

1 Monetary valuation of recreational fishing in a restored estuary and 2 implications for future management measures

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9 Abstract

10 Recreational fishing is considered a cultural ecosystem service, important in terms of
11 the socio-economic benefits that it provides. In the Nerbioi estuary (northern Spain),
12 investments in water treatment and the closure of polluting industries have led to
13 several benefits such as improvements in water quality, fish abundance and richness
14 and recreational fishing activity. Currently, this activity is performed along the whole
15 estuary including areas that previously were severely polluted. Valuing the benefits of
16 recreational fishing is crucial to support the management of the estuary. The economic
17 valuation is performed using a multi-site travel cost analysis. In addition, the effect on
18 welfare measures of future scenarios where environmental conditions and accessibility
19 change is analysed. Results indicate that each recreational trip in Nerbioi has a use value
20 of 14.98 euros, with an aggregate value of 1.12 M euros year⁻¹ for the whole recreational
21 fishers' community. The simulated scenarios suggest that further environmental
22 improvements would have a positive effect in the activity, increasing the current welfare
23 by 7.5-11.5%. In contrast, worsening of environmental conditions and accessibility could
24 translate into a welfare reduction up to 71%. The monetary use value of recreational
25 fishing partially covers (4.7%) the costs of maintaining the environmental quality of the
26 estuary (i.e. treatment plant maintenance costs).

27 Keywords

28 Economic valuation, ecosystem services recovery, random utility models, recreational
29 fishing, travel cost.

30 **1. Introduction**

31 Ecological restoration can reverse the environmental degradation caused by human
32 activities, resulting in a positive impact on ecosystem services (Benayas *et al.*, 2009;
33 Matzek, 2018). Consequently, an improvement on ecosystem services will have positive
34 outcomes for human wellbeing, which is known to depend, to some extent, on the
35 natural environment (Summers *et al.*, 2012).

36 With 43% of the world's population living no further than 50 km from an estuary
37 (O'Higgins *et al.*, 2010), estuaries have become some of the most degraded ecosystems
38 (Lotze *et al.*, 2006). Numerous human activities have historically developed around them
39 (Barbier *et al.*, 2011), increasing pressures, generating impacts and compromising their
40 ecological integrity and capacity to provide ecosystem services (Lotze *et al.*, 2006;
41 Barbier, 2017). Investing in restoration of degraded estuaries could help to enhance
42 their ecological status, to recover the ecosystem services they provide, and will likely
43 contribute to improved human wellbeing.

44 When located in urban areas, healthy estuaries are considered "blue spaces"
45 from which inhabitants can benefit in multiple ways (e.g. recreation, social interactions)
46 (Bullock *et al.*, 2018) and translate into physical and mental health benefits (Nutsford *et al.*,
47 2016). Recreational fishing is one of the many recreational activities taking place in
48 estuaries, important in terms of the socio-economic benefits that they provide (Pita *et al.*,
49 2017). It is a cultural ecosystem service (Ghermandi *et al.*, 2012), which, according
50 to the Common International Classification of Ecosystem Services (CICES), are the non-
51 material outputs of ecosystems that affect physical and mental states of people (Haines-
52 Young and Potschin, 2018). Recreational fishing can involve the consumption of material
53 (i.e. catch), and therefore, it has been described as a cultural-consumptive service
54 (Ghermandi *et al.*, 2012). In developed countries, there is an increasing trend for catch-
55 and-release fishing, which does not involve keeping the captured fish (Cooke and
56 Schramm, 2007).

57 The benefits of recreational fishing can be assessed in monetary terms, for which
58 non-market valuation techniques are considered more adequate than market valuation
59 techniques (Viana *et al.*, 2017). First, because even if it involves the consumption of fish,
60 to base the economic value entirely on the market price of fish-catches would not

61 capture the social benefits that fishers obtain through the practice of the activity.
62 Indeed, the motivations for practicing recreational fishing have been described as a
63 combination of non-catch and catch-related motives (Fedler and Ditton, 1994). Similarly,
64 in the overall satisfaction of fishing, both catches and social aspects are important
65 (Arlinghaus, 2006; Pouso *et al.*, 2018b). Second, non-market valuation techniques are
66 preferred because they estimate consumer values.

67 The non-market valuation techniques available to assess the recreational
68 benefits are classified in two groups: stated preference and revealed preference
69 methods. Stated preference are direct methods, as user's are asked how much they are
70 willing to pay or receive for an environmental quality change, while the latter are
71 indirect methods, because they use user's actual behaviour to build models (Adamowicz
72 *et al.*, 1994).

73 Travel cost is a well-established revealed preference technique, commonly
74 applied to value recreational uses of the environment (Boyle, 2003). The simplest travel
75 cost models are the single-site models, which estimate access value of a recreational
76 site based on the number of trips demanded by a person in a season and the trip cost of
77 reaching the site (Parsons, 2003). However, these models are unable to account for
78 changes on natural settings that can affect users' recreational choices.

79 As recreational fishers choose the fishing site considering expected catches and
80 a wide set of factors (e.g. environmental conditions, infrastructures) (Arlinghaus *et al.*,
81 2017), incorporating those variables into the econometric models can provide more
82 accurate estimates. The multi-site Random Utility Models (RUM) consider the site-
83 characteristics known to influence the frequency of the recreational trips and are
84 preferred over single-site models because they allow the analysis of value change when
85 those characteristics change (Parsons, 2003). Indeed, RUMs have often been used to
86 analyse the variables that influence both professional and recreational fisher's decision
87 on where to fish (Hutniczak and Münch, 2018; Pokki *et al.*, 2018).

88 The use of RUMs for valuing recreational fishing benefits could be especially
89 interesting in restored ecosystems. Environmental factors conditioning the recreational
90 activity could have improved after restoration (Pouso *et al.*, 2019), and if the RUM
91 contains those improved factors, an economic value can be assigned to the

92 improvement, establishing a direct link to the social benefits. Monetary valuation of
93 recreational benefits on restored ecosystems (i.e. valuing changes in recreational
94 ecosystem services) is also useful for assessing the outputs of a restoration project (De
95 Groot *et al.*, 2013). Managers could use the monetary estimate of the benefits to design
96 future management measures, accounting for all the loss and gains that each alternative
97 will involve.

98 The objective of this study is to assess in monetary terms the current and future
99 recreational fishing benefits generated in the restored Nerbioi estuary. Recreational
100 fishing in Nerbioi has been described as an important social activity highly dependent
101 on the environmental amelioration (Pouso *et al.*, 2018b); performing an economic
102 valuation of the activity could complement these data. To achieve the objective, a multi-
103 site RUM is built. The results of the econometric model are used to value, in monetary
104 terms, the gain/loss of recreational fishing benefits as consequence of future plausible
105 changes in estuarine environmental and access conditions.

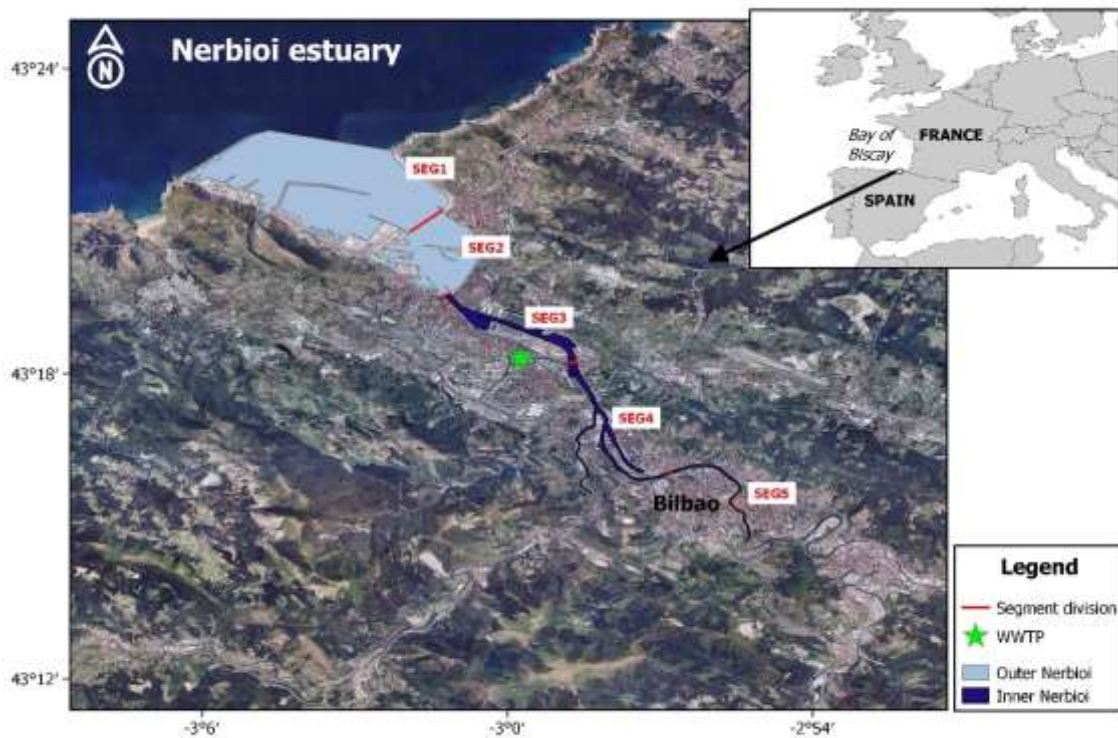
106 **2. Methodology**

107 **2.1. Nerbioi estuary restoration and recreational fishing**

108 The Nerbioi estuary (Fig. 1) is located on the coast of the Basque Country (northern
109 Spain). It has two distinct zones: the inner estuary, a narrow (25-270m width) channel
110 of 15km length; and the outer estuary, a coastal embayment of 30km² that flows into
111 the Bay of Biscay.

112 During the 19th and 20th Centuries, the intense economic development of the
113 region transformed the area into one of the most economically developed areas of
114 Spain, but it irreversibly changed the morphology of the estuary, altering its ecological
115 conditions (Cearreta *et al.*, 2004). During the 20th Century, Nerbioi was considered one
116 of the most polluted European estuaries; domestic and industrial sewages were directly
117 discharged into its waters causing intense pollution, with anoxic conditions in the inner
118 part (Cearreta *et al.*, 2004; Borja *et al.*, 2006). The sanitation plan, approved in 1979, led
119 to the implementation of a wastewater treatment plant (WWTP) in 1990. The
120 wastewater treatment was completed with the addition of the biological treatment in
121 2001. These actions, together with the closure of heavily polluting industries, allowed

122 the progressive recovery of the water quality (Borja *et al.*, 2006, 2010), biotic
123 components (Uriarte and Borja, 2009; Pascual *et al.*, 2012), and the recovery of several
124 cultural ecosystem services, such as beach recreation and recreational fishing (Pouso *et*
125 *al.*, 2018b, 2018a).



126
127 **Fig. 1** - Location of Nerbioi estuary within the Bay of Biscay. Estuary division in segments
128 (SEG), used as alternatives on the Random Utility Model. WWTP: Wastewater
129 Treatment Plant.

130 For this study, the estuary was divided in five segments (SEG), two in the outer
131 estuary (SEG1 and SEG2) and three in the inner estuary (SEG3, SEG4 and SEG5) (Fig. 1).
132 The segments were defined according to the existing sampling stations of the
133 environmental monitoring programmes (Pouso *et al.*, 2019) and following previous
134 studies on ecological status and recreational fishing (Uriarte and Borja, 2009; Pouso *et*
135 *al.*, 2018b). The sampling stations were established to obtain representative data along
136 the salinity gradient.

137 In a previous study, Pouso *et al.* (2018b) analysed recreational fishing patterns
138 within the same segments of the Nerbioi estuary, crossing historical biotic and abiotic
139 data and recreational fishers' behaviour and perceptions obtained from a survey (Pouso
140 *et al.*, 2018b). The activity was found to be mainly practiced by locals, middle-aged males

141 whose motivations were more social-oriented than catch-oriented (Pouso *et al.*, 2018b).
142 Significant differences on fishing patterns between SEGs were found, with fishers
143 preferring to fish from shore and in the outer part, having fished in the inner part over
144 more recent years, after restoration of the estuary (Pouso *et al.*, 2018b).

145 **2.2. Multi-site random utility travel cost model**

146 To perform the economic valuation of the recreational fishing in Nerbioi, a multi-site
147 RUM-travel cost model was defined. Contrary to the single-site models, where the
148 dependent variable is the quantity demanded (i.e. number of trips to a recreational site),
149 in RUMs, the dependent variable is the site selected (Parsons, 2003).

150 The information required to define the model was retrieved from previous
151 studies that analyse recreational fishing in the estuary (Pouso *et al.*, 2018b, 2019) and
152 the entire Basque Country (Ruiz *et al.*, 2014). Environmental data from two monitoring
153 networks (Borja *et al.*, 2016) were also used in the model. The coefficients of the RUM
154 were used to estimate in monetary terms the effect that environmental and access
155 changes can have in the current recreational fishing benefits.

156 *2.2.1. Description of the model*

157 The theoretical basis of the RUM is that individuals make choices under a “utility
158 maximisation framework”, and that individual’s utility (U_i) for a given site is a function
159 of observable (V_i) and unobservable (ε_i) characteristics (McFadden, 1973):

$$U_i = V_i + \varepsilon_i \quad (1)$$

160 As a non-market valuation technique, RUM can be applied in travel cost
161 recreational demand analyses, assuming that the individual (i) chooses a site (j) based
162 on the cost incurred to get there (TC_{ij}) and site-specific characteristics (Z_j) (Pendleton
163 and Mendelsohn, 2000; Haab and McConnell, 2002; Viana *et al.*, 2017). Therefore, the
164 utility associated with visiting a site is a function of the travel costs (TC_{ij}), site-specific
165 characteristics (Z_j) and a random error term (e_{ij}):

$$U_{ij} = f(TC_{ij}, Z_j) + e_{ij} \quad (2)$$

166 To specify a RUM for recreational fishing in Nerbioi, the five SEGs defined by
167 Pouso *et al.* (2018b) (see 2.1.) were used as the alternative-sites. We assumed that the

168 respondents compared the SEGs using site-specific characteristics and travel cost to
 169 reach the sites, choosing the option that maximized the utility.

170 Based on these premises and with the information on the number of trips per
 171 year that each fisher makes to each SEG, a conditional logit model (i.e. considering only
 172 alternative specific variables) was specified (McFadden, 1973). Precisely, each trip made
 173 by each respondent over a year was considered as a single choice occasion and assumed
 174 not to be conditioned by previous choices made. The conditional logit model was
 175 calculated with the *mlogit* package (Croissant, 2018) in software R (R Core Team, 2015).

176 The parameters of the model were used to estimate the relative WTP of each
 177 attribute known to affect the site chosen,

$$WTP_x = \beta_x / -\beta_{tc} \quad (3)$$

178 where β_x is the coefficient for the x attribute, one of the site-specific characteristics (Z_i),
 179 and β_{tc} is the coefficient of the travel cost. The “maximum expected trip utility” (EU^0)
 180 was estimated for each trip as:

$$EU^0 = \ln\{\sum_{ij}^s \exp(\beta_{tc}tc_{ij} + \beta_z Z_j)\} \quad (4)$$

181 where β_{tc} and β_z represent the coefficients of the travel cost (tc_{ij}) and the site-specific
 182 characteristics (Z_j), respectively. The mean maximum utility value per trip in monetary
 183 units (\bar{s}) was estimated dividing the sample mean “maximum expected trip utility”
 184 ($\overline{EU^0}$) by the travel cost coefficient:

$$\bar{s} = \overline{EU^0} / -\beta_{tc} \quad (5)$$

185 The aggregated value per recreational fisher (\bar{S}) was calculated as:

$$\bar{S} = \bar{s} \cdot T \quad (6)$$

186 where T is the average seasonal number of trips per recreational fisher, and fixed to 30
 187 (Ruiz *et al.*, 2014; Pouso *et al.*, 2019). The aggregated seasonal value was calculated as:

$$AS = \bar{S} \cdot POP \quad (7)$$

188 where POP is the recreational fishers’ community in Nerbioi, estimated in 2,500 fishers
 189 (Pouso *et al.*, 2019).

190 2.2.2. Travel cost estimation

191 The travel cost was calculated using data gathered from a survey administered to
192 recreational fishers in Nerbioi (Pouso *et al.*, 2018b). The questionnaire was distributed
193 between January and September 2016 using two approaches: (i) on-site face-to-face
194 interviews (*in situ* sampling) and (ii) contacting fishing clubs and federations (*ex situ*
195 sampling). A total of 146 questionnaires were completed (50 *ex situ* and 96 *in situ*),
196 which represents 5.8% of the estimated recreational fisher's community in Nerbioi.
197 More details on questionnaire design and distribution can be found in Pouso *et al.*
198 (2018b).

199 The travel cost for each respondent in each SEG was estimated using the survey
200 questions regarding: (i) the fishing experience in each of the SEG (if they fish nowadays
201 in the SEG and how many days year⁻¹); and (ii) questions about the specific day when
202 they answered the questionnaire (if they fished in the estuary that day, which was the
203 fishing site destination, the origin and the transport used to reach it).

204 For each respondent i and each alternative j , travel cost (TC_{ij}) was defined as the
205 sum of the travel expenses required to reach the fishing site (TE_{ij}) and the time cost
206 (tC_{ij}):

$$TC_{ij} = TE_{ij} + tC_{ij} \quad (8)$$

207 The origin was unique for each respondent and considered as the coordinates of
208 the centroid of the postal code from where they began their journey (e.g. home, work)
209 to the five alternatives. The first destination estimated was the real destination, i.e. the
210 SEG visited by the respondent the day when answering the questionnaire. The
211 coordinates for the remaining alternatives were fixed selecting the two most popular
212 fishing spots in each SEG, one per estuarine bank, with the information collected on the
213 previous study (Pouso *et al.*, 2018b). When various fishing spots in the same SEG and
214 estuarine bank received similar number of visitors, we selected the one that was better
215 connected by road and by public transport. Also, mobility between the two banks of the
216 estuary is easy and it would not be uncommon for the same fisher to move from one
217 bank to the other to practice fishing. However, in order to keep the number of
218 alternatives fixed to five (i.e. one per SEG), we assumed that each respondent will

219 remain on the same bank (i.e. bank of the real destination) and reach all the SEGs using
220 the same transportation.

221 The distance and time were calculated using the *ggmap* package (Kahle and
222 Wickham, 2013) in R environment (R Core Team, 2015), following the methodology
223 explained in Pouso *et al.* (2018c). The travel expenses (TE_i) were dependent on the type
224 of transport used to reach the fishing site; therefore, considered equal to zero when the
225 fisher walked or cycled. When public transport was used, the price of a round ticket from
226 origin to destination was considered. If the visitor reached the fishing site driving, the
227 travel expenses were calculated as:

$$TE_{ijcar} = 2 \times (toll_{ij} + D_{ij} \times carCost) + parkfee_j \times tfishing_{ij} \quad (9)$$

228 where $toll_{ij}$ is the one-way price of the highway toll; D_{ij} is the distance travelled;
229 $carCost$ is the average running cost per km of a vehicle in Spain (=0.35€)¹; $parkfee$ is the
230 price per hour of car park (=0.53€, only applicable in the left bank at SEG4); and
231 $tfishing_i$ is the time spent fishing. For visitors who travelled by car and accompanied,
232 the TE_{ijcar} was divided by 2 because they were expected to share the costs.

233 Time costs (tC_{ij}) for each visitor and segment were calculated as:

$$tC_{ij} = t_{ij} \times tC_{mean} \quad (10)$$

234 where t_{ij} is the time spend travelling from the origin to the destination (j) by each
235 visitor; and tC_{mean} is a constant that indicates the monetary value of the time spend
236 travelling (€ min⁻¹), calculated as:

$$tC_{mean} = VTT \times I_{ind}/wh \times 1/60 \quad (11)$$

237 where I_{ind} is the mean available income per individual in the sample (=10,920 € year⁻¹);
238 wh is the average annual working hours (=2080 h); and VTT is the average value of
239 travel time per income, which following Fezzi *et al.* (2014) was considered equal to 3/4.

¹ The average running cost per km of a vehicle was estimated with the information from the report that estimated the average cost of maintenance of petrol and diesel cars in Spain in 2017 (<http://aeaclub.org/cuanto-cuesta-tener-coche/>), and considering the diesel/petrol car-fleet ratio in Spain (<http://www.acea.be/statistics/article/Passenger-Car-Fleet-by-Fuel-Type>)

240 2.2.3. *Site-specific variables*

241 The RUM assumes that site-specific attributes influence individual's choices and should
242 be included in the model. Recreational fishing is considered to be influenced by fishers
243 characteristics (Abernethy *et al.*, 2007), by the infrastructures around fishing sites
244 (Griffiths *et al.*, 2017), by environmental conditions (Hampton and Lackey 1976) and by
245 the possibility of catching fish (Fedler and Ditton, 1986; Arlinghaus, 2006). These
246 variables can potentially determine the recreational experience and consequently,
247 fisher's satisfaction with the activity (Hunt, 2005; Arlinghaus *et al.*, 2014, 2017),
248 ultimately influencing the fishers' choice and the number of trips to a site. Considering
249 the effect of catch and non-catch variables to the overall recreational fishing experience,
250 we selected four site-specific variables to be included in the RUM (Table 1).

251 **Table 1** – Site-specific variables considered to be introduced in the Random Utility Model. SEG: Segment

Variable	Description	SEG1	SEG2	SEG3	SEG4	SEG5
Fish	The ecological status in each segment was estimated using the data from (Borja <i>et al.</i> , 2017).	High	High	Good	Good	Moderate
Water access	The number of metres available to fish from shore, calculated by (Pouso <i>et al.</i> , 2019).	1500	3500	1755	1020	450
Car park facilities	1= if there are car park facilities close to the fishing spots and 0=if there are not car park facilities or if facilities are shared with other groups such as residents.	1	1	0	0	0
Aquatic conflicts	1= If there is conflict with aquatic activities such as fishing boats, aquatic sports, etc. and 0=No conflict	1	1	1	0	0

252

253 The *Fish* variable is qualitative and defined considering the AZTI's Fish Index (AFI)
254 values (Uriarte and Borja, 2009) measured between 2007 and 2017. From these
255 measurements, we differentiated the segments according to three categories: "high"
256 ecological status, for the two segments in the outer Nerbioi, "good" in the SEG3 and
257 SEG4, and "moderate" for the innermost SEG5 (Table 1).

258 Facilities in the recreational site could affect the number of trips taken by fishers.
259 Therefore, two indicators were selected to be included in the RUM: (i) *water access*,
260 defined as the shoreline metres available to fishers to practice the activity; and (ii) *car*
261 *park facilities*, a dummy variable indicating the availability of car park facilities. Finally,
262 to represent the possible conflicts with other activities that might have a negative effect
263 on the recreational fishing activity, we defined an additional dummy variable, *aquatic*
264 *conflicts*, which represents the conflict that might arise when the space is shared with
265 other aquatic activities (e.g. recreational sports, maritime transport) (Table 1). The
266 values of *car park facilities* and *aquatic conflicts* for each SEG were based on recreational
267 fishers' comments when carrying out the recreational fishing survey (Pouso *et al.*,
268 2018b).

269 **2.3. Future scenarios**

270 The RUM coefficients were used to calculate the future welfare changes in recreational
271 fishing benefits, which might occur if environmental conditions or accessibility change,
272 by defining and simulating future scenarios.

273 Seven future scenarios were defined considering the site-specific variables
274 included in the final RUM and based on plausible changes in the estuarine
275 environmental conditions and the disappearance of certain SEGs as fishing sites (see
276 Table 3). All the scenarios were defined considering previous studies, current space
277 conflicts and possible management measures, which could change the estuarine
278 conditions in coming years and affect the recreational fishing activity.

279 Scenarios SC1 and SC2 simulate extreme changes, based on the disappearance
280 of recreational fishing from the outer Nerbioi. The SC1 simulated a fishing ban in SEG1,
281 while SC2 simulated a ban in SEG1 and SEG2. These scenarios could only happen if the
282 competition between recreational fishing and other activities (e.g. maritime transport,

283 professional fishing, cruises) lead managers to ban the recreational fishing from the
284 outer estuary.

285 In SC3 and SC4, improvement/worsening of environmental conditions were
286 simulated for the whole estuary. The improvement of environmental conditions (SC3)
287 could be achieved if a coastal submarine outfall, which would divert the WWTP inputs
288 to the open sea, is built (Pouso *et al.*, 2019). Currently, the WWTP outputs are
289 discharged to SEG3, negatively affecting the environmental conditions in the estuary. In
290 SC4, the opposite situation, general worsening in environmental conditions, was
291 simulated. This scenario could be related with future accidental failures of the WWTP,
292 intense dredging works, etc. (Pouso *et al.*, 2019). Although this is unlikely to occur, this
293 scenario gives an idea of how much welfare has been gained due to the improvement
294 after the ecological restoration of the estuary.

295 In SC5 and SC6, the loss of accessible shoreline in the most popular SEGs (SEG1
296 and SEG2) (Pouso *et al.*, 2018b) is simulated. In SEG2, a recreational port has recently
297 been expanded to allow cruise mooring in an area that is intensively used by recreational
298 fishers, making the coexistence of the two activities difficult. In SEG1, the most popular
299 recreational fishing site is a small port located on the left bank of the estuary, where the
300 competition with other activities (mainly maritime transport) and the presence of boats
301 (professional and recreational) is high. Therefore, the disappearance of shoreline in
302 SEG2 (SC5) or a combined shoreline loss in SEG1 and SEG2 (SC6) were considered
303 plausible scenarios. The SC7 is a combination of the previous SC3 (improvement of
304 environmental condition) and SC6 (loss of shoreline in SEG1 and SEG2).

305 Following Parsons (2003), the change on welfare due to the disappearance of a
306 fishing sites (ΔW_l), is calculated based on the equation for the maximum expected trip
307 utility (eq. 4):

$$\Delta W_l = \frac{[\ln \sum_{j-1}^i \exp(\beta_{tc}tc_j + \beta_z Z_j) - \ln \sum_j^i \exp(\beta_{tc}tc_j + \beta_z Z_j)]}{-\beta_{tc}} \quad (12)$$

308 where the difference between the maximum expected utilities with (j-1) and without (j)
309 the disappearance of one site are divided by the travel cost coefficient. Change in
310 welfare is again calculated per choice occasion (i.e. trip).

311 The welfare change per choice occasion (i.e. trip) after changes in estuarine
312 conditions ΔW_q was calculated as:

$$\Delta W_q = \frac{[\ln \sum_j^i \exp(\beta_{tc}tc_j + \beta_z Z_j^*)] - \ln \sum_j^i \exp(\beta_{tc}tc_j + \beta_z Z_j)}{-\beta_{tc}} \quad (13)$$

313 where Z_j^* captures the quality change in the variable Z on site j .

314 A mean value per trip is estimated as the mean value of ΔW_l or ΔW_q for the
315 sample. The seasonal value per fisher and for the estuary were calculated following
316 equation (6) and (7) for each change scenario.

317 **3. Results**

318 **3.1. Characteristics of the sample**

319 A total of 95 out of the 146 questionnaires obtained were used for defining the RUM.
320 The rest were discarded due to: (i) respondents answered the questionnaire on a day
321 when they did not fish inside Nerbioi, not providing information on transport (n=29); or
322 (ii) the information regarding fishing days in each SEG was incomplete (n=22). The
323 demographical characteristics of the sample are resumed in the Appendix Table A.1.

324 **3.2. Valuation of recreational fishing benefits**

325 Out of the four site-specific variables considered (Table 1), two were included in the
326 RUM: *fish* and *water access*. *Car park facilities* and *aquatic conflicts* were tested but also
327 discarded, as their contribution to the model was negligible.

328 In the selected RUM (Table 2), the TC estimate was negative and significant,
329 meaning that the likelihood of choosing a specific site for fishing decreases as travel
330 costs increase. The *fish* estimates are positive, meaning the lower the fish quality, the
331 lower the recreational benefit that recreational fishers obtain from the estuary. The
332 *water access* variable was positive, meaning that utility increases as the number of
333 metres available for fishing increases.

334

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337

338 **Table 2** - Coefficients of the Random Utility Model in the Nerbioi.

	Coefficient	Std. Error	z-value	Pr(> z)
Travel Cost	-0.1837	0.0050	-36.7315	<0.0001
Fish “good”	1.7510	0.0712	24.5804	<0.0001
Fish “high”	2.2722	0.0781	29.0818	<0.0001
Water access (m)	0.0003	0.0000	21.0661	<0.0001
log-Likelihood	-14,762			

339

340 The mean maximum expected utility per trip was estimated at 14.97€ per trip
 341 (sd=3.93). Considering the mean number of trips that each fisher makes to Nerbioi, the
 342 seasonal utility per fisher was estimated at 449€ per year, while the aggregated value
 343 for the entire recreational fishers’ community was 1.12M€ per year. The marginal WTP
 344 was 9.53€ per trip for *fish* in “good” status with the higher value corresponding to *fish*
 345 in “high” condition (12.37€ per trip). The *water access* variable affects each trip in a
 346 positive way, 0.1€ per trip per 100m (0.001€ m⁻¹).

347 **3.3. Future scenarios**

348 The disappearance of recreational fishing sites from Nerbioi, simulated in scenarios SC1
 349 and SC2 (complete disappearance of SEG1 and SEG1+SEG2, respectively) resulted in
 350 recreational fishing welfare loss with respect to the baseline, especially high for SC2
 351 (42.4%).

352 Changes in estuarine conditions were simulated by modifying the values of the
 353 variables *fish* and *water access* in the RUM (Table 3). The SC3 corresponded to an
 354 improvement scenario, where *fish* was upgraded to “high” and resulted in a welfare
 355 increase of 11.5%. The worst scenario was registered in SC4, where *fish* was worsened
 356 to “moderate”, leading to a welfare loss of 71%. The reduction of the variable *water*
 357 *access* (SC5: loss of 1000m in SEG2 and SC6: additional loss of 700m in SEG1) had a
 358 moderate negative impact, with the lowest welfare change from the seven simulations.

359 The effect of change in *fish* was more intense than that observed after change in
 360 *water access*. Indeed, when changes in both variables were combined (SC7), the positive
 361 effect of fish improvement was able to compensate the shoreline loss, resulting in a final
 362 welfare gain of 7.5%.

364 **Table 3** – Welfare change for seven scenarios. In SC1 & SC2 the complete ban of fishing in some sites (SEG) was simulated. In SC3-SC7 changes in
 365 *fish* and *water access* variables were simulated. Data in italic indicates welfare change values. Key: “Change”, gain or loss in the aggregated
 366 seasonal value; “Absolute”, the aggregate seasonal value for each scenario and estimated by applying to the baseline aggregate seasonal value
 367 (1.12M euro year⁻¹) the value indicated in “Change”.

Scenario	Description	€ trip ⁻¹ (mean)	€ season ⁻¹ (fisher)	€ season ⁻¹ (fishers' community)	
				Change	Absolute
Baseline	Current situation	14.98	449.4		1,123,426
Change in access					
SC1	Fishing is forbidden in SEG1	<i>-1.28</i>	<i>-38.4</i>	<i>-95,915</i>	1,027,511
SC2	Fishing is forbidden in SEG1 and SEG2	<i>-6.35</i>	<i>-190.5</i>	<i>-476,220</i>	647,206
Change in quality					
SC3	<i>Fish</i> improves to “high” in all SEG	<i>+1.73</i>	<i>+51.8</i>	<i>+129,571</i>	1,252,997
SC4	<i>Fish</i> decreases to “moderate” in all SEG	<i>-10.64</i>	<i>-319.2</i>	<i>-797,909</i>	325,517
SC5	Shoreline reduction: 1000m (35%) in SEG2 right bank	<i>-0.61</i>	<i>-18.3</i>	<i>-45,645</i>	1,077,781
SC6	Shoreline reduction: 1000m (35%) in SEG2 right bank & 700m (47%) in SEG1 left bank	<i>-0.82</i>	<i>-24.6</i>	<i>-61,549</i>	1,061,877
SC7	Combination of SC3 & SC6	<i>+1.12</i>	<i>+33.5</i>	<i>+83,676</i>	1,207,102

368

369 4. Discussion

370 The probability of visiting the different fishing sites in the Nerbioi is determined by the
371 costs and distances to reach the fishing sites, the environmental conditions (i.e. fish
372 conditions) and the length of accessible shoreline. The dependence of the utility with
373 the different characteristics is consistent with previous economic valuation studies
374 performed in other aquatic environments (Bateman *et al.*, 2016). Indeed, spatial
375 restrictions, crowding, fish catches and environmental quality are some of the most
376 important variables considered to influence recreational fishers' satisfaction
377 (Arlinghaus, 2005; Griffiths *et al.*, 2017). We included two of those four variables in the
378 model (i.e. spatial restrictions and environmental quality), while crowding and fish
379 catches could not be added due to lack of data.

380 The environmental improvement of the Nerbioi estuary in the last decades (Borja
381 *et al.*, 2010; Cajaraville *et al.*, 2016) is responsible for the current good status of fish
382 (Uriarte and Borja, 2009). Also, the RUM highlighted the importance of fish status in the
383 fishing utility associated with the SEGs, as the better the fish status in a specific SEG, the
384 greater the probability of a fisher visiting it. Therefore, the current value of recreational
385 fishing (estimated at 449€ year⁻¹ fisher⁻¹ and in 1.12M€ year⁻¹ for recreational fishers'
386 community) is a direct consequence of the management measures adopted to improve
387 the estuarine sanitary and ecological conditions. Environmental changes can encourage
388 recreational fishers to change their behaviour (Fulford *et al.*, 2016), as reported for
389 Nerbioi (Pouso *et al.*, 2018b), and this results in additional social benefits that can be
390 monetarily assessed.

391 The analysis of future scenarios suggested that the environmental conditions (i.e.
392 fish status) impact the recreational fishing activity. Indeed, the highest welfare gain and
393 loss were obtained in the scenarios where improvement and worsening of *fish* status
394 were simulated. The presence of fish and the possibility of catching them is essential for
395 fishers when deciding where to fish (Fedler and Ditton, 1986; Arlinghaus, 2006). The
396 combination of shoreline loss with improvement on fish status resulted in a positive
397 effect on welfare, which indicates that environmental conditions (in terms of fish and
398 catches) are more important than shoreline accessibility on fishing-site choice.

399 Changes in accessible shoreline have a lower effect on recreational fishing than
400 changes in fish condition, as reflected in the scenarios where the changes in shoreline
401 were analysed alone. The incidence on welfare was relatively lower for shoreline loss
402 than for fish variable changes. The low number of accessible fishing spots has been
403 pointed out as an important limitation for recreational fishing in urban areas (Arlinghaus
404 and Mehner, 2004); therefore, future management measures which negatively affect
405 accessibility should be carefully analysed. Indeed, the extension of the industrial port in
406 the left bank at SEG1 worsened the accessibility in the outer Nerbioi in the last decades.
407 According to Pouso *et al.* (2018b), this activity was intensively practiced in this part of
408 the estuary before the port extension, but the welfare loss could not be estimated due
409 to the lack of historical data on recreational fishing in Nerbioi. Even with the reduction
410 of shoreline, the competition with other activities in outer Nerbioi, and the
411 improvement of the environmental conditions in the inner estuary, fishers still prefer to
412 fish in the outer Nerbioi (Pouso *et al.*, 2018b). Therefore, the monetary value of
413 recreational fishing in the estuary is highly dependent on the outer area. However, if
414 other maritime activities continue to compete with recreational fishing in the outer
415 Nerbioi and the environmental conditions continue to improve in the inner part, a
416 change in recreational fishers' preferences and behaviour might occur.

417 The functional form of the RUM selected result in certain limitations and
418 therefore, the estimated value should be used with caution. The relatively low number
419 of surveys and the high number of trips taken by each respondent led to the adoption
420 of a model where each trip is a single choice occasion, independent of the previous trips
421 taken by the same individual. Considering that previous trips will not influence decisions
422 taken by anglers in future trips (e.g. where to fish) is an important assumption (Parsons
423 and Massey, 2003). Also, the model only uses site-specific variables as explanatory
424 variables, ignoring the characteristics of the decision-maker (Paltriguera *et al.*, 2018).
425 The number of responses did not allow the application of the more precise mixed
426 conditional model, which introduces decision-makers characteristics as dependent
427 variable and allows the correlation between the different aspects of the utility
428 (Paltriguera *et al.*, 2018).

429 The data used for aggregation was based on Ruiz *et al.* (2014) and Pouso *et al.*
430 (2019), who estimated the fisher community in Nerbioi in 2,500 fishers, with 30 fishing
431 trips per year in mean. This is a rough approximation to the recreational fishers'
432 community, and future studies able to differentiate between active and inactive
433 recreational fishers, as well as preferred fishing areas, would improve the accuracy of
434 the aggregated value.

435 This study suggests that recreational fishing in Nerbioi is an important economic
436 activity, which adds to its social importance (Pouso *et al.*, 2018b). Furthermore, this
437 activity is only one of the multiple activities that could have benefited from water
438 improvement, and that the positive effect could be even higher for the others. Viana *et*
439 *al.* (2017), who studied different recreational activities in a marine sanctuary, found that
440 the group of recreational users that place the less relative importance to environmental
441 quality were indeed recreational fishers.

442 The monetary valuation of recreational fishing complements previous studies
443 that analysed the activity for its social importance and environmental dependency
444 (Pouso *et al.*, 2018b, 2019). These studies offer complementary information, and their
445 combination could be helpful in advancing towards an integrative approach for
446 ecosystem services valuation and for better understanding and managing of these
447 social-ecological systems (Outeiro *et al.*, 2017). Marine recreational fishing has been
448 reported as an important activity in terms of economic and social revenues for other
449 Spanish regions and Europe (Hyder *et al.*, 2017; Pita *et al.*, 2018); however, research and
450 information on the activity is still scarce, especially in southern European countries (Pita
451 *et al.*, 2017). This study, together with the aforementioned studies covering social and
452 environmental aspects of the recreational fishing in Nerbioi, can help to advance
453 towards a better understanding of the activity in southern European countries.

454 The monetary value of recreational fishing estimated in this study adds to a
455 previous study that estimated the recreational use value of the estuarine beaches
456 (Pouso *et al.*, 2018c). The aggregated use value of these two activities is estimated in
457 more than 4.6M€ year⁻¹, which is an important amount able to partially cover the costs
458 of WWTP maintenance, estimated in 23.7M€ year⁻¹.

459 Due to the econometric methodology followed in this study and the one
460 performed in beaches (Pouso *et al.*, 2018c), the benefits provided in Nerbioi have only
461 been partially valued. First, because the travel cost methodology can only estimate the
462 use values of the activities, but this environment can also provide non-use values. To
463 calculate non-use benefits, the current information could be complemented with a
464 stated preference method exercise, asking direct questions to identify both use and non-
465 use values. Also, the economic valuation is considered partial because, recreational
466 fishing and beach recreation are only two of the multiple recreational activities
467 happening in Nerbioi, activities that have not been valued yet, and that will increase the
468 economic value of the ecosystem services provided by this restored ecosystem.

469 The valuation of cultural ecosystem services and their non-market benefits, such
470 as recreational fishing, provide useful information to managers, who could incorporate
471 the data in analysis for policy decisions (Viana *et al.*, 2017). Nerbioi estuary, being in a
472 highly populated area, offers to its inhabitants many recreational opportunities, and
473 ecological restoration has increased those opportunities. Indeed, increasing recreational
474 outdoor opportunities in urban areas can have a greater impact on welfare than in rural
475 areas, which could be related to the scarce number of similar recreational alternatives
476 (Bateman *et al.*, 2016).

477 **5. Conclusion**

478 Economic valuation of changes in recreational activities in restored ecosystems can be
479 performed specifying multi-site travel cost RUMs. This revealed preference technique
480 allows the incorporation of the environmental conditions that changed after ecosystem
481 restoration and that potentially influenced the recreational activity. The economic
482 valuation of restored ecosystems provides valuable information for managers in two
483 ways: first, because it allows the valuation of the welfare change after restoration; and
484 second, because the built model can be used to simulate future conditions and analyse
485 the expected gains or losses in welfare.

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494 **References**

- 495 Abernethy, K. E., Allison, E. H., Molloy, P. P., and Côté, I. M. 2007. Why do fishers fish
496 where they fish? Using the ideal free distribution to understand the behaviour of
497 artisanal reef fishers. *Canadian Journal of Fisheries and Aquatic Sciences*, 64:
498 1595–1604.
- 499 Adamowicz, W., Louviere, J., and Williams, M. 1994. Combining Revealed and Stated
500 Preference Methods for Valuing Environmental Amenities. *Journal of*
501 *Environmental Economics and Management*, 26: 271–292.
- 502 Arlinghaus, R., and Mehner, T. 2004. A Management-Orientated Comparative Analysis
503 of Urban and Rural Anglers Living in a Metropolis (Berlin, Germany).
504 *Environmental Management*, 33: 331–344.
- 505 Arlinghaus, R. 2005. A conceptual framework to identify and understand conflicts in
506 recreational fisheries systems, with implications for sustainable management.
507 *Aquatic Resources, Culture and Development*, 1: 145–174.
- 508 Arlinghaus, R. 2006. On the Apparently Striking Disconnect between Motivation and
509 Satisfaction in Recreational Fishing: The Case of Catch Orientation of German
510 Anglers. *North American Journal of Fisheries Management*, 26: 592–605.
- 511 Arlinghaus, R., Beardmore, B., Riepe, C., Meyerhoff, J., and Pagel, T. 2014. Species-
512 specific preferences of German recreational anglers for freshwater fishing
513 experiences, with emphasis on the intrinsic utilities of fish stocking and wild
514 fishes: utility of stocking to freshwater anglers. *Journal of Fish Biology*, 85: 1843–
515 1867.
- 516 Arlinghaus, R., Alós, J., Beardmore, B., Daedlow, K., Dorow, M., Fujitani, M., Hühn, D., *et*
517 *al.* 2017. Understanding and Managing Freshwater Recreational Fisheries as
518 Complex Adaptive Social-Ecological Systems. *Reviews in Fisheries Science &*
519 *Aquaculture*, 25: 1–41.
- 520 Barbier, E. B., Hacker, S. D., Kennedy, C., Koch, E. W., Stier, A. C., and Silliman, B. R. 2011.
521 The value of estuarine and coastal ecosystem services. *Ecological Monographs*,
522 81: 169–193.
- 523 Barbier, E. B. 2017. Marine ecosystem services. *Current Biology*, 27: R507–R510.
- 524 Bateman, I., Agarwala, M., Binner, A., Coombes, E., Day, B., Ferrini, S., Fezzi, C., *et al.*

- 525 2016. Spatially explicit integrated modeling and economic valuation of climate
526 driven land use change and its indirect effects. *Journal of Environmental*
527 *Management*, 181: 172–184.
- 528 Benayas, J. M. R., Newton, A. C., Diaz, A., and Bullock, J. M. 2009. Enhancement of
529 Biodiversity and Ecosystem Services by Ecological Restoration: A Meta-Analysis.
530 *Science*, 325: 1121–1124.
- 531 Borja, A., Muxika, I., and Franco, J. 2006. Long-term recovery of soft-bottom benthos
532 following urban and industrial sewage treatment in the Nervión estuary
533 (southern Bay of Biscay). *Marine Ecology Progress Series*, 313: 43–55.
- 534 Borja, A., Dauer, D., Elliott, M., and Simenstad, C. 2010. Medium- and Long-term
535 Recovery of Estuarine and Coastal Ecosystems: Patterns, Rates and Restoration
536 Effectiveness. *Estuaries and Coasts*, 33: 1249–1260.
- 537 Borja, A., Chust, G., Rodríguez, J. G., Bald, J., Belzunce-Segarra, M. J., Franco, J.,
538 Garmendia, J. M., *et al.* 2016. ‘The past is the future of the present’: Learning
539 from long-time series of marine monitoring. *Science of The Total Environment*,
540 566–567: 698–711.
- 541 Borja, A., Bald, J., Franco, J., Larreta, J., Menchaca, I., Muxika, I., Revilla, M., *et al.* 2017.
542 Red de seguimiento del estado ecológico de las aguas de transición y costeras de
543 la Comunidad Autónoma del País Vasco. Informe de resultados 2016. AZTI-
544 Tecnalia.
545 [http://www.uragentzia.euskadi.eus/contenidos/documentacion/red_costa_20](http://www.uragentzia.euskadi.eus/contenidos/documentacion/red_costa_2016/es_red_agua/adjuntos/01_informe_completo_2016_RSEETyC.pdf)
546 [16/es_red_agua/adjuntos/01_informe_completo_2016_RSEETyC.pdf](http://www.uragentzia.euskadi.eus/contenidos/documentacion/red_costa_2016/es_red_agua/adjuntos/01_informe_completo_2016_RSEETyC.pdf).
- 547 Boyle, K. J. 2003. Introduction to the revealed preference methods. *In* A primer on
548 nonmarket valuation, pp. 259–268. Ed. by P. A. Champ, K. J. Boyle, and T. C.
549 Brown. Springer Netherlands, Dordrecht.
- 550 Bullock, C., Joyce, D., and Collier, M. 2018. An exploration of the relationships between
551 cultural ecosystem services, socio-cultural values and well-being. *Ecosystem*
552 *Services*, 31: 142–152.
- 553 Cajaraville, M. P., Orive, E., Villate, F., Laza-Martínez, A., Uriarte, I., Garmendia, L., Ortiz-
554 Zarragoitia, M., *et al.* 2016. Health status of the Bilbao estuary: A review of data
555 from a multidisciplinary approach. *Estuarine, Coastal and Shelf Science*, 179:
556 124–134.
- 557 Cearreta, A., Irabien, M. J., and Pascual, A. 2004. Human activities along the Basque
558 coast during the last two centuries: geological perspective of recent
559 anthropogenic impact on the coast and its environmental consequences. *In*
560 *Oceanography and marine environment in the Basque Country*, pp. 27–50. Ed.
561 by A. Borja and M. Collins. Elsevier.
- 562 Cooke, S. J., and Schramm, H. L. 2007. Catch-and-release science and its application to
563 conservation and management of recreational fisheries. *Fisheries Management*

- 564 and Ecology, 14: 73–79.
- 565 Croissant, Y. 2018. mlogit: Multinomial Logit Models. [https://CRAN.R-](https://CRAN.R-project.org/package=mlogit)
566 [project.org/package=mlogit](https://CRAN.R-project.org/package=mlogit).
- 567 De Groot, R. S., Blignaut, J., Van Der Ploeg, S., Aronson, J., Elmqvist, T., and Farley, J.
568 2013. Benefits of Investing in Ecosystem Restoration. *Conservation Biology*, 27:
569 1286–1293.
- 570 Fedler, A. J., and Ditton, R. B. 1986. A framework for understanding the consumptive
571 orientation of recreational fishermen. *Environmental Management*, 10: 221–
572 227.
- 573 Fedler, A. J., and Ditton, R. B. 1994. Understanding angler motivations in fisheries
574 management. *Fisheries*, 19: 6–13.
- 575 Fezzi, C., Bateman, I. J., and Ferrini, S. 2014. Using revealed preferences to estimate the
576 Value of Travel Time to recreation sites. *Journal of Environmental Economics and*
577 *Management*, 67: 58–70.
- 578 Fulford, R., Yoskowitz, D., Russell, M., Dantin, D., and Rogers, J. 2016. Habitat and
579 recreational fishing opportunity in Tampa Bay: Linking ecological and ecosystem
580 services to human beneficiaries. *Ecosystem Services*, 17: 64–74.
- 581 Ghermandi, A., Nunes, P. A. L. D., Portela, R., Rao, N., and Teelucksingh, S. S. 2012.
582 Recreational, cultural and aesthetic services from estuarine and coastal
583 ecosystems. Chapter 11 in M. van den Belt and R. Costanza (eds.), Volume 12:
584 Ecological Economics of Estuaries and Coasts. *Treatise on Estuarine and Coastal*
585 *Science* (Series eds., E. Wolanski, and D. McLusky), Waltham, MA: Academic
586 Press: 217–237.
- 587 Griffiths, S. P., Bryant, J., Raymond, H. F., and Newcombe, P. A. 2017. Quantifying
588 subjective human dimensions of recreational fishing: does good health come to
589 those who bait? *Fish and Fisheries*, 18: 171–184.
- 590 Haab, T. C., and McConnell, K. E. 2002. *Valuing Environmental and Natural Resources*
591 *The Econometrics of Non-market Valuation*. Cheltenham, UK.
- 592 Haines-Young, R., and Potschin, M. 2018. Common International Classification of
593 Ecosystem Services (CICES) V5.1 and guidance on the application of the revised
594 structure. Fabis consulting. www.cices.eu.
- 595 Hunt, L. M. 2005. Recreational Fishing Site Choice Models: Insights and Future
596 Opportunities. *Human Dimensions of Wildlife*, 10: 153–172.
- 597 Hutniczak, B., and Münch, A. 2018. Fishermen’s location choice under spatio-temporal
598 update of expectations. *Journal of Choice Modelling*, 28: 124–136.
- 599 Hyder, K., Weltersbach, M. S., Armstrong, M., Ferter, K., Townhill, B., Ahvonen, A.,
600 Arlinghaus, R., *et al.* 2017. Recreational sea fishing in Europe in a global context-

- 601 Participation rates, fishing effort, expenditure, and implications for monitoring
602 and assessment. *Fish and Fisheries*. <http://doi.wiley.com/10.1111/faf.12251>
- 603 Kahle, D., and Wickham, H. 2013. ggmap: Spatial Visualization with ggplot2. *The R*
604 *Journal*, 5: 144–161.
- 605 Lotze, H. K., Lenihan, H. S., Bourque, B. J., Bradbury, R. H., Cooke, R. G., Kay, M. C.,
606 Kidwell, S. M., *et al.* 2006. Depletion, degradation, and recovery potential of
607 estuaries and coastal seas. *Science*, 312: 1806–1809.
- 608 Matzek, V. 2018. Turning delivery of ecosystem services into a deliverable of ecosystem
609 restoration: Measuring restoration’s contribution to society. *Restoration*
610 *Ecology*, 26: 1013–1016.
- 611 McFadden, D. 1973. Conditional logit analysis of qualitative choice behavior. *In* *Frontiers*
612 *in econometrics*, pp. 105–142. Ed. by P. Zarembka. ELSEVIER ACADEMIC PRESS,
613 New York.
- 614 Nutsford, D., Pearson, A. L., Kingham, S., and Reitsma, F. 2016. Residential exposure to
615 visible blue space (but not green space) associated with lower psychological
616 distress in a capital city. *Health & Place*, 39: 70–78.
- 617 O’Higgins, T. G., Ferraro, S. P., Dantin, D. D., Jordan, S. J., and Chintala, M. M. 2010.
618 Habitat scale mapping of fisheries ecosystem service values in estuaries. *Ecology*
619 *and Society*, 15: 7.-[online] URL: <http://www.ecologyandsociety.org/vol15/iss4/art7/>.
- 621 Outeiro, L., Ojea, E., Garcia Rodrigues, J., Himes-Cornell, A., Belgrano, A., Liu, Y.,
622 Cabecinha, E., *et al.* 2017. The role of non-natural capital in the co-production of
623 marine ecosystem services. *International Journal of Biodiversity Science,*
624 *Ecosystem Services & Management*, 13: 35–50.
- 625 Paltriguera, L., Ferrini, S., Luisetti, T., and Turner, R. K. 2018. An analysis and valuation
626 of post-designation management aimed at maximising recreational benefits in
627 coastal Marine Protected Areas. *Ecological Economics*, 148: 121–130.
- 628 Parsons, G. R. 2003. The Travel Cost Model. *In* *A Primer on Nonmarket Valuation*, pp.
629 269–329. Ed. by P. A. Champ, K. J. Boyle, and T. C. Brown. Springer Netherlands,
630 Dordrecht.
- 631 Parsons, G. R., and Massey, D. M. 2003. A Random Utility Model of Beach Recreation. *In*
632 *The New Economics of Outdoor Recreation*. Edward Elgar Publishing.
- 633 Pascual, M., Borja, A., Franco, J., Burdon, D., Atkins, J. P., and Elliott, M. 2012. What are
634 the costs and benefits of biodiversity recovery in a highly polluted estuary?
635 *Water Research*, 46: 205–217.
- 636 Pendleton, L., and Mendelsohn, R. 2000. Estimating recreation preferences using
637 hedonic travel cost and random utility models. *Environmental and Resource*
638 *Economics*, 17: 89–108.

- 639 Pita, P., Artetxe, I., Diogo, H., Gomes, P., Gordo, A., Hyder, K., Pereira, J., *et al.* 2017.
640 Research and management priorities for Atlantic marine recreational fisheries in
641 Southern Europe. *Marine Policy*, 86: 1–8.
- 642 Pita, P., Hyder, K., Gomes, P., Pita, C., Rangel, M., Veiga, P., Vingada, J., *et al.* 2018.
643 Economic, social and ecological attributes of marine recreational fisheries in
644 Galicia, Spain. *Fisheries Research*, 208: 58–69.
- 645 Pokki, H., Artell, J., Mikkola, J., Orell, P., and Ovaskainen, V. 2018. Valuing recreational
646 salmon fishing at a remote site in Finland: A travel cost analysis. *Fisheries
647 Research*, 208: 145–156.
- 648 Pouso, S., Uyarra, M. C., and Borja, Á. 2018a. The recovery of estuarine quality and the
649 perceived increase of cultural ecosystem services by beach users: A case study
650 from northern Spain. *Journal of Environmental Management*, 212: 450–461.
- 651 Pouso, S., Uyarra, M. C., and Borja, Á. 2018b. Recreational fishers' perceptions and
652 behaviour towards cultural ecosystem services in response to the Nerbioi estuary
653 ecosystem restoration. *Estuarine, Coastal and Shelf Science*, 208: 96–106.
- 654 Pouso, S., Ferrini, S., Turner, R. K., Uyarra, M. C., and Borja, Á. 2018c. Financial Inputs for
655 Ecosystem Service Outputs: Beach Recreation Recovery After Investments in
656 Ecological Restoration. *Frontiers in Marine Science*, 5.
- 657 Pouso, S., Borja, Á., Martín, J., and Uyarra, M. C. 2019. The capacity of estuary
658 restoration to enhance ecosystem services: System dynamics modelling to
659 simulate recreational fishing benefits. *Estuarine, Coastal and Shelf Science*, 217:
660 226–236.
- 661 R Core Team. 2015. R: A language and environment for statistical computing. R
662 Foundation for Statistical Computing, Vienna, Austria. [https://www.R-
663 project.org/](https://www.R-project.org/).
- 664 Ruiz, J., Zarauz, L., Urtizbera, A., Andonegi, E., Mugerza, E., and Artetxe, I. 2014.
665 Establecimiento de un sistema de recogida sistemática de datos sobre pesca
666 recreativa. *Eusko Jaurlaritz - Gobierno Vasco*.
- 667 Summers, J. K., Smith, L. M., Case, J. L., and Linthurst, R. A. 2012. A Review of the
668 Elements of Human Well-Being with an Emphasis on the Contribution of
669 Ecosystem Services. *AMBIO*, 41: 327–340.
- 670 Uriarte, A., and Borja, A. 2009. Assessing fish quality status in transitional waters, within
671 the European Water Framework Directive: Setting boundary classes and
672 responding to anthropogenic pressures. *Estuarine, Coastal and Shelf Science*, 82:
673 214–224.
- 674 Viana, D., Gornik, K., Lin, C.-C., McDonald, G., Ng, N. S. R., Quigley, C., and Potoski, M.
675 2017. Recreational boaters value biodiversity: The case of the California Channel
676 Islands National Marine Sanctuary. *Marine Policy*, 81: 91–97.

