

1 **Evaluating deterrents of illegal behaviour in conservation: carnivore killing in rural**  
2 **Taiwan**

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20

21 **Abstract**

22 Rules restricting resource use are ubiquitous to conservation. Recent increases in poaching of  
23 iconic species such as African elephant and rhino have triggered high-profile interest in  
24 enforcement. Previous studies have used economic models to explore how the probability and  
25 severity of sanctions influence poacher-behaviour. Yet despite evidence that compliance can  
26 be substantial when the threat of state-imposed sanctions is low and profits high, few have  
27 explored other factors deterring rule-breaking. We use the randomised response technique  
28 (RRT) and direct questions to estimate the proportion of rural residents in north-western  
29 Taiwan illegally killing wildlife. We then model how potential sources of deterrence:  
30 perceived probabilities of detection and punishment, social norms and self-imposed guilt,  
31 relate to non-compliant behaviour (reported via RRT). The perceived likelihood of being  
32 punished and two types of social norms (injunctive and descriptive) predict behaviour and  
33 deter rule-breaking. Harnessing social norms that encourage compliance offers potential for  
34 reducing the persecution of threatened species.

35  
36 **Keywords:** compliance; enforcement; guilt; randomized response technique; social norms  
37

## 38 **1. Introduction**

39 Effective conservation depends on understanding human behaviours, particularly those that  
40 threaten biodiversity such as illegal logging (Laurance 2008), fishing (Hilborn 2007) and  
41 hunting (Milner-Gulland and Bennett 2003). Positive incentives, such as the provision of  
42 resources to those behaving in a pro-conservation manner, is one way of encouraging  
43 behaviour change (Milner-Gulland and Rowcliffe 2007). However, conservation and natural  
44 resource management are widely dependent upon negative incentives, principally the making  
45 and enforcing of rules that restrict access and use of resources (St. John et al. 2013). As a  
46 result, successful management demands an understanding of factors deterring rule-breaking  
47 so that compliance can be encouraged.

48

49 Recent increases in wildlife crime including the poaching of iconic, commercially valuable  
50 species such as African elephant (Burn et al. 2011) and white rhino (Biggs et al. 2013; Smith  
51 et al. 2013) have triggered increased interest in enforcement (Goldenberg 2013; The White  
52 House 2013) which typically involves the use of patrols to detect infractions (Keane et al.  
53 2008) and the application of state-imposed legal sanctions to punish violators. By increasing  
54 the severity of sanctions, criminal justice policies aim to increase deterrence (Kennedy 1997).  
55 Rational choice theories of crime assume that individuals weigh up potential costs  
56 (probability of being detected and likelihood and severity of penalties), rewards and  
57 preferences when deciding how to act (Becker 1968; Garoupa 1997). The rational actor  
58 therefore should comply when fairly certain of capture and punishment. The physical  
59 distribution or 'ecology' of crimes suggests that offenders do make rational choices: by  
60 committing crimes against poorly protected targets (e.g. houses, public property or people) in  
61 familiar locations, offenders reduce risk, effort, and inconvenience (Clarke and Cornish  
62 1985). However, the assumption that offenders act as rational utility maximizers who  
63 respond to the threat of sanctions in a predictable fashion has been challenged (Akers and  
64 Sellers 2009; Paternoster 1987). Evidence suggests that, constrained by availability of time,  
65 ability and information, human behaviour is only boundedly rational (Simon 1955): rather  
66 than assessing the pros and cons of alternative courses of action, people employ 'shortcuts' or  
67 rules-of-thumb (also referred to as heuristics) when processing information and opt for  
68 satisfactory rather than optimal solutions (Clarke and Cornish 1985; Cornish and Clarke  
69 1986; Milner-Gulland 2012). Further, social-psychological factors also influence people's  
70 behaviour. With respect to pro-environmental behaviours, attitude, social norms, behavioural  
71 control and moral norms influence the decisions that people make (Bamberg and Möser  
72 2007; Mastrangelo et al. 2013; Williams et al. 2012), whilst people's feelings (Van Gelder  
73 2012), perceptions of informal social control (Felson 1986), self-control (Pratt and Cullen  
74 2000) and an ability to manage fears, moral scruples and guilt influence criminal decision  
75 making (Cornish and Clarke 1986).

76

77 There is evidence that investment in conservation law enforcement is effective. For example,  
78 anti-poaching patrols were a determining factor in the recovery of African buffalo and  
79 elephant in Serengeti National Park, Tanzania (Hilborn et al. 2006) and increased  
80 effectiveness of anti-poaching patrols reduced poaching of wildlife in Ghana's protected  
81 areas (Jachmann 2008). Enforcement however is costly and studies investigating illegal

82 behaviour have reported mixed results concerning the influence that probabilities of capture  
83 and punishment have on actors (Kroneberg et al. 2010). For example, compliance in some  
84 fisheries was found to be high despite low probabilities of detection and illegal profits in  
85 excess of fines (Sutinen and Kuperan 1999), the threat of detection failed to deter drink-  
86 driving (Berger and Snortum 1986) and the expectations of capture and punishment were  
87 unrelated to people's intention to commit tax fraud or shop-lift (Kroneberg et al. 2010). In  
88 addition, industry characteristics more strongly deterred corporate crime compared to formal  
89 sanction risk (Simpson and Koper 1992). This raises questions about what other factors  
90 encourage compliance and whether they can be harnessed to supplement or even reduce  
91 reliance on conventional and costly enforcement.

92  
93 Economic models of law enforcement in conservation and natural resource management have  
94 incorporated probabilities of detection and punishment based upon information including  
95 enforcement data and legal proceedings (Milner-Gulland and Leader-Williams 1992; Sumaila  
96 et al. 2006). However, would-be-violators do not know the actual probability of being caught  
97 or punished, rather their behaviour is influenced by their perceived threat of enforcement  
98 action (Grasmick and Bryjak 1980; Grasmick and Green 1980). Studies investigating the  
99 links between perceived sanction risk and severity generally find that criminality is lower  
100 amongst those perceiving higher risks of detection and severity of punishment (Nagin 1998).  
101 There is evidence in conservation that rule-breakers adjust their perceptions of the risks of  
102 sanctions. For example, following an initial market inspection, trade in the North Sulewesi  
103 endemic babirusa (*babryrousa celebensis*) halted for one year. However, by the third  
104 inspection trade only stopped for one month as traders refined their perceptions of the threat  
105 of capture from high to the true level of virtually zero (Milner-Gulland and Clayton 2002).  
106 However, none have investigated how an individual's compliance behaviour relates to their  
107 reports of the perceived probabilities of detection and punishment.

108  
109 Any factor that reduces the expected utility of a crime may encourage compliance and  
110 empirical evidence suggests that sources of social control may play a greater role in shaping  
111 compliance compared to the certainty and severity of punishment (Paternoster 1987). In  
112 addition to regulations enforced by formal institutions, social norms (obligatory, shared or  
113 forbidden behaviours) mediate the way in which people in societies behave (Ostrom 2000).  
114 Peers may reward individuals for following social norms by conferring status or material  
115 resources towards them, or punish transgressions through ostracism or the withholding of  
116 favours or goods (Posner 1997). Social norms have been found to deter a range of antisocial  
117 behaviours including drink-driving (Berger and Snortum 1986), illegal gambling (Grasmick  
118 and Green 1980) and environmental theft (Cialdini 2003). Further, enforcement within some  
119 fisheries appears to stem largely from social influences (Gezelius 2002; Sutinen and Gauvin  
120 1989). For example, Norwegian fishers comply for fear of being labelled dishonourable by  
121 gossiping peers (Gezelius 2002). Evidence from social psychology suggests that two types of  
122 social norm influence behaviour: injunctive norms (what people typically approve of) and  
123 descriptive norms (what people typically do) (Cialdini et al. 1991). To date, the role of these  
124 two types of social norm in encouraging compliance with conservation rules has not been  
125 explored in a quantitative manner.

126

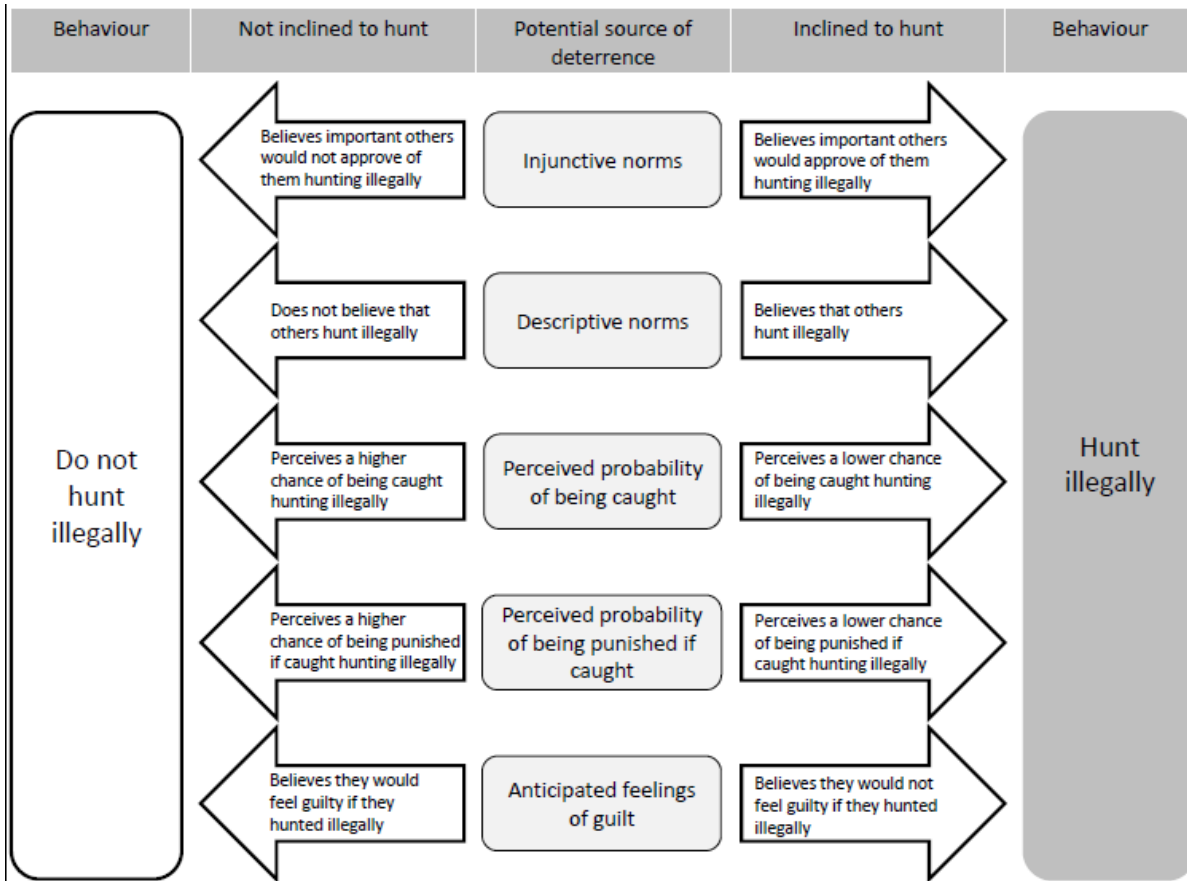
127 The behaviour of individuals is also regulated by internal feelings such as guilt, shame and  
128 self-esteem. Anticipated or actual guilt may be felt by an individual when they consider  
129 performing, or actually execute a behaviour that defies their morals, values or social norms  
130 (Vining and Ebreo 2002). The immediate response may be felt in the form of physiological  
131 discomfort, however, long-term impacts may include anxiety or depression impeding  
132 personal performance (Grasmick and Bursik 1990). Whilst acts that trigger guilt may differ  
133 between cultures (Scollon et al. 2004), feelings of guilt have been shown to influence a range  
134 of behaviours including willingness to help others (Freedman et al. 1967), participate in  
135 extra-curricular activities (Boster et al. 1999) and engage in pro-environmental behaviours  
136 (Ahn et al. 2013). With respect to compliance, guilt has been found to have a stronger  
137 influence on behaviour compared to the threat of capture in the case of tax fraud and drunk-  
138 driving (Grasmick and Bursik 1990; Wenzel 2004). Whilst fishers have reported feeling  
139 'morally uncomfortable' when breaking the law (Gezelius 2002; Sutinen and Kuperan 1999),  
140 the utility of self-imposed guilt as a deterrent has not been investigated within a conservation  
141 and natural resource management context.

142

143 Understanding the potential value of such factors as deterrents requires that they be linked to  
144 reports of people's compliance behaviour. Innovative developments in the analysis of  
145 randomised response data (van den Hout et al. 2007) recently applied in conservation (St.  
146 John et al. 2012) support such an approach. The randomised response technique (RRT)  
147 (Warner 1965) has improved estimates of rule-breaking in conservation producing higher  
148 estimates of non-compliance compared to direct questions (Razafimanahaka et al. 2012;  
149 Solomon et al. 2007; St. John et al. 2010a). By using a randomising device such as dice, RRT  
150 provides respondents with levels of protection greater than a simple guarantee of anonymity.  
151 For example, provided with a beaker and a die, respondents may be instructed to: answer a  
152 sensitive question truthfully choosing 'yes' or 'no' if the die lands on one through to four  
153 (probability = 0.66); select 'yes' if the die lands on five (probability = 0.167); or select 'no' if  
154 the die lands on six (probability = 0.167) (St. John et al. 2010a). The result of the die is never  
155 revealed to the interviewer so a truthful response can never be distinguished from a  
156 prescribed one. By adapting the logistic regression model to account for answers forced by  
157 the randomising device (van den Hout et al. 2007), characteristics of respondents (e.g.  
158 attitudes) can be linked to behaviours of interest such as killing of protected carnivores (St.  
159 John et al. 2012).

160

161 In this study we use both RRT and direct questions (DQ) to estimate the proportion of rural  
162 residents in north-western Taiwan killing four species as well as asking someone else to hunt  
163 a legally protected endangered species on their behalf. We then use an adapted form of  
164 logistic regression (St. John et al. 2012; van den Hout et al. 2007) to investigate the potential  
165 deterrent effects of the perceived probabilities of detection and punishment, injunctive and  
166 descriptive norms, and self-imposed guilt on wildlife persecution reported via RRT (Figure  
167 1). By linking reports of rule-breaking behaviour to potential sources of deterrence, this study  
168 makes a novel contribution to the study of conservation enforcement, a neglected area of  
169 research (Keane et al. 2012; Robinson et al. 2010).



171  
 172 Figure 1 Conceptual framework of factors influencing an individual’s decision to hunt a  
 173 legally protected species. All things held equal, the more strongly a person believes killing a  
 174 protected species is disapproved of, that others do not kill protected species, that the  
 175 probability of being caught and punished is high, and that they would feel guilty for engaging  
 176 in such a behaviour, the more deterred they are from hunting illegally.

177  
 178 **2. Methods**

179 *2.1 Case study: wildlife persecution in rural north western Taiwan*

180 Data from ecological surveys confirm the existence of leopard cat (*Prionailurus bengalensis*  
 181 *chinensis*) and masked palm civet (*Paguma larvata taivana*) within Miaoli County, Taiwan  
 182 (Pei 2008). Before 1970 the leopard cat population was greatly reduced through habitat loss  
 183 and commercial harvesting for their skin, resulting in a call for their legal protection (Ian  
 184 1979; McCullough 1974). Now listed as endangered under Taiwan’s Wildlife Conservation  
 185 Act (WCA) (Council of Agriculture 1989), Miaoli County is probably the only area where a  
 186 viable population of this species is still found (Pei 2008). Whilst more common, the masked  
 187 palm civet, long popular in game meat markets (Wang 1986) is also protected under the  
 188 WCA due to intensive trapping pressure in rural areas. Article 21 of the WCA only permits  
 189 the authorised killing of protected species under limited circumstances including risk to  
 190 human life, damage to crops or stock and for indigenous people’s traditional ceremonies or  
 191 rituals. Any unauthorised person caught killing protected wildlife may be fined between  
 192 NT\$200 000 and NT\$1 000 000 (between approx. US\$6 600 and US\$33 000) and face up to

193 five years in prison. Despite these considerable sanctions, anecdotes from Miaoli County  
194 suggest that leopard cat and masked palm civet are still trapped for the commercial gain of  
195 professional hunters, and, with respect to leopard cat, because they are perceived by poultry  
196 farmers as pest. Other species including rodents and ferret badger (*Melogale moschata*) are  
197 not protected under the WCA but are included in this study so that both illegal and legal  
198 behaviours could be investigated. All species are found across the study site (Pei 2008).

## 200 *2.2 Data collection*

201 We drafted the questionnaire (available from F.A.V.St.John) in English, it was then translated  
202 to Chinese and back-translated to English to verify the translation. We then piloted it on  
203 colleagues, clarifying wording where required, before a formal pilot with residents within the  
204 study site. The questionnaire were administered through face-to-face interviews at the homes  
205 of residents between August and October 2012 by CHM. Hakka, Taiwanese or Mandarin (all  
206 dialects spoken by CHM) were used to deliver the questions; as there are no written  
207 characters for Hakka and Taiwanese, Chinese characters were used throughout. The  
208 sampling strategy used to identify respondents involved multiple steps. First, we identified  
209 three townships in Miaoli County with the highest leopard cat densities using data from  
210 camera trap surveys (Pei 2008). Second, after excluding urban areas we listed all rural  
211 villages per township; the RAND function in Microsoft Excel was then used to select a  
212 simple random sample (Newing 2011) of four villages per township. Lastly, using either the  
213 phone book (two townships) or electoral role (one township) as a sampling frame, we  
214 systematically sampled (Newing 2011) 20 households per village by selecting every *nth*  
215 household on the list (the first house to be surveyed was selected using the  
216 RANDBETWEEN function in Microsoft Excel) i.e. we sampled 242 households across the  
217 12 villages; approximately 4% of the total households. Within households, elder members  
218 were recruited as respondents as locally they were believed to have more experiences with  
219 the study species. Names of villages are not revealed to protect respondents.

221 To verify respondents' familiarity with species included in the questionnaire we showed  
222 respondents photos of study species (rodents, ferret badger, masked palm civet and leopard  
223 cat) and non-study species (domestic cat and pangolin). Those familiar with each of the study  
224 species completed the questionnaire which included sections on rule-breaking (RRT and  
225 DQ), demographics and three potential sources of deterrence. Using the Morakot '88' flood  
226 of 2009 as a historic reference, RRT and DQ questions referred to the last three years (e.g. for  
227 DQ: '*Since the 88 Flood which was 3 years ago, did you kill any leopard cats?*'). This time  
228 period was chosen as it was considered long enough to have allowed the behaviours under  
229 investigation to have occurred whilst not being too long ago for people to remember.

## 231 *2.3 Estimating the proportion of people killing wildlife*

232 We used the 'forced response' randomised response technique (Warner 1965) to question  
233 respondents about their involvement in the killing of wildlife and whether they had requested  
234 another to hunt a leopard cat on their behalf. Respondents were given a set of instruction and  
235 question cards, including one example question, a pair of dice and a non-transparent beaker.

236 RRT was first explained to respondents using the example question: ‘*Since 88 Flood*’ which  
237 was three years ago, did you ever ride a motorbike without a helmet?’ Roles of interviewer  
238 and respondent were reversed when required and the interviewer did not proceed with RRT  
239 questions until it was clear that the respondent understood the method. Before each RRT  
240 question, respondents shook the dice in the beaker and added the value of the dice together. If  
241 the sum of the two dice came to five through to ten (probability = 3/4), respondents were  
242 asked to answer the sensitive question honestly by saying ‘yes’ or ‘no’ out loud to the  
243 interviewer. If the dice summed two, three or four (probability 1/6) respondents were  
244 instructed to give a fixed answer ‘yes’. Finally, if the dice summed 11 or 12 (probability  
245 1/12), respondents were instructed to give the fixed answer ‘no’. Respondents never revealed  
246 their dice roll to the interviewer therefore the interviewer could not tell if a respondent was  
247 saying ‘yes’ because they have performed the sensitive behaviour, or because they were  
248 providing a prescribed response. However, by knowing the probability of respondents  
249 instructed to answer honestly, and the probability of respondents instructed to provide the  
250 prescribed response of ‘yes’, the prevalence of the sensitive characteristic could be estimated.  
251 To maximise respondents’ compliance with RRT instructions we used the analogy of playing  
252 a game encouraging respondents to follow RRT instructions just as they would follow the  
253 rules of a game. Literacy and numeracy are high in Taiwan so are not believed to limit  
254 respondents’ understanding or use of RRT.

255

256 In order to test the utility of RRT, we asked respondents the same wildlife killing questions  
257 directly at the end of the questionnaire. The wording of DQ and RRT questions was identical.  
258 Respondents answered DQs by placing a tick in either a ‘yes’ or ‘no’ box.

259

#### 260 *2.4 Perceived probabilities of detection and punishment as deterrents*

261 Economic models of enforcement focus on the probabilities of rule-breaking being detected  
262 and punished, with non-compliance occurring when the benefits outweigh the costs (Becker  
263 1968). To investigate how the perceived probability of being caught relates to behaviour  
264 (measured via RRT) we asked respondents to indicate how frequently they believed the  
265 authorities would catch them if they killed each of the four species. Respondents also  
266 reported their perceived likelihood of receiving a penalty for killing each animal if they were  
267 caught (eight statements in total). Answers were given using a five-point Likert scale (from  
268 ‘never’ through to ‘always’) coded so that lower scores corresponded to lower deterrence.

269

#### 270 *2.5 Social norms as deterrents*

271 To understand the relationship between social pressures and behaviour reported via RRT we  
272 investigated two different types of social norms: injunctive norms, which measure what  
273 friends, family or peers typically approve or disapprove of; and descriptive norms which  
274 capture respondents’ perceptions of how other people typically behave (Cialdini 2003). To  
275 measure injunctive norms we asked respondents to indicate on a five point Likert scale (from  
276 ‘highly disapprove’ through to ‘highly approve’) the degree to which they thought their  
277 family and friends would approve or disapprove of them for killing each of the four species  
278 (four statements in total). We measured descriptive norms by asking respondents to state  
279 whether or not they thought people that they know, had killed each of the species in the last



280 three years. Response options were ‘yes’ and ‘no’. The coding of answers for injunctive and  
281 descriptive norms means that lower scores suggest weaker social deterrence for wildlife  
282 persecution.

283

### 284 *2.6 Self-imposed guilt as a deterrent*

285 To investigate the relationship between anticipated guilt and behaviour reported via RRT, we  
286 asked respondents to indicate, using a five point Likert scale (from ‘strongly agree’ through  
287 to ‘strongly disagree’) how much they agreed or disagreed with the statement ‘*I would feel*  
288 *guilty if I killed x*’. This statement was repeated for each of the four species. Higher scores  
289 were indicative of stronger feelings of guilt, which is suggestive of stronger self-imposed  
290 deterrence for killing wildlife.

291

### 292 *2.8 Data analysis*

293 We analysed data using R version 2.15.0 (R Development Core Team 2012). The proportion  
294 of respondents admitting via RRT to killing each species was estimated using the following  
295 equation (Hox and Lensvelt-Mulders 2004):

296

$$\pi = \frac{\lambda - \theta}{s}$$

297

298 where  $\pi$  is the estimated proportion of the sample admitting to the behaviour,  $\lambda$  is the  
299 proportion of all answers that are ‘yes’,  $\theta$  is the probability of the answer being a prescribed  
300 ‘yes’, and  $s$  is the probability of being asked to answer the question truthfully. Ninety-five per  
301 cent confidence intervals for RRT and DQ data were estimated from 10,000 bootstrap  
302 samples (St. John et al. 2012). A significant difference between RRT and DQ estimates was  
303 concluded when the 95% confidence intervals for the mean difference did not include zero  
304 (St. John et al. 2010a).

305

306 Before modelling, we used Cronbach’s alpha coefficient (Cortina 1993) to check each set of  
307 four species-specific statements measuring the probability of being caught, probability of  
308 receiving a penalty, injunctive norm and self-imposed guilt for internal consistency.  
309 Categories within predictor variables measuring probabilities of detection and punishment  
310 were collapsed from five to two representing ‘never caught’ and ‘sometimes caught’.  
311 Categories measuring injunctive norms and anticipated guilt were collapsed from five to three  
312 corresponding to low, neutral and high levels of social approval and guilt.

313

314 Following St. John et al. (2012), we used generalised linear mixed models (GLMMs) with a  
315 binary response and binomial error to investigate relationships between behaviour reported  
316 via RRT and each predictor variable. GLMMs were fitted by penalised-quasi-likelihood using  
317 the glmmPQL function from the MASS package. Because of the forced ‘yes’ responses  
318 contained within randomised response data, simple logistic regression is not appropriate  
319 therefore models were fitted using a customised link function able to incorporate the known  
320 probabilities of the prescribed RRT responses (St. John et al. 2012; van den Hout et al. 2007)  
321 (supplementary material). To account for the grouping structure of the data whereby each

322 respondent answered multiple questions on each species, we included respondent ID as a  
323 random effect. Species, probability of detection, likelihood of punishment, injunctive and  
324 descriptive norms and anticipated guilt were all independently considered as potential fixed  
325 effects in GLMMs. We generated predictive scenarios illustrative of respondents reporting  
326 polar opposites of opinions from fitted GLMMs.

327

### 328 **3. Results**

329 Two hundred and forty two residents completed the questionnaire. Most respondents were  
330 male (64.5%,  $n = 242$ ) which reflects the underlying population (Miaoli County Government  
331 Household Registration Service 2014) and the mean age was 62 years (s.e. = 0.84,  $n = 242$ ).  
332 Because our sampling strategy targeted elder members of households, the sample does not  
333 perfectly represent the underlying population in terms of age (people above and below 55  
334 years of age were over and under sampled respectively) (Miaoli County Government  
335 Household Registration Service 2014). The primary occupation of most interviewees was  
336 agriculture, forestry or fish-farming (60.7%,  $n = 147$ ), whilst some worked in industry,  
337 commerce, or the service sector (19.8%,  $n = 48$ ), were unemployed (16.9%  $n = 41$ ), or  
338 engaged in other occupations (2.5%,  $n = 6$ ). Nearly all respondents were farming some type  
339 of crop (91.3%,  $n = 221$ ), and 47.9% ( $n = 116$ ) were keeping poultry. Over eighty percent of  
340 respondents (80.2%,  $n = 194$ ) were aware that there was no penalty for killing rodents whilst  
341 43% ( $n = 104$ ) knew there was no penalty for killing ferret badgers. Less than one-quarter  
342 (24.0%,  $n = 58$ ) of the sample reported being aware that there is a penalty for killing leopard  
343 cats; fewer (13.6%,  $n = 33$ ) reported being aware that penalties exist for killing masked palm  
344 civet. Few respondents (4%,  $n = 10$ ) reported thinking that leopard cats were a pest; these ten  
345 respondents stocked fewer head of poultry (43.2, s.e. = 17.5) compared to the sample mean  
346 (274.9, s.e. = 180.9,  $n = 116$ ).

347

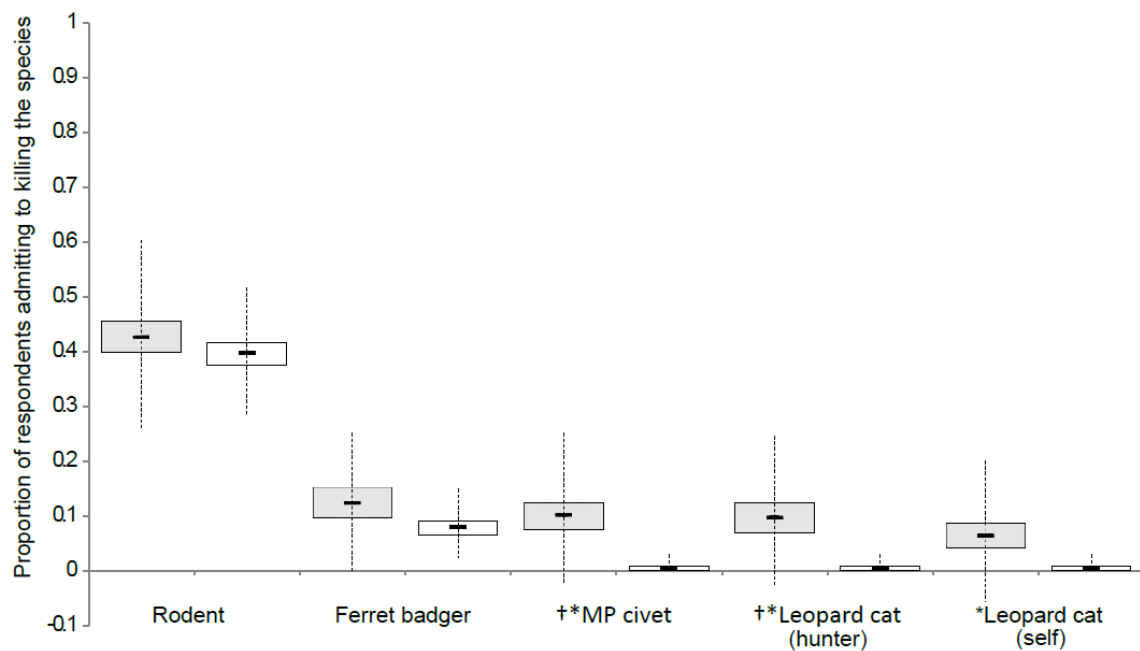
348 Cronbach's alpha was high for each set of four species-specific statements measuring the  
349 probability of detection (0.75,  $n = 242$ ), receiving a punishment (0.74,  $n = 242$ ), injunctive  
350 norms (0.77,  $n = 242$ ), and anticipated guilt (0.79,  $n = 242$ ) indicating high interval  
351 consistency.

352

#### 353 *3.1 estimating the proportion of people killing wildlife*

354 The proportion of respondents estimated by RRT and DQ to have killed each of the four  
355 species, or asked a hunter to kill a leopard cat in the last three years is shown in Figure 2.  
356 RRT produced higher estimates than DQ for each of the five behaviours (significantly higher  
357 for masked palm civet and asking a hunter to kill a leopard cat). Over 40% (42.7%) (mean  
358 difference between RRT and DQ estimates 3.05%) and 12.4% (mean difference between  
359 RRT and DQ 4.63%) of respondents admitted to killing legally unprotected rodents and ferret  
360 badgers respectively in the three years preceding the study. More than 10% (10.2%) of  
361 respondents admitted to killing the protected masked palm civet (mean difference between  
362 RRT and DQ 9.82%). A greater proportion of respondents admitted to asking a hunter to kill  
363 leopard cat (9.7%) compared to admitting to killing this species themselves (6.0%) (mean  
364 difference between RRT and DQ 9.32% and 5.91% respectively). Elder members of  
365 households were selected as respondents because locally they are reported to have more

366 experiences with the study species. However, this may have introduced bias to our results.  
 367 Estimates of reported levels of killing should therefore be considered conservative.  
 368



369 Figure 2 The proportion of respondents admitting to killing each of the species, or asking a  
 370 hunter to kill leopard cats on their behalf in the three years preceding the study estimated  
 371 using the randomised response technique (grey bars) and direct questions (white bars). Bold  
 372 lines represent the median, the lower and upper edges of the boxes represent the first and  
 373 third quartiles, and whiskers denote the maximum and minimum values. . Asterisks indicate  
 374 species protected under the Wildlife Conservation Act of 1989. †denotes RRT estimates are  
 375 significantly different compared to DQ.  
 376

377  
 378

### 379 3.3 Deterrence

380 The perceived probability of detection by the authorities for killing wildlife was not modelled  
 381 as most of our respondents perceived no chance of capture for any of the species. The  
 382 likelihood of admitting to killing wildlife was negatively related to the perceived probability  
 383 of being punished if caught ( $t = -1.324$ , d.f. = 722,  $p = 0.186$ ), however, this result was not  
 384 significant.

385

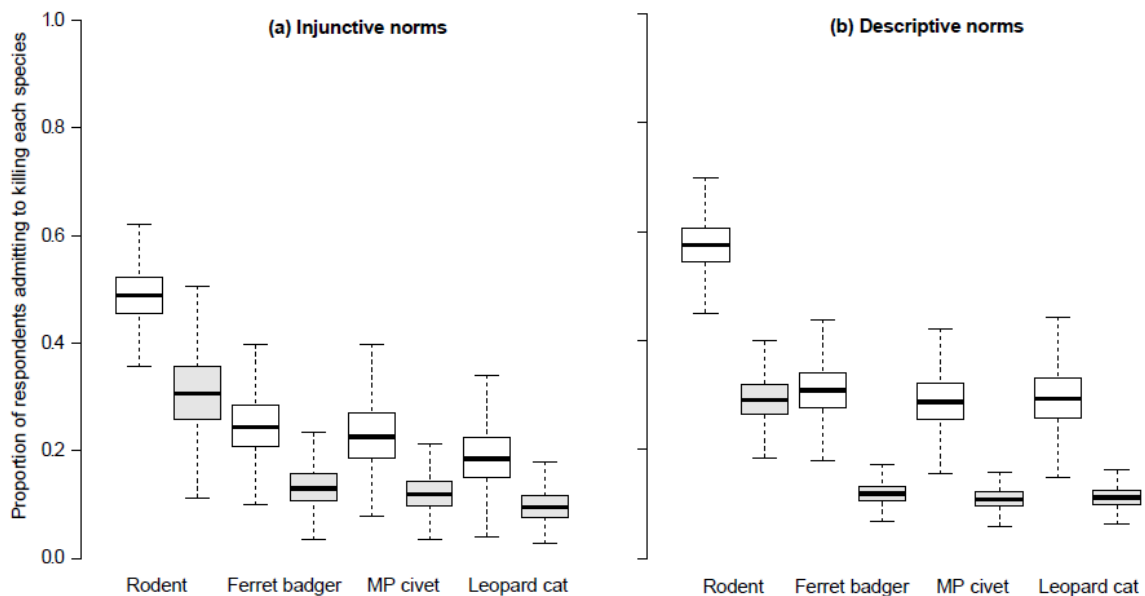
386 The likelihood of admitting to killing any of the four species was negatively and significantly  
 387 related to both injunctive ( $t = -2.294$ , d.f. = 722,  $p = 0.022$ ) and descriptive norms ( $t = -5.709$ ,  
 388 d.f. = 722,  $p = <0.001$ ). Scenarios simulated from each of our fitted GLMMs predict that  
 389 respondents reporting the injunctive norm that their family or friends would disapprove of  
 390 them killing leopard cat were 9% less likely to have killed this species compared to those  
 391 reporting that their friends and family would approve of such behaviour (Figure 3a).  
 392 Respondents reporting the descriptive norm that they knew someone who had killed leopard  
 393 cat in the last three years were 18.3% more likely to have admitted to killing this species

394 when asked via RRT, compared to someone reporting that they did not know anybody that  
395 had killed leopard cat (Figure 3b).

396

397 Self-imposed deterrence, measured as the level of guilt respondents associated with the  
398 killing of each species, was not related to behaviour reported via RRT ( $t = 0.078$ , d.f. = 722,  $p$   
399 = 0.938).

400



401

402 Figure 3 Simulations from fitted generalised linear mixed models illustrating the relationships  
403 between human persecution of wildlife and (a) injunctive norms – perceived social approval  
404 and (b) descriptive norms – perceived typical behaviour of others. In Scenario 1 (white bars)  
405 the norm is set to its minimum value indicative of a weaker norm. In scenario 2 (grey bars)  
406 the norm is set to its maximum value indicative of a stronger social norm. Bold lines  
407 represent the median, the lower and upper edges of the boxes represent the first and third  
408 quartiles, and whiskers denote the maximum and minimum values.

409

410

#### 411 4. Discussion

412 Investigating illegal resource use presents methodological challenges (Gavin et al. 2010) with  
413 data subject to unquantifiable biases, consequently much of our understanding of the  
414 determinants of compliance stem from modelling studies (Keane et al. 2008). For example  
415 bio-economic and agent-based models underpinned by rational actor assumptions have been  
416 used to explore the influence of sanctions on poacher behaviour (Keane et al. 2012; Milner-  
417 Gulland and Leader-Williams 1992). However, rule-breakers do not simply compare  
418 marginal benefits with marginal costs, but respond to sociological norms internalised  
419 throughout their lifetime (Garoupa 1997). Recent developments in the application and  
420 analysis of specialised questioning techniques (techniques that add stochastic noise to  
421 respondents' answers preventing individually incriminating information from being revealed  
422 whilst allowing population-level estimates to be calculated) including RRT (St. John et al.

423 2012) and the unmatched count technique (Nuno et al. 2013), facilitate linking reports of  
424 rule-breaking behaviour to a range of characteristics, including potential sources of  
425 compliance, thus contributing to a greater understanding of factors driving behaviour.

426

427 Validation studies where the actual status of individuals is known (e.g. police or medical  
428 records) provide evidence that RRT stimulates more honest answers to sensitive questions  
429 compared to conventional survey techniques (Lensvelt-Mulders et al. 2005). This suggests  
430 that whilst anonymity may increase response rates and reduce social-desirability bias (Ong  
431 and Weiss 2000), other mechanisms that offer respondents added protection further increase  
432 the validity of sensitive data. Studies comparing survey methods (including one study in  
433 Taiwan (Chi et al. 1972)) have reported that RRT returned higher estimates than DQ when  
434 the questions were sensitive; these higher estimates have been interpreted as evidence of  
435 more honest reporting (Chi et al. 1972; Lensvelt-Mulders et al. 2005; Solomon et al. 2007).  
436 There is growing evidence that RRT produces more accurate reports of involvement in illegal  
437 natural resource extraction compared to conventional direct questions: Twelve per cent of the  
438 population surveyed near Andasibe-Mantadia protected area, Madagascar reported eating  
439 sifaka (*Propithecus diadema*) when asked using RRT, compared to 3% using DQ  
440 (Razafimanahaka et al. 2012); RRT estimates of the proportion of people illegally extracting  
441 six types of natural resources from Kibale National Park, Uganda exceeded DQ estimates  
442 across all resource types (Solomon et al. 2007); and compared to DQ, RRT estimated that a  
443 significantly higher proportion of fishers fished without permits in North Wales, UK (St.  
444 John et al. 2010a). However, even when using questioning techniques designed specifically  
445 for asking sensitive questions it is impossible to rule out untruthful reporting (Landsheer et al.  
446 1999). To maximise compliance with RRT instructions we used a symmetrical RRT design  
447 (meaning that prescribed responses were set as both yes (dice sum two, three or four), *and* no  
448 (dice sum 11 or 12), rather than as *either* yes or no) which has been shown to increase the  
449 extent to which people follow RRT instructions (Ostapczuk and Musch 2011). Further, the  
450 analogy of ‘playing a game’ was used when describing RRT to respondents (Chi et al. 1972).  
451 One principle disadvantage of RRT is that, because noise is added to the data by forced  
452 responses, the method demands a large sample size in order to achieve estimates with an  
453 acceptable margin of error; further, the random noise complicates analyses of associations  
454 (e.g. between behaviour and norms) (Lensvelt-Mulders et al. 2005; Moshagen et al. 2013).

455

456 Our estimates that within the last three years nearly 10% of residents asked someone to hunt  
457 leopard cat, whilst 6% admitted to killing them in person require serious consideration,  
458 particularly given the recent confirmed extinction of the clouded leopard (*Neofelis nebulosa*)  
459 in Taiwan, a loss partially attributed to human encroachment and hunting (Chiang 2007;  
460 Taipei Times 2013). Whilst there may be some overlap in the two estimates (i.e. some people  
461 admitting to killing the species themselves may be the hunters reported by other respondents)  
462 the number of killings every year may be detrimental to the population which numbers no  
463 more than several hundred individuals (Pei 2008). Leopard cats are nocturnal lowland forest  
464 edge species with home ranges of ca. 5-6 km<sup>2</sup> as such it is inevitable that their home ranges  
465 will overlap with rural residences and agriculture lands (Pei 2008). Conflicts between humans  
466 and carnivores often stem from threats to human lives or livelihoods (Treves and Karanth

467 2003). This small carnivore (weighing 3-5kg; Francis 2008) poses neither threat within  
468 human-managed landscapes in Taiwan, with faecal analysis confirming that livestock do not  
469 constitute a major part of leopard cat diet. Nearly 60% of their diet constituted mammalian  
470 species (mainly rodents), the remainder being passerine birds, reptiles and invertebrates.  
471 Evidence of gallinaceous birds was found in just two out of 74 faecal samples (Chuang  
472 2012). Contrary to anecdotal evidence, poultry farmers (those owning thousands of poultry)  
473 did not report thinking that the leopard cat was a pest. The ten respondents perceiving leopard  
474 cat to be a pest owned less poultry (quantities below the mean), so any loss to predators  
475 represent a greater proportion of their property. Ten per cent of respondents also admitted to  
476 killing masked palm civets, the other protected species included in this study. Just three  
477 respondents reported perceiving this small omnivorous mammals, which feed mainly on  
478 fruits, other plant parts and occasionally invertebrates (Hwang 2008; Wang and Fuller 2003),  
479 as a pest. Further, masked palm civets have never been reported to injure or kill livestock  
480 such as chickens in Taiwan.

481  
482 A number of studies have used rational choice models to explore how economic incentives of  
483 illegal resource extraction should influence people's behaviour (Keane et al. 2012; Milner-  
484 Gulland and Leader-Williams 1992; Sumaila et al. 2006), but none have investigated  
485 relationships between peoples' perceived threat of sanctions and their actual non-compliant  
486 behaviour. Deterrence is created by the threats of detection and punishment being  
487 communicated to individuals who then mediate these threats before they influence behaviour;  
488 perceived deterrence may therefore be a more informative way of understanding how  
489 enforcement influences behaviour (Grasmick and Green 1980). Across all species few  
490 respondents in our study perceived any threat of capture, precluding this variable from  
491 modelling. However, evidence that violators adjust their rule-breaking behaviour in response  
492 to patrol frequency (Milner-Gulland and Clayton 2002) suggests that this factor warrants  
493 further attention. Incorporating the perceived probability of receiving a penalty into our  
494 GLMM allowed us to investigate how the probability of being punished relates to rule-  
495 breaking behaviour. Results suggest that respondents perceiving lower chances of being  
496 punished once caught, were marginally more likely to have admitted (via RRT) to killing  
497 wildlife in the three years preceding the study. Research on perceived deterrence indicates  
498 that the influence of penalties on behaviour strengthens as the perceived probability of  
499 capture increases. For example across eight illegal acts Grasmick and Bryjak (1980) reported  
500 a strengthening relationship between behaviour and severity of penalties as the perceived  
501 certainty of capture increased. The zero chance of capture perceived by most of our  
502 respondents prevented us from exploring any interaction effects between perceived  
503 probabilities of detection and punishment.

504  
505 Social norms established by informal institutions have long contributed towards the  
506 management of natural resources (Berkes et al. 2000) and continue to exert influence. For  
507 example social norms influenced re-enrolment to China's grain-to-green payment for  
508 ecosystem services scheme (Chen et al. 2009) and decisions by foresters to conserve habitat  
509 (Primmer and Karppinen 2010). In this study we measured two types of social norm in order  
510 to explore their potential deterrent effects. Results from our fitted GLMMs indicate that

511 social approval (injunctive norms) is related to behaviour. Respondents reporting that their  
512 family and friends would disapprove of them killing wildlife were less likely to have  
513 admitted (via RRT) to killing each species as compared to respondents reporting that their  
514 friends and family would approve of such behaviours. Our findings suggest that perceptions  
515 of how others behave (descriptive norms) have a stronger influence on behaviour compared  
516 to social approval. In our model there was a negative relationship between the descriptive  
517 norm reported for each species and RRT response; people reporting that they did not know  
518 others who had killed each animal, were less likely to have admitted killing it. The stronger  
519 association between behaviour and descriptive, compared to injunctive norms may be an  
520 artifice of the ‘false consensus’ effect (Ross et al. 1977) whereby people bias their reports of  
521 others’ behaviour in accordance with their own. This phenomenon has previously been  
522 suggested as a proxy indicator of involvement in illicit acts (Petróczi et al. 2008; St. John et  
523 al. 2012). However, relationships in our data between behaviour and both injunctive and  
524 descriptive norms, whereby behaviours typically disapproved of and not thought to be  
525 conducted by others are deterred, support the findings of others. For example, messages of  
526 social disapproval reduced environmental theft and littering (Cialdini 2003); and estimates of  
527 the number of friends’ performing illegal behaviours was positively related to respondents’  
528 rule-breaking behaviour (Cross et al. 2013; Grasmick and Green 1980; Petróczi et al. 2008).

529

530 The anticipation of guilt has been shown to influence decisions to perform pro-environmental  
531 behaviours (Ahn et al. 2013) and break the law (Grasmick and Bursik 1990). In Taiwan three  
532 types of guilt have been described: *Nei jiu* associated with failure to fulfil obligations to  
533 others; *Zui e gan* associated with moral transgressions and; *Fan zui gan* linked to breaking  
534 rules or laws that apply to everyone (Bedford 2004). Whilst *fan zui gan* may be experienced  
535 when breaking rules (actual or perceived), if a rule is not accepted or known, guilt may not be  
536 associated with transgression (Bamberg and Möser 2007; Bedford 2004). The limited  
537 knowledge of wildlife laws observed in our sample may explain why we did not find any  
538 association between guilt and respondents’ wildlife-killing behaviour (reported using RRT).  
539 However, clear relationships between explanatory factors and behaviour may fail to become  
540 apparent due to mismatches between information gathered and the behaviour of interest (St.  
541 John et al. 2010b), or because questions posed fail to capture the construct of interest  
542 (Robinson et al. 1991). Our statements aiming to measure guilt may have lost some of their  
543 meaning through delivery or translation although we believe our survey-delivery training and  
544 translation-back-translation procedure minimized such errors. Whilst there is considerable  
545 evidence that internalised values (e.g. attitude and social norms) influence behaviour  
546 (Armitage and Conner 2001), personal values do not always accord with the law. Therefore  
547 some people may engage in illegal acts because they do not perceive them to be wrong  
548 (Tyler 2006). As such it is possible that guilt is not always associated with rule-breaking  
549 behaviour.

550

551 Few respondents were aware that law protects leopard cat and masked palm civet and that  
552 they could be penalised if caught killing either species. This suggests that knowledge of  
553 wildlife laws is insufficient. However, whilst rules are only likely to be effective when they  
554 are known by the people whose behaviour they are designed to regulate, currently the extent

555 to which changes in awareness of rules translate into changes in compliance is unclear  
556 (Keane et al. 2011). There is evidence that environmental campaigns that solely provide  
557 information can be ineffective at bringing about behaviour change (Kollmuss and Agyeman  
558 2002). Consequently, providing residents of Miaoli County with information on the  
559 characteristics and legal status of Taiwan's protected species alone may not reduce illegal  
560 hunting. However, social marketing campaigns, which apply commercial marketing concepts  
561 to promote behaviour change have had considerable success in reducing undesirable  
562 behaviours (e.g. tobacco use) and promoting desirable ones (e.g. using mosquito nets to  
563 prevent malaria) (Lee and Kotler 2011). A social marketing campaign promoting the existing  
564 social norm that killing protected species is generally disapproved of, may be an effective  
565 way of influencing the behaviour of the small minority who currently hunt illegally or seek  
566 the services of professional hunters. This information will be fed into the strategy of the  
567 Miaoli Leopard Cat Conservation Action Plan run by the Taiwan Forestry Bureau (Pei et al.  
568 2014) which is already undertaking protection activities including establishing the Miaoli  
569 Leopard Cat Important Habitat. However, as any behaviour-change intervention takes time,  
570 conservation law enforcement will remain important. This study has drawn upon rational  
571 choice theories of crime and research in social psychology exploring the influence of social  
572 norms and guilt on people's behaviour. Other internal and external factors undoubtedly  
573 influence how people behave in complex social-ecological systems, however, a single  
574 study investigating all potential factors would most probably lose its practicality and meaning  
575 (Kollmuss and Agyeman 2002).

576

## 577 **Conclusion**

578 Investigating sensitive topics, such as the persecution of protected species, requires the use of  
579 specialised questioning techniques that provide respondents with additional assurances of  
580 confidentiality. In this study we investigated relationships between past rule-breaking  
581 behaviour, reported via RRT, and current perceptions of three potential sources of deterrence:  
582 probabilities of detection and punishment, social norms and self-imposed guilt. Our results  
583 provide evidence that social pressures influence rule-breaking behaviour even when the  
584 perceived threat of state-imposed sanctions is low. We found that two types of social norms  
585 deter wildlife persecution: perceptions of what others typically approve or disapprove of; and  
586 perceptions of how others typically behave. Whilst conventional enforcement is likely to  
587 remain an essential part of any compliance regime, harnessing social norms that encourage  
588 compliance offers potential for reducing the persecution of protected species whose survival  
589 is threatened. Critically, at a time when conservation law enforcement is receiving increased  
590 attention and adopting new technologies (often associated with war zones), care must be  
591 taken not to breakdown existing norms that encourage compliance.

592

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