

1 **Title:** Investigating determinants of compliance with wildlife protection laws: Bird persecution in  
2 Portugal.

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11 **Keywords:** Avian, Attitudes, Rule Knowledge, Subjective norms, Theory of Planned Behaviour  
12 (TPB), Unmatched Count Technique (UCT)

13 **Article Type:** Original Paper

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17 **Abstract**

18 Conservation interventions are generally underpinned by formal rules. These rules often suffer from  
19 high rates of non-compliance which is difficult to investigate due to its clandestine nature. Here we  
20 apply socio-psychological approaches to investigate the prevalence and determinants of three illegal  
21 bird-threatening behaviours - shooting raptors, trapping passerines for consumption, and poison use -  
22 by surveying 146 respondents in Portugal. We apply the Theory of Planned Behaviour to understand  
23 behavioural determinants, and an indirect questioning method, the Unmatched Count Technique  
24 (UCT), to estimate behaviour prevalence. The UCT estimated a high prevalence of trapping for  
25 consumption (47% SE 15) and shooting raptors (14% SE 11); both estimates being higher than from  
26 direct questioning. Poisoning had a lower prevalence according to direct questioning (7%), while the  
27 UCT generated a negative estimate suggesting that poisoning is a particularly sensitive behaviour.  
28 Different demographic groups were associated with different behaviours and determinants; men with  
29 greater rule knowledge were more likely to trap birds, while locally-born people were less likely to  
30 approve themselves, or to think others approved of, trapping. Those with more positive attitudes to  
31 poisoning were more likely to admit to it, and these positive attitudes were found more in older non-  
32 hunters. Rule knowledge was better in younger male hunters. These findings suggest that NGOs  
33 aiming to reduce poisoning could enlist the support of hunters, while locally-born people may be  
34 more receptive than others to working with NGOs to reduce trapping. These groups may be powerful  
35 allies in reducing illegal behaviours in their communities.

36 **1. Introduction**

37 Conservation interventions commonly rely on the use of rules and regulations to alter human  
38 behaviour (Keane et al. 2008). However rules are often rendered ineffective due to high rates of non-  
39 compliance (Rowcliffe et al. 2004). Understanding rule-breaking involves investigating the complex  
40 processes by which different factors, such as knowledge of the rules, attitudes and societal norms,  
41 combine to impact behaviour (St John et al. 2013). Effective rules are designed based on an  
42 understanding of the factors that affect compliance (Schlager 2005).

43 Despite having some of the strongest legal protection in the world (Stroud 2003), European birds  
44 continue to suffer from illegal persecution that threatens their conservation status (Birdlife 2011). The  
45 Portuguese Society for the Study of Birds (SPEA) has identified a number of illegal activities that  
46 continue to threaten birds in Portugal, including trapping songbirds for consumption, poison use, and  
47 shooting of raptors (Birdlife 2011). These activities are illegal under the European Birds Directive  
48 (Council Directive 79/209/EEC) and the Berne Convention (19.IX.1979), both of which Portugal is a  
49 signatory. Despite investigation of these behaviours in neighbouring Mediterranean countries  
50 (Martínez-Abraín et al. 2013; Mateo-Tomás et al. 2012; Murgui 2014) there remains limited  
51 information on the prevalence of these activities in Portugal (Birdlife 2011). Without data on  
52 prevalence rates and the demographic groups involved it remains difficult to tackle these issues.

53 Identifying ineffective conservation rules requires understanding associated rates of non-compliance,  
54 the true extent of which is difficult to quantify. Participants' fear of reprimand and legal sanction  
55 makes investigation susceptible to bias due to low response rates and evasive answers (Gavin et al.  
56 2010). Indirect questioning techniques have been developed to minimize these sources of bias and  
57 have been applied to the investigation of conservation problems (Nuno and St John 2014). The  
58 Unmatched Count Technique (UCT) (Droitcour et al. 1991) has been shown to work well when  
59 investigating sensitive behaviours that threaten wildlife (Nuno et al. 2013). In the western Serengeti,  
60 researchers using direct questions to assess prevalence of illegal bushmeat hunting reported

61 participation rates of between 8 (Kaltenborn et al. 2005) and 57 percent (Loibooki et al. 2002) of  
62 households, depending on the study. In the same area of the Serengeti, a UCT study reduced rates of  
63 evasive answers and suggested that 18% (SE 5) of people hunted bushmeat illegally (Nuno et al.  
64 2013).

65 To intervene effectively, it is not only necessary to know the prevalence of behaviours, but also the  
66 characteristics of those involved, and what affects their personal choices to comply. Socio-  
67 psychological models have been advocated to investigate the complexities of the decision-making  
68 process in conservation (Schlüter et al. 2012; St John et al. 2010). The Theory of Planned Behaviour  
69 (TPB) (Ajzen 1985), a well-researched theory of human behaviour, posits that an individual's  
70 behavioural intention is shaped by three aspects; their attitude towards a behaviour, their perceptions  
71 of social expectations (subjective norms), and the measure of control they perceive they have over  
72 performing a behaviour (perceived behavioural control; Fig. 1). Meta-analyses of studies using the  
73 TPB to investigate multi-domain (Armitage and Connor 2001) and pro-environmental (Bamberg and  
74 Moser 2007) behaviours illustrate the importance of these aspects in predicting behavioural intention,  
75 while highlighting the need to expand the TPB with additional aspects to increase its explanatory  
76 power.

77 The TPB has been applied to the investigation of compliance with rules regarding digital downloading  
78 (Wang and McClung 2011), drug use (Armitage et al. 1999), and recently to compliance with  
79 wildlife-protection laws (Shrestha et al. 2012). Normative compliance is influenced by what people  
80 regard as just and moral. The TPB reveals psychological aspects relevant to normative compliance in  
81 the form of personal attitudes and perceived social norms. The different aspects of the TPB  
82 framework vary in their influence, depending on the behaviour. For example, attitudes have been  
83 found to be of importance in relation to the conservation of forest habitat (Primmer and Karppinen  
84 2010), natural resource use (Holmes 2003) and illegal poaching (St John et al. 2012), but not  
85 compliance with protected area restrictions (Aipanjiguly et al. 2003; Seeland et al. 2002). Subjective  
86 norms have been shown to influence conservation behaviours including compliance with fishery  
87 regulations (Gezelius 2004; Hatcher et al. 2000) and protected area restrictions (Aipanjiguly et al.

88 2003) and to vary in importance by behaviour and demographic group (Beedell and Rehman 2000;  
89 Zubair and Garforth 2006). Identification of the most important behaviour-specific aspect(s) of the  
90 TPB can inform the design of behaviour-change interventions (St John et al. 2013).

91 Instrumental compliance is the behaviour occurring in response to external factors, such as formal  
92 rules and regulations. Knowledge of conservation rules may influence a person's behaviour and  
93 compliance (Keane et al. 2011) but there is limited evidence as to the routes by which it affects  
94 behavioural intention (whether directly, or through aspects of the TPB; Fig. 1). We use the TPB to  
95 investigate the influence of attitudes, subjective norms, and rule knowledge on the decisions of  
96 individuals to comply with wildlife-protection laws. Rather than explicitly testing the theory itself, we  
97 chose key aspects of the TPB to frame the investigation of predictors of compliance (knowledge,  
98 attitudes and subjective norms), similar to previous work (Steinmetz et al. 2014). We do not  
99 investigate perceived behavioural control, because our study aims to explore the TPB aspects most  
100 relevant to the public engagement activities of NGOs.

101 As well as understanding the predictors of non-compliance, it is also important to understand the  
102 characteristics of rule-breakers. Hunting, including of birds, is an important part of rural culture in  
103 Portugal, practiced by 8% of the adult male population (Apollonio et al. 2010), although the number  
104 of younger hunters has been decreasing. Laying of poison in this region is associated with the control  
105 of pest and predator species on agricultural and hunting land (Hernández and Margalida 2008). We  
106 investigate three demographic characteristics: age, gender, and locality of birth, to test whether the  
107 individuals associated with the illegal activities investigated are similar to the demographics typical of  
108 the Portuguese hunting and agricultural industries i.e. the older, rural male population.

109 We apply the UCT to estimate prevalence rates and the TPB to identify important behaviour-specific  
110 aspects of three illegal behaviours that threaten biodiversity in Portugal: the shooting of raptors,  
111 trapping of passerines for consumption, and use of poison to control wild animals (Birdlife 2011).  
112 Given the lack of data for validation purposes, we followed previous researchers' assumption that any  
113 prevalence estimate produced by the UCT higher than one produced by direct questioning is

114 potentially more accurate (Dalton et al. 1994; Rayburn et al. 2003; Tsuchiya et al. 2007). We test the  
115 UCT alongside direct questioning to assess whether it does estimate higher prevalence rates in this  
116 study system. To investigate predictors of the three behaviours, we apply the TPB to quantify the role  
117 of attitudes, subjective norms, and wildlife rule knowledge on individuals' self-reported behaviours  
118 under direct questioning.

## 119 **2. Materials and Methods**

### 120 **2.1 Study system and population**

121 Portugal supports 308 bird species, including eight globally threatened species including *Neophron*  
122 *percnopterus* (Egyptian Vulture) (Birdlife International 2014). Hunting, including of birds, is an  
123 important part of rural Portuguese culture, practiced by 8% of the adult male population (Apollonio et  
124 al. 2010). A general hunting licence is required to hunt game birds in Portugal, which is obtained by  
125 passing an examination on hunting capabilities and knowledge.

### 126 **2.2 Data collection**

127 Between 1st and 31st May 2012 interviews were conducted in two villages in the Alentejo, Portugal.  
128 Village identities are not reported to preserve respondents' anonymity. The two villages had  
129 demographic and livelihood profiles consistent with the region as a whole but were of interest due to  
130 the presence of an environmental organisation in one of the villages (Village A). This organisation  
131 had not worked on hunting or bird conservation, but was interested in our findings. Village B had a  
132 slightly larger population than A, and was the location for meetings of a local hunting association. 146  
133 interviews were conducted in Portuguese, by the first author (AF) or local interpreters. Sampling was  
134 conducted opportunistically through household visits. In 48 households, two interviews were  
135 conducted with different household members simultaneously in separate rooms. These interviews  
136 were treated as independent data points, because decisions about the behaviours concerned are made  
137 by individuals not at household level. As a pilot methodological study, issues of non-independence  
138 could not be addressed with the sample size available; for this reason the study focus is on areas of

139 future investigative potential rather than drawing general conclusions about the wider population.  
140 Research was conducted according to the Imperial College London research ethics policy.

### 141 **2.3 Interview protocol**

142 Respondents were randomly assigned to a control or treatment group for the UCT using a coin toss.  
143 The questionnaire commenced with an explanation of the study purpose, the interviewer's  
144 independent student status, and assurances that participants' responses would be anonymous, at which  
145 point respondents could decline to proceed. Consenting respondents (146/147) were firstly asked  
146 several socio-demographic questions, then administered the UCT, followed by a series of attitudinal  
147 questions, a rule knowledge quiz, a series of perceived subjective norms questions, and finally the  
148 direct questions.

149 To administer the UCT, respondents were shown four cards, one initial non-sensitive training card,  
150 and one card for each of the three behaviours investigated. For each card, respondents were asked to  
151 state a number in response to the question, "How many of these activities have you conducted in the  
152 past 12 months?". Each control card depicted four non-sensitive behaviours. Each treatment card  
153 contained the addition of one of the illegal behaviours under investigation. Cards were shown to all  
154 respondents in the same order. All non-sensitive items related to legal behaviours typical of the local  
155 population and were chosen based on the authors' knowledge of the study system. Items were  
156 grouped based on similarity of activity. For example, catching wild birds was grouped with other  
157 activities related to harvesting resources, such as picking olives. Laying of poison was grouped with  
158 other activities related to the use of chemical substances such as the use of insect repellent.

159 Next, respondents were asked about their attitudes toward the three investigated behaviours by stating  
160 on a seven-point Likert scale (1="completely disagree" through 7="completely agree") their feelings  
161 towards the statements, "[Conducting specific sensitive behaviour] *would be useful*", and,  
162 "[Conducting specific sensitive behaviour] *would be enjoyable*".

163 Next, respondents were shown a randomised series of cards depicting 13 Portuguese animal species  
164 accompanied by their locally-common names and asked to state whether killing of the species was  
165 ‘always legal’, ‘always illegal’, or ‘legal only at certain times of the year’.

166 Respondents were then asked about their perceived subjective norms by stating in a seven-point  
167 Likert scale their feelings towards the statements “*The majority of people in this village [conduct*  
168 *specific sensitive behaviour]*”, “*The majority of people important to me think that I should/I should*  
169 *not [conduct specific sensitive behaviour]*”, and “*The approval of my family and friends is important*  
170 *to me.*”.

171 Finally, respondents were asked the direct question, “Have you undertaken [sensitive behaviour] in  
172 the past 12 months?”, and asked to respond with either “Yes”, “No”, “I don’t know”, or “I don’t want  
173 to answer”. The order of asking about the three behaviours was randomised. A sample questionnaire,  
174 full list of UCT behaviours, and full list of the species tested and protection status are provided in the  
175 Electronic Supplementary Material.

## 176 **2.4 Statistical Analysis**

### 177 **2.4.1 Prevalence estimates**

178 UCT prevalence estimates were calculated as the mean difference between the sample means of the  
179 UCT treatment (74) and control (72) group counts (i.e. number of self-reported activities). As  
180 respondents were randomly assigned to the two groups, the difference in means represents the  
181 estimated proportion of the treatment group engaging in the sensitive behaviour. Welch’s t-test was  
182 employed to calculate the standard error of the estimates as the variance of the error term was likely to  
183 be different between the two groups. Direct question prevalence estimates were calculated as the  
184 proportion of respondents who answered “Yes” to the direct questions regarding participation in each  
185 behaviour investigated.

186                    **2.4.2 Multivariate analysis**

187    One drawback of the UCT is that large sample sizes are required to conduct multivariate analysis  
188    using UCT counts. Unfortunately the sample size of this study was not sufficient to reliably conduct  
189    multivariate analysis with the UCT data. Instead, multivariate analysis was used to identify predictors  
190    of two illegal behaviours based on the direct question data. TPB variables were used as predictor  
191    variables, as well the demographic variables which were judged to be of importance. Due to the small  
192    number of respondents answering affirmatively to the direct question regarding shooting of raptors  
193    this behaviour was omitted from multivariate analysis. Those answering positively to direct questions  
194    are a biased sub-sample of those who have actually undertaken the behaviour (hence the need for  
195    indirect questioning for accurate prevalence estimation). Therefore, the results of this analysis are an  
196    indication of who is prepared to admit to the behaviour rather than of who is actually undertaking it.

197    Data were visually assessed for normality. The two variables related to attitude were combined to  
198    generate a composite score, and similarly for the two variables related subjective norms. Composite  
199    scores were not checked for internal consistency as they were a product of just two variables each.  
200    These two composite scores, along with the answer to whether others' approval mattered to the  
201    respondent, were binomially transformed, due to their positive skew. To estimate the correlates of  
202    behaviour, generalised linear models (GLMs) were fitted with a binomial error structure and a logit  
203    link function, with respondents' direct question answers as binomial dependent variables. Where TPB  
204    variables were included in the top models, their predictors were investigated using GLMs fitted with  
205    binomial error structure and a logit link function, with composite attitude, social norm, and approval  
206    scores as binomial dependent variables. Residuals of all models were checked with QQ-plots and  
207    found to be Normal.

208    Knowledge scores were computed as the total of correctly answered questions regarding the legal  
209    protection of 13 Portuguese animal species, and arc-sine transformed for normality. GLMs fitted with  
210    a Gaussian error structure were employed to model knowledge scores against demographic and TPB

211 variables. Respondents' ability to correctly classify species' protection status (game, protected,  
212 unregulated) was compared using Wilcoxon paired-tests for proportional data.

213 In all multivariate analyses, the relative importance of predictor variables was computed as the sum of  
214 the Akaike weights (based on the Akaike information criterion, AIC) for the variables included in the  
215 averaged models (Burnham and Anderson 2002). GLMs were fitted in R v.2.15.1 (R Development  
216 Core Team 2011). Parameter estimates were averaged across models with  $\Delta AIC < 4$ , and the  
217 corrected AIC was used to select and rank the most parsimonious models using the MuMIn package  
218 v.1.7.7 (Bartoń 2012). Details of predictor variables and models considered are given in the Electronic  
219 Supplementary Material.

## 220 **3. Results**

### 221 **3.1 Sample characteristics**

222 More men (60%) were interviewed than women (40%). The treatment group contained significantly  
223 more men (Treatment: 70% Control: 49%,  $\chi^2(1)=6.24, p=0.013$ ) and non-significantly more hunters  
224 (T: 32% C: 18%,  $\chi^2(1)=3.26, p=0.071$ ) than the control group. The groups did not differ by age ( $\chi^2$   
225 (7)=8.16,  $p=0.32$ ), village ( $\chi^2(1)=0.055, p=0.81$ ), knowledge (two-sample t-test (144)=-0.15,  $p=$   
226 0.56), or locality of birth ( $\chi^2(1)=0.99, p=0.32$ ).

### 227 **3.2 Prevalence estimates**

228 UCT prevalence estimates suggest that trapping birds for consumption was conducted by  
229 approximately 47% (15 SE) and shooting of raptors by approximately 14% (11 SE) of respondents  
230 during the 12 months prior to interview, 31% and 12% higher than direct question estimates  
231 respectively (Fig. 2). In the case of poison use, the UCT failed to produce a valid prevalence estimate,  
232 estimating a negative prevalence rate for the behaviour (Fig. 2).

### 233 **3.3 Correlates of trapping and poison use behaviours**

234 Due to the small sample size of this study, the direct question results were used to investigate  
235 determinants of the illegal behaviours rather than the results of the UCT, which limits inference to the  
236 characteristics of people prepared to admit to the behaviour in question. Individuals admitting to  
237 trapping birds for consumption in answer to a direct question tended to be male hunters who scored  
238 highly on the knowledge quiz (Table. 1). Those admitting to trapping were more likely to come from  
239 village B. Three variables from the TPB, relating to social norms, social approval and individual  
240 attitudes, were also positively but weakly related to admitting to trapping (Table 1). The admission of  
241 using poison to control populations of wild animals was strongly predicted by an individual's attitude  
242 towards the behaviour, with individuals with a positive attitude being more likely to admit to  
243 engaging in it (Table. 1).

### 244 **3.4 Correlates of underlying constructs affecting trapping and poison use**

245 We investigated the correlates of TPB aspects that were included in the minimum model set for  
246 trapping birds (attitudes, approval and social norms). The main correlate of all three aspects was  
247 respondents' location of birth (Table. 2). Locally born respondents held a more negative attitude  
248 towards trapping and perceived it to be less socially acceptable, while also attributing less importance  
249 to the approval of others. Older hunters perceived trapping to be less socially-acceptable, while male  
250 respondents attributed greater importance to the approval of others. We investigated the correlates of  
251 attitudes surrounding poison use, as attitude was an important predictor in the minimum model set.  
252 Individuals who held a positive attitude towards poison use tended not to hold a hunting licence, to be  
253 older, and scored highly on the knowledge quiz (Table. 2).

### 254 **3.5 Knowledge of wildlife laws**

255 Respondents correctly classified on average 86% of protected and unregulated species and 65% of  
256 game species. Game species were correctly classified significantly less often than protected  
257 ( $W=968.5$ ,  $p<0.001$ , paired-test) and unregulated species ( $W=1163.5$ ,  $p<0.001$ , paired-test).  
258 Knowledge of wildlife laws was a relatively important correlate of admitting to trapping birds for

259 consumption and was strongly associated with age, gender, and possession of a hunting licence  
260 (Table. 3). Younger male respondents scored highest in the quiz, while respondents in possession of a  
261 hunting permit scored higher than those without ( $W=1063$ ,  $p=<0.001$ ). Respondents from village B  
262 performed better than respondents from village A, and locally born respondents performed better than  
263 those born outside the local area.

#### 264 **4. Discussion**

265 Here we use two socio-psychological approaches, the UCT and the TPB, to investigate illegal  
266 wildlife-threatening behaviours. The UCT revealed that trapping birds for consumption remains  
267 widely practiced in our sample, and that a smaller number of people continue to shoot raptor species.  
268 Our analysis indicated that the characteristics of self-confessed rule-breakers were behaviour-specific.  
269 A positive attitude towards poisoning was found to be the most important correlate of admitting to  
270 poison use whereas men from one of the villages and those with a good knowledge of game laws were  
271 more likely to admit to trapping birds for consumption. We also showed that the demographic groups  
272 who approved of these behaviours differed. Those who felt trapping was socially acceptable and held  
273 a positive attitude towards this behaviour tended to be from outside the area, while those admitting to  
274 poisoning were less likely to be registered hunters.

275 There currently exists only limited and anecdotal information on the prevalence of shooting, trapping  
276 and poisoning of birds in Portugal (Birdlife 2011). Our results reveal that Portuguese bird populations  
277 continue to be threatened by these illegal activities, and that the demographics of offenders differ  
278 between the activities. Ongoing initiatives include a broad national assessment of illegal bird  
279 persecution behaviours in Portugal which has focused on law enforcement records, advertisements in  
280 online platforms, reports on injured, sick and dead animals, and direct observation reports by the  
281 public (Leitão et al. 2014). Our results highlight the need for further investigation into this topic using  
282 techniques from social science to understand the attitudes and characteristics of offenders. There is  
283 also a need for greater conservation attention on these behaviours in Portugal, and in the other  
284 Mediterranean countries where these behaviours remain widespread.

285 The characteristics of respondents admitting to catching birds for consumption were congruent with a  
286 formal association to hunting. This finding suggests that a targeted conservation intervention to tackle  
287 this behaviour in the region should focus resources on changing behaviours of the hunting  
288 community. Respondents admitting to using poison to control populations of wild animals were  
289 strongly predicted by expressing a positive attitude towards this behaviour and tended not to be  
290 hunters. Examples of conservation behaviour-change interventions elsewhere suggest that members of  
291 local hunting organisations are likely to influence attitudes and subjective norms of the local  
292 community more than external environmental organisations (Heberlein 2012). This, together with the  
293 importance of holding a hunting licence as a correlate in our models for knowledge and attitudes,  
294 suggests that Portuguese hunters are potential partners for organisations wishing to tackle poison use  
295 in this region. A partnership between hunting associations and *Programa Antídoto*, a national  
296 platform incorporating a range of organisations dedicated to tackling this issue, could focus on  
297 influencing the attitudes of non-hunters towards the use of poison in Portugal. Successful partnership  
298 on this issue may then make it easier to work with hunters to reduce their trapping of songbirds for  
299 consumption.

300 Our results suggest that the UCT was effective in reducing the response bias associated with  
301 investigation of two illegal activities, but not for poison use. It is unclear why this might be in the  
302 absence of more detailed study. The confidence interval of the UCT overlaps both zero and the  
303 estimate of the direct question, suggesting that people were answering the sensitive card in a strategic  
304 manner to avoid revealing their behaviours. One explanation may be that poison use is a highly  
305 sensitive behaviour because of its indiscriminate nature; there were anecdotal claims that domestic  
306 pets had been killed by poisoning in the villages and that this was a source of conflict between people.  
307 The direct question regarding poison use noticeably elicited the most evasive answers, with one  
308 respondent refusing to respond and two respondents appearing to give false negative answers. It has  
309 been argued that conservationists should take advantage of social taboos by using them in partnership  
310 with formal rules, involving cooperation between conservationists and local communities (Colding  
311 and Folke 2001). This supports our argument for a partnership between the Portuguese hunting and

312 conservation communities to tackle poison use, with hunters strengthening the social taboo of the use  
313 of poison and acting as advocates for conservation.

314 Alternatively, it may also be that the non-sensitive behaviours on this card were not well aligned with  
315 the sensitive behaviour, revealing it too clearly as being an outlier. This experience highlights the  
316 limitations even of indirect questioning methods when the behaviour concerned is seen as particularly  
317 shameful, when prevalences are relatively low and sample sizes small.

318 Unfortunately we did not have the sample size to be able to use the UCT results in the TPB model. A  
319 larger sample size would have allowed this work to be extended to use the UCT estimates in  
320 multivariate analyses including socio-psychological constructs, thereby producing an integrated  
321 approach to investigating illegal behaviours. We propose that such an integrated approach could  
322 facilitate the investigation of illegal and socially-unacceptable behaviours that threaten biodiversity,  
323 and could be used to supplement SPEA's ongoing investigation into illegal activities in Portugal. Our  
324 results suggest that the illegal trapping of birds for consumption, use of poison to control populations  
325 of wild animals, and shooting of raptor species continue to be practiced in Portugal. Future  
326 conservation efforts aimed at combating these activities require a greater understanding of the  
327 characteristics of the demographic groups undertaking each activity, and of the attitudes and  
328 perceived subjective norms which they hold. Conservation interventions designed to alter human  
329 behaviours must take these differences into account and should tailor behaviour-changing  
330 interventions to specific activities and target groups.

## 331 **5. Acknowledgements**

332 We thank the Centro de Convergência, research assistants and respondents for supporting the study.  
333 AF was supported by Imperial College London. AN was supported by the Portuguese Foundation for  
334 Science and Technology (FCT; doctoral grant SFRH/BD/43186/2008). NB acknowledges the  
335 financial support of the European Commission under the HUNT project of the Seventh Framework  
336 Programme for Research and Technological Development. This paper is a contribution to Imperial  
337 College's Grand Challenges in Ecosystems and the Environment initiative. This study complies with

338 the current laws of the countries in which it was performed. The authors declare that they have no  
339 conflict of interest.

## 340 **6. Electronic Supplementary Material**

341 The Electronic Supplementary Material contains Portuguese and English versions of the study  
342 questionnaire, UCT protocol and example set of UCT cards, list of the species included in the  
343 knowledge quiz and their protection status, and a summary of the predictor variables used in the  
344 multivariate analysis and details of all models considered.

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## 464 **8. Figures**

465 **Fig. 1** Adapted model of the theory of planned behaviour which includes knowledge of conservation  
466 rules as a predictor of behavioural intention, attitudes, and subjective norms. Knowledge may affect  
467 several aspects so we consider multiple pathways. Shading indicates the aspect not present in Ajzen's  
468 (1985) original model. Dashed lines indicate relationships that were investigated in this study

469 **Fig. 2** Prevalence rates (+/- standard error) estimated by the UCT and direct questions for illegal  
470 trapping of birds for consumption, shooting of raptors, and use of poison in the villages in the 12  
471 months prior to the study

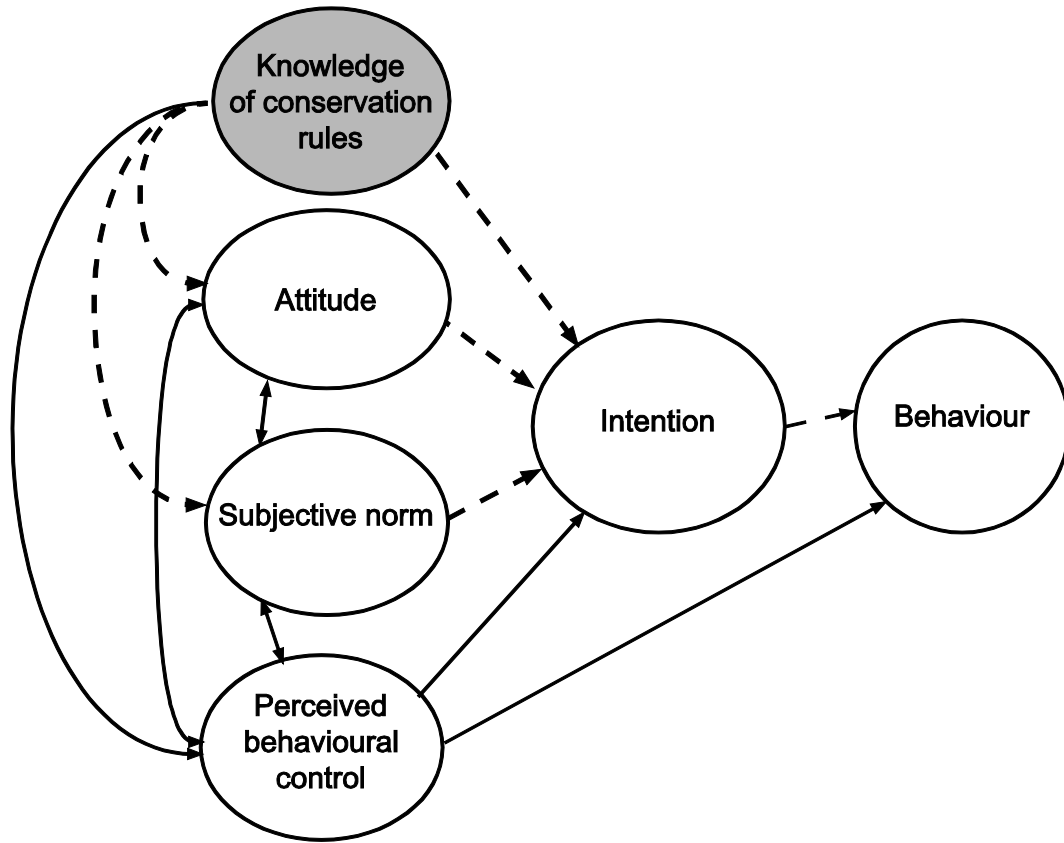
## 472 **9. Tables**

473 **Table. 1** Parameter estimates obtained from the averaged generalised linear models for answers to  
474 direct question about (a) trapping birds for consumption, and (b) using poison. Variables of  
475 importance <40% omitted

476 **Table. 2** Parameter estimates obtained from the averaged generalised linear models for : (a) perceived  
477 subjective norms of trapping birds for consumption, (b) attitudes towards trapping birds for  
478 consumption, (c) respondent's stated importance of approval, and (d) attitudes towards poison use.  
479 Variables of importance <40% omitted

480 **Table. 3** Parameter estimates obtained from the full generalised linear model of knowledge of wildlife  
481 laws. Variables of importance <40% omitted

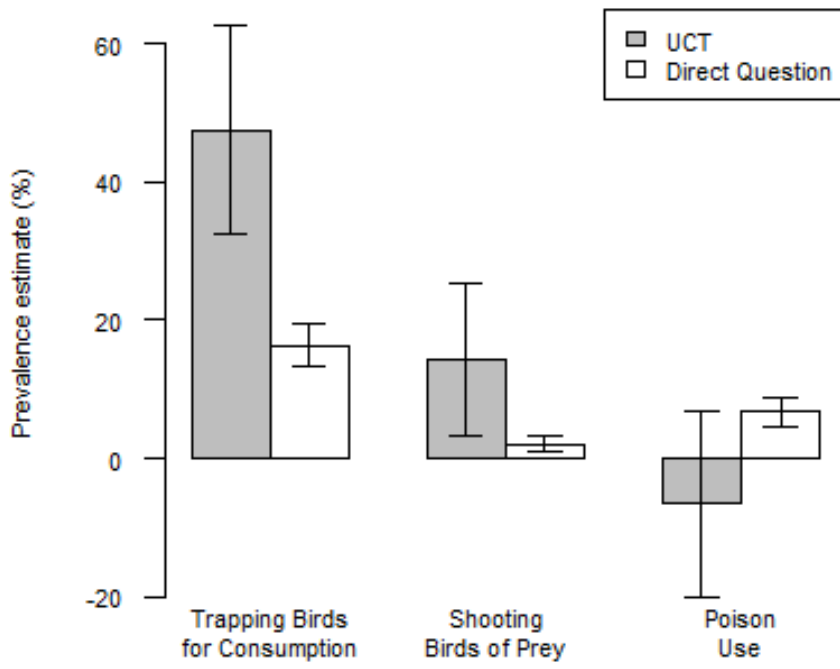




483

484 **Fig. 1**

485



486

487 **Fig. 2**

488

489 **Table. 1**

<b>Parameter</b>	<b>Estimate</b>	<b>S.E.</b>	<b>z-value</b>	<b>Relative variable importance</b>
<i>(a) Model of predictors of answers to direct questions about trapping birds for consumption</i>				
<i>Intercept</i>	-7.470	2.051	3.622	1
<i>Gender: Male</i>	2.630	1.108	2.353	1
<i>Knowledge</i>	2.358	1.131	2.069	0.85
<i>Village: B</i>	1.169	0.555	2.088	0.83
<i>Hunting permit: Yes</i>	0.949	0.597	1.578	0.54
<i>Social norm</i>	0.939	0.627	1.486	0.52
<i>Approval</i>	0.797	0.604	1.310	0.47
<i>Attitude</i>	0.822	0.588	1.386	0.46
<i>(b) Model of predictors of answers to direct questions about poison use</i>				
<i>Intercept</i>	-4.623	1.352	3.395	1
<i>Attitude</i>	2.664	0.833	3.170	1

490

491

492 **Table. 2**

<b>Parameter</b>	<b>Estimate</b>	<b>S.E.</b>	<b>z-value</b>	<b>Relative variable importance</b>
<i>(a) Model of predictors of perceived subjective norms of trapping birds for consumption</i>				
<i>Intercept</i>	2.728	0.928	2.918	1
<i>Local Born: Yes</i>	-2.104	0.771	2.704	1
<i>Age</i>	-0.015	0.010	1.487	0.52
<i>Hunting permit: Yes</i>	-0.520	0.442	1.168	0.42
<i>(b) Model of predictors of attitudes towards trapping birds for consumption</i>				
<i>Intercept</i>	1.677	0.753	2.211	1
<i>Local Born: Yes</i>	-1.291	0.586	2.182	0.97
<i>(c) Model of predictors of respondents stated importance of approval</i>				
<i>Intercept</i>	0.839	0.624	1.336	1
<i>Local Born: Yes</i>	-1.253	0.484	2.567	1
<i>Gender: Male</i>	0.495	0.379	1.296	0.46
<i>(d) Model of predictors of attitudes towards poison use</i>				
<i>Intercept</i>	-2.538	1.374	1.839	1
<i>Hunting Permit: Yes</i>	-1.748	0.678	2.560	1
<i>Age</i>	0.023	0.012	1.969	0.83
<i>Knowledge</i>	1.387	0.931	1.477	0.52

494 **Table. 3**

<b>Parameter</b>	<b>Estimate</b>	<b>S.E.</b>	<b>z- value</b>	<b>Relative variable importance</b>
<i>Intercept</i>	1.083	0.064	16.746	1
<i>Age</i>	-0.002	0.001	2.527	1
<i>Hunting Permit: Yes</i>	0.195	0.052	3.661	1
<i>Gender: Male</i>	0.114	0.043	2.582	1
<i>Village: B</i>	0.069	0.042	1.624	0.57
<i>Local Born: Yes</i>	0.065	0.052	1.240	0.43

495