understandable by the general public that would be responding to the
230 survey. The UK based market research company YouGov was employed to collect the data
231 using their established online panel of the general public. Pilot testing of the survey instruments
232 was conducted prior to the main survey.

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

244 To generate the choice cards used in the survey, a Bayesian efficient design was employed that
245 attempts to minimize the Bayesian Db-error criterion (Hess et al., 2008; Scarpa and Rose,
246 2008). A sequential experimental design where the choice cards were updated from the pilot to
247 the main survey was employed where the prior coefficients used in the design are updated.
248 Initially, prior coefficients for the pilot study were based on the results of similar surveys in
249 the literature. New prior coefficients estimates were generated based on the estimation of
250 choice models from the pilot study (n = 63). Such a sequential approach to choice card design
251 has been shown to deliver significant efficiency gains (Scarpa et al., 2007). The design for the
252 main survey was generated using the NGENE software and the value of the D-Error for the
253 main design was 0.55 (mean value).

254 For the choice experiment, respondents were first informed that: "*The Scottish Government are*
255 *responsible for delivering new plans on how best to manage Scotland's deep seas and wildlife.*
256 *As part of this scientists are assessing the "health" or the environmental quality of the deep*
257 *sea, including the Mingulay Reef Complex, with regard to a number of characteristics"*

258 Respondents were then presented with a description of the 5 characteristics used in the choice
259 cards; the health of commercial fish stocks, the amount of marine litter, the size of area that is
260 protected, the possible expansion of the ocean economy in the area of the reef associated with
261 the creation of new marine related jobs and the price of each restoration option.

262 The health of commercial fish stocks was measured by the number of adult fish compared to
263 young fish in the population (scientists refer to this as the abundance ratio). The more adult
264 fish, the healthier the population. Respondents were told this and informed that the reef is an
265 important nursery area for young fish where they can mature into breeding adults and
266 eventually move out of the reef complex into the surrounding seas where they can be
267 commercially caught. The levels of the attribute were presented as high, medium or low in each
268 option of the choice cards. The level of marine litter was described as good, moderate or poor
269 and was based on the observed number of items of litter per square mile. Marine scientists
270 within the EU ATLAS project developing indicators of Good Environmental Status (GES) of
271 EU deep-sea waters as required under the Marine Strategy Framework Directive (MSFD)
272 advised on what the corresponding number of items of litter should be for each level of the
273 marine litter attribute. The size of protected area attribute was presented in the form of a
274 percentage of the Sea of Hebrides and as the corresponding multiple of the current management
275 area; either 1% of the Sea of the Hebrides (current management), 6% of the Sea of the Hebrides
276 (six times the size of current management), 10% of the Sea of the Hebrides (10 times the size
277 of current management) or 15% of the Sea of the Hebrides (15 times the size of “current
278 management).

279 - **Table 1 here**

280 The fourth attribute chosen was the possible expansion of the ocean economy in the area of the
281 reef through the creation of new marine related jobs. Additional jobs have tended to be the
282 most popular economic factor to be used in environmental valuation surveys, framed in the
283 concept of the non-use value of employment (Aanesen et al., 2018; Morrison et al. 1999;
284 Othman et al. 2004). Respondents were informed that in the Mingulay Reef Complex there is
285 potential to develop new industries such as fisheries, new forms of aquaculture, tourism and
286 marine renewable energy and that it was possible that these developments could provide
287 employment for local communities. This attribute was included to examine possible perceived
288 trade-offs between developing the area commercially and protecting the cold-water coral reef
289 and associated marine wildlife. Finally, the cost of each option (the price) was presented in the

290 form of an annual increase in personal income tax. The reef management attributes and levels
291 used to describe the choice alternatives are also shown in Table 1. While the description in the
292 choice cards for each attribute was kept simple for the sake of clarity, additional information
293 explaining each of the attributes was provided to respondents in the questionnaire.

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

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

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

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.

319

320 **4. Methodology**

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

336

$$337 U_{int} = (\beta + k_i)x_{int} + \varepsilon_{int} \quad (1)$$

338

339 where within the deterministic component of the model (V_{int}), the vector of coefficients β
340 associated with the attributes denoted by x_{int} , vary across individuals (n), thus
341 accommodating heterogeneous preferences in the sampled population. The error term ε_{int}
342 captures the factors that affect utility but are not observed by the modeller. The error
343 components of different alternatives within the RPL is also allowed to be correlated. The
344 unknown parameters of the RPL model are distributed across the population according to a
345 specified distribution function (Hensher and Greene, 2003). In this paper, the RPL has a fixed
346 cost parameter but assumes normally distributed parameters for the other management

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).

347 attributes, with mean β and standard deviation σ . The conditional choice probability for
 348 respondent i choosing alternative n is given by:

349

$$350 \quad P_{int} = \Pr(y_i^t | \cdot) = \int_{\beta} \prod_{t=1}^{Ti} \frac{e^{V_{int}}}{\sum_{m=1}^M e^{V_{imt}}} f(\beta|\theta) d\beta, \quad (2)$$

351

352 Finally, the model is estimated by simulated maximum likelihood. The log-likelihood (LL)
 353 function for the model is given by $LL(\theta) = \sum_{i=1}^N \ln P_{int}$ where N is the size of the sample
 354 population. This expression cannot be solved analytically and simulation-based estimation of
 355 the model is used to evaluate P_{int} with a large number of draws from β (in this study we use
 356 300 Halton draws).

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

358

$$359 \quad LL(\theta) = \sum_{i=1}^N \ln \left[\frac{1}{R} \sum_{r=1}^R P_i(\beta^{in/\theta}) \right] \quad (3)$$

360

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

366 The marginal utility estimates for changes in the level of each attribute from the choice
 367 models can be easily converted to the marginal willingness to pay for the particular change in
 368 each attribute. These marginal values are derived by dividing a β parameter for a non-cost
 369 attribute x in alternative n (x_n) by the β parameter for the cost attribute:

370

$$371 \quad \text{Marginal WTP}_{x_n} = \frac{\beta_{x_n}}{-\beta_{cost}} \quad (4)$$

372

373 In estimating the marginal effects using the RPL the expected measure requires integration
 374 over taste distribution in the population which is computed by simulation from draws of the

375 estimated distributions for the random parameters (Scarpa and Thiene, 2005; Hynes et al.,
376 2008). In addition, the value (the compensating surplus) of a management option that leads to
377 specified changes in the cold water coral reef ecosystem service provision, as described by
378 the attribute levels, may be calculated using the standard utility difference expression
379 (Hanemann, 1984). Two management scenarios where the average WTP to move from the
380 state of the world given in the baseline (the status quo scenario) to the state of the world that
381 results with alternative levels of each attribute in the choice experiment is therefore
382 estimated.

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

391 Ideally, one would have two identical groups, one of which was exposed to BPPII and another
392 that was not. The difference in outcomes could then be attributed to their exposure to BPPII.
393 One could achieve this by randomising individuals to watch/not watch BPPII. As is usual in
394 observational studies this was not possible in this case. Therefore, in order to examine the
395 impact of having seen the BPPII series on preferences and WTP, EB is used to reweight those
396 who have not seen the nature series to be similar to those individuals in the sample that have
397 seen any of the series, in terms of the mean, variance, and skewness of a range of observed
398 covariates. The approach assures that the two sets of respondents are exactly the same on these
399 three moments across the chosen variables. Thus, any observed differences in outcomes are not
400 attributable to these covariates. Choosing covariates that might be considered important
401 explanatory variables in explaining the respondent's environmental attitudes, perceptions, etc.
402 should provide more assurance to the analyst that any observed impacts of having viewed BPPII
403 are meaningful.

404 The EB reweighting procedure employed in this paper is formally presented by Hainmueller
405 (2012). In this analysis the population average treatment effect on the treated group is used.
406 Assuming there is no unobserved confounding, the outcomes of the observed control group can

407 be reweighted to represent the expected counterfactual outcome of the treated group. While
 408 there are a number of data pre-processing methods that could be used to reduce the imbalance
 409 in the covariate distributions (e.g. nearest neighbour matching, coarsened exact matching,
 410 propensity score matching) EB is used in this application as it has the advantage that it directly
 411 incorporates the information about the known sample moments (m) for those who have not
 412 seen BPII and adjusts the weights such that the user obtains exact covariate balance for all
 413 moments included in the reweighting scheme (Hainmueller and Xu, 2013). The EB weights w_i
 414 are chosen by minimizing the entropy distance metric:

$$415 \quad \min_{w_i} H(w) = \sum_{\{i|D=0\}} w_i \log(w_i/q_i) \quad (5)$$

417 subject to balance and normalizing constraints

$$418 \quad \sum_{\{i|D=0\}} w_i c_{ri}(x_i) = m_r \text{ with } r \in 1, \dots, R$$

419 and

$$420 \quad \sum_{\{i|D=0\}} w_i = 1$$

421 and

$$422 \quad w_i \geq 0 \text{ for all } i \text{ such that } D = 0$$

423

424 where $q_i = 1/k_0$ is a base weight, k_0 is the sample of control units, and $c_{ri}(x_i) = m_r$ describes
 425 a set of R balance constraints imposed on the covariate moments of the reweighted control
 426 group and D is the binary treatment indicator coded 1 or 0 if individual i has seen the BPII
 427 series or has not (the control condition), respectively. In this application the moment constraints
 428 include the mean, the variance, and the skewness. EB is less prone to giving extreme weights
 429 to individuals than approaches such as Inverse Probability Weighting and is generally more
 430 efficient than propensity score matching.

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

436

437 $LL(\theta) = \sum_{i=1}^N w_i \ln \left[\frac{1}{R} \sum_{r=1}^R Pn(\beta^{in/\theta}) \right]$ where w_i is the balancing weight used for
438 individual i .

439

440 **5. Results**

441 Table 2 provides summary statistics for the sample of the 1,025 Scottish respondents to the
442 survey. The average age in the sample (adults aged 18 plus) is 49 while 44% were male and
443 52% had a third level qualification (including technical, professional or higher qualification).
444 Six per cent of the sample were active students, 28% were retired and 4% indicated that they
445 were currently unemployed. Six per cent of respondents were from the Highlands and Islands
446 region. Only 2% had visited the island of Mingulay while 12% indicated that they had visited
447 the nearest populated island Barra. Just under 25% of the sample had however visited the Outer
448 Hebrides at some point previously. Of particular interest to this study is the fact that there was
449 almost a 50/50 split in terms of those who had and had not watched BPII with 55% indicating
450 that they had seen at least one episode of the series.

451 - **Table 2 here**

452 Before proceeding to choice modelling results we first review the EB procedure used to pre-
453 process the choice data. All observations in the sample are used in the choice models, but these
454 observations are given different weights. Each respondent who has seen BPII is given a weight
455 of 1 because we are interested in the effect of having been exposed to the television series on
456 deep-sea management choice. Respondents who have not seen BPII are assigned varying
457 weights greater than zero that meet the EB conditions. The procedure effectively assigns more
458 weight to respondents who have not seen BPII, who have more comparable case conditions
459 and characteristics to respondents who have seen BPII, and less weight to respondents who
460 have not seen BPII whose features are more different. The entropy weights were generated
461 using the “ebalance” package in the statistical software package STATA (Hainmueller & Xu,
462 2013).

463 Respondents who have not seen BPII were weighted to meet the targets of balance on the three
464 moments (mean, variance, and skew) of the 9 independent variables shown in table 3. The EB
465 algorithms were restricted to a maximum number of 20 iterations and a maximum tolerated
466 deviation is set at .015 for the reweighted moments of the covariates. As pointed out by
467 MacDonald and Donnelly (2019) this maximum number of iterations and predefined tolerance

468 level encourages convergence and the optimization of covariate balance. Table 3 displays
469 descriptive statistics for the 9 covariates before and after matching the sub samples based on
470 EB. The balance table includes the means, variances, and skewness of covariates for both
471 treatment, and control pre and post weighting. As can be seen from the table the moments of
472 these variables across the 2 subsamples are already reasonably similar prior to reweighting
473 which should also aid the convergence and optimization process. In fact, the balancing
474 algorithms only required 13 iterations to fully converge.

475 Also evident in Table 3, before reweighting, the treated and control groups differ slightly in
476 terms of their covariate distributions, suggesting perhaps some degree of self-selection.
477 However, a simple logit model where 'watches BPII or not' is the dependent variable and the
478 nine independent variables are the regressors would suggest that only age and being aware of
479 information given on Scottish marine environment at start of survey have a significant
480 influence on the decision to watch BPII or not. The pseudo R^2 of this model is also low at 0.026
481 (see logit model results in table A1 of the appendix). This is further indication that the initial
482 level of imbalance between treatment and control groups is low. A 'leave-covariates-out'
483 (LCO) approach (Cerulli, 2019) was also employed to assess the sensitivity of the results to
484 unobserved confounders. The entropy balancing procedure was rerun a further eight times,
485 excluding one of the nine independent variables each time. The results of this analysis show
486 little variation in the resulting effect estimates. The effect estimate in each case range from
487 0.01586 to 0.01984 and hence the main choice model estimates are likely to be relatively
488 insensitive to unobserved confounders, since a potential omitted confounder would have to
489 exert a greater influence than all of the observed confounders to overturn the findings. This
490 provides some reassurance that the assumption of no unobserved confounders is not too
491 restrictive in this case.

492 - **Table 3 here**

493 The EB procedure produces an almost perfect balance between the groups across all observed
494 covariates. The means of the covariates in the reweighted control group (those who did not
495 watch BPII) perfectly match the means in the treatment group (those who did watch BPII). The
496 only slight imbalance occurs for the variance and skew of the income and age variables,
497 although their means are well-balanced so we do not anticipate this will introduce significant
498 bias. The individual level EB weights generated in the pre-processing step are stored for use in

499 the subsequent discrete choice analysis where they enter the log-likelihood function of the
500 chosen models as outlined in the methodology section.

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

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

513 All of the choice attribute level coefficients are significant at the 1% level. For all attributes,
514 the level against which estimates are compared in all models is the lowest level in each case
515 (attributes and all associated levels were summarized in table 1). As shown in table 4, the
516 magnitude and signs of the attribute coefficients in the CL models are broadly in line with
517 expectations. In particular, respondents show a stronger preference for higher levels of healthy
518 fish stock, lower levels of marine litter, more ocean economy job opportunities and a larger
519 area protected. In the latter case though, the medium level (10% of the Sea of Hebrides around
520 the reef complex protected) has a marginally lower coefficient than the 6% protection level.
521 The 15% protection area is still the most preferred however. As expected the coefficient on
522 cost is negative and significant, suggesting that *ceteris paribus*, respondents prefer to pay lower
523 amounts of additional taxation. The alternative specific constant for the status quo alternative
524 is negative and significant indicating that respondents are more likely all else being equal to
525 choose a management option that is different from the status quo option.

526 The attribute level dummies were also interacted with a binary variable that indicates whether
527 a person watched even one episode of the BPII series and these interaction terms were included
528 in all models. Examining the results of the weighted CL model, which thanks to the EB pre-

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).

529 possessing procedure is closer to an experimental data setting, one can see that those who have
530 seen BPII display statistically higher preferences for management options that achieve the
531 highest level of fish stock health, higher levels of area protected and lower levels of marine
532 litter compared to those who have not seen any of the series. The BPII watchers do not appear
533 to have any statistically different preferences when it comes to the creation of additional ocean
534 economy jobs however. Interestingly though, they do display higher sensitivity to the price of
535 a management option than those who have not seen the series as is evident from the significant
536 and negative sign on the cost interaction term. The results also highlight that a respondent who
537 is male or older is not statistically more or less likely to choose the status quo option but being
538 from the Highlands and Islands is a negative and significant predictor of choosing the status
539 quo option.

540 - **Table 4 here**

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

549 As is evident from Table 5 both the means and the standard deviations are significant for all
550 random parameters. The mean coefficients for the attribute level dummies are all of the
551 expected sign and also show the same pattern as in the CL case. As with the CL model the
552 highest level of the marine litter attribute has the largest coefficient value indicating a strong
553 preference for management options that achieve this outcome. There is however a wide
554 distribution in the preferences for the management attributes as seen in the magnitude and
555 significance of the standard deviation coefficients. The largest difference between mean and
556 standard deviation coefficient is observed for the highest level of the area protected and may
557 reflect the fact that some respondents believe that too large an area under protection may be
558 detrimental to other users of the marine space.

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.

559 - **Table 5 here**

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

570 In Tables 6 and 7, the marginal WTP per person per year estimates calculated based on both
571 the EB weighted CL model and EB weighted RPL model are presented for both those who had
572 and had not seen BPII along with their 95% confidence intervals. The marginal values were
573 estimated using the Krinsky and Robb (1986) procedure. As was the case for CL and RPL
574 models it follows through that there were no statistical differences in the marginal WTP values
575 derived from the weighted versus unweighted versions of the models so once more the focus
576 is on the EB weighted results. The estimates produced by the CL and RPL models across both
577 subgroups are similar. The highest estimated marginal WTP figure is for a high level (Good)
578 for marine litter in both the CL and RPL models (£54.68 and £46.85 for those who have not
579 and who had seen BPII respectively, in the case of the RPL model results) followed by the
580 highest possible level for health of fish stocks (£41.23 and £35.66 for those who have not and
581 who had seen BPII respectively, in the case of the RPL model results). The lowest level of the
582 ocean economy jobs created attribute (+20 jobs) is associated with the lowest marginal WTP
583 in both models. The results of a Poe test (Poe et al. 2005) however fails to reject the null
584 hypothesis that the difference in the two empirical distributions of the individual level marginal
585 WTP values, across those who have and have not seen BPII, are equal to zero and thus indicates
586 no statistical difference in the marginal WTP estimates across the groups.

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

588 The results in Table 8 present the estimates of the compensating surplus (CS) associated with
589 two possible management scenarios, based on the results of the EB weighted RPL model. The
590 first is a cold-water coral reef conservation management option and is associated with the

591 highest levels of the attributes health of fish stocks, marine litter and area to be protected but
592 the status quo level for blue growth opportunities, i.e. no new ocean economy jobs are created.
593 We also estimate the compensating surplus associated with a management plan that is more
594 focused on blue growth with 40+ ocean economy jobs created in the area, but the plan only
595 achieves the medium levels of all the other attributes. As was the case for the marginal WTP
596 per person per year estimates, and as can be seen from the results presented in table 8, no
597 statistical differences in the estimated welfare impact of alternative management options are
598 observed between those who have seen and have not seen BPII. This can be seen in the
599 overlapping confidence intervals and once again confirmed with a Poe test.

600 - **Table 8 here**

601 The welfare impact for scenario 1 (management to the highest possible level of all attributes)
602 is significantly larger than for the medium level management of scenario 2 based on the results
603 of the CL model (£70.70 versus £51.89). The difference is not as great in absolute terms (or
604 statistically) when the RPL results are used to estimate the scenario welfare effects. Although
605 not reported here, the estimated compensating surplus measures are higher from the CL model
606 compared to the RPL model (not unexpected given the observed magnitude of the coefficient
607 estimates in Tables 3 and 4). However, the estimates are not significantly different between the
608 models.

609

610 **6. Discussion and Conclusions**

611 This paper presented the results of a discrete choice experiment that was employed to estimate
612 the willingness to pay of the Scottish public to conserve the Mingulay cold water reef complex
613 and analysed how respondents make trade-offs between blue growth potential and ecosystem
614 service delivery. The impact that having watched the BBC Blue Planet II documentary series
615 may have had on individuals' preferences and willingness to support marine conservation
616 activity was also examined. To test this impact we first had to control for the possibility of
617 confounding covariates using EB, a multivariate reweighting method to produce balanced
618 samples in observational studies. It may be the case that those who have watched BPII have
619 different characteristics (education levels, environmental awareness, etc) from those that have
620 not, resulting in the non-random selection into the subgroups of those who have versus have
621 not watched the BPII series. The EB procedure allows the researcher to control for the

622 differences in characteristics across subgroups through the subsequent use of the generated
623 individual EB weights in the choice models.

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

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

648 The fact that those who have seen BPII were found to display higher sensitivity to the price of
649 a management option as indicated by the significant and negative interaction term $\text{Cost} \times \text{BPII}$
650 in all model specifications suggest that those who have seen the series are not willing to pay as
651 much for deep-sea management as those who have not seen the television series (the larger
652 coefficient of the price coefficient in the denominator in equation (4) in effect cancels out the
653 higher attribute coefficient values in the numerator). So, while the weighted models suggest an

654 influence of watching BPII on an individual's preferences for better management of marine
655 litter, for moderate increases in the size of the protected area and for the highest level for
656 healthy fish stocks they are not found to be willing to pay a premium for these outcomes
657 compared to the average person who did not watch BPII.

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

673 While the use of the EB procedure allows us, to some extent, to gets closer to saying what the
674 effect of BPII watching has on the demand for potential marine conservation outcomes it is
675 important to keep in mind that the underlying choice data is still observational rather than
676 experimental. There could still be other unobserved factors that may have a confounding effect
677 on the analysis that are not being controlled for in the balancing of the chosen covariates
678 although the results of the LCO analysis would suggest that this is not a major concern in this
679 case. Balancing on covariates that are likely to have a key influence on both the treatment and
680 decision making over choices is important for confidence in results. Also, while the EB
681 approach could be extremely useful where the only goal of the modelling exercise is to analyse
682 the effect of some treatment on choices made if the initial level of imbalance in the covariates
683 is high, then the reweighted model results may not be appropriate to draw general conclusions
684 about preferences in the population. Having said this Hainmueller (2012) points out that one
685 of the key advantages of EB is that it retains valuable information in the pre-processed data by
686 allowing the unit weights to vary smoothly across units; "it reweights units appropriately to

687 achieve balance, but at the same time keeps the weights as close as possible to the base weights
688 to prevent loss of information and thereby retains efficiency for the subsequent analysis”.

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

705 The paper started with a quote from a young Sir David Attenborough in which the broadcaster
706 was espousing the view that demonstrating the value of nature to the public is more beneficial
707 than lecturing them on what they should be doing to prevent damages. Although it would take
708 another decade for the first mention of the idea of ecosystem services (Ehrlich and Ehrlich,
709 1981), forty years on ‘ecosystem services’ now constitute a key conceptual framework for
710 discussing ecological, economic and social interactions in many areas of policy and has done
711 what Attenborough hoped; shifting the conversation from the negative impacts of humans on
712 the environment to the positive benefits society receives from a healthy environment. As
713 Kronenberg (2014) points out, the concept of ecosystem services refocuses the conversation
714 by suggesting that destroying the environment runs counter to societies’ interests. The results
715 presented in this paper show that Sir David Attenborough’s BPII series has not only highlighted
716 the importance of the ecosystem services provided by the marine environment but may also
717 have had an impact on how the public form their preferences for the services that marine
718 ecosystems such as cold water corals deliver, and their choices on how they should be managed
719 in the future.

720

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855 **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"/>

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857 **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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861 **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

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

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864 **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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870 **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)
<u>Blue Planet (BPIL) Interactions</u>			
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)
<u>Other Interactions with ASC3</u>			
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		

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

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873 **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)

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

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877 **Table 7. Marginal WTP based on EB weighted Random Parameter Logit model results (£**
878 **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	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)

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

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885 **Table 8. Attribute levels and compensating surplus value estimates for two policy**
886 **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			101.22*** (89.72, 112.72)
	15% of the Sea of the Hebrides	107.11*** (96.32, 117.90)	117.61*** (97.39, 137.84)	

No new ocean economy jobs created in area

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)

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

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890 **Appendix 1**

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

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

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895 **Table A2. Separate conditional logit models for portion of sample who watched BP II, who did not watch it, who did not watch it with EB weights, and model for entire sample excluding BP II 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

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