

## The bean method as a tool to measure sensitive behavior

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1 Introducing the bean method as a tool to measure sensitive behaviour

2

3 ABSTRACT

4

5 Conservationists need to measure human behaviour to guide decisions and evaluate their  
6 impact. However, activities can be misreported and reporting accuracy might change following  
7 conservation interventions, making it hard to verify any apparent changes. Techniques for  
8 asking sensitive questions are increasingly integrated into survey designs to improve data  
9 quality but some can be costly or hard for non-experts to implement. We demonstrate a  
10 straightforward, low-cost approach, the “bean method” in which respondents give anonymous  
11 answers by adding a coloured bean to a jar to denote a yes or no response. We apply the bean  
12 method to measure wildmeat hunting and trading over two years at a conservation project site  
13 in Gola Forest, Liberia, and extend the technique to accommodate questions about hunting  
14 frequency. We compare responses given using the bean method and direct questions, for  
15 groups that did and did not participate in conservation interventions. Results from the bean  
16 method corresponded to those from direct reports, giving no indication of change in question  
17 sensitivity following conservation interventions. Estimates from both methods indicate that  
18 wildmeat trading decreased in project and non-project households (from 36% to 20%), while  
19 hunting decreased in one project group (38% to 28%). Where inconsistent answers were given  
20 (2 to 6% of respondents), differences were in both directions and were most likely attributable  
21 to measurement error. The bean method was quick and straightforward to administer in a low-

22 literacy setting. We show it can be modified for answers of more than two categories and  
23 consider it a valuable tool that could be adapted for a wide range of conservation settings.

24

## 25 INTRODUCTION

26

27 Where conservation interventions aim to influence human behaviour, it is essential to measure  
28 behaviour-change impacts and build an evidence base to guide decisions (Schultz, 2011).

29 However, behaviours of interest to conservationists are often illegal, making them challenging  
30 to study (Gavin et al., 2010). One problem is social desirability bias: systematic error introduced  
31 when people inaccurately report behaviour in order to convey a more socially desirable image  
32 (Krumpal, 2013). Such bias can lead to under-reporting of sensitive activities or over-reporting  
33 of desirable behaviour (Tourangeau and Yan, 2007). It presents a particular problem for  
34 evaluating conservation impacts, since many interventions explicitly aim to alter the social  
35 desirability of behaviour, for instance through education or social marketing campaigns (Salazar  
36 et al., 2019). Consequently, data collected before and after interventions may have different  
37 degrees of misreporting, making it hard to identify genuine changes. The issue that sensitive  
38 behaviour may be misreported has led to increased use by conservationists of survey methods  
39 explicitly designed to address this (Nuno and St. John, 2015).

40

41 A growing body of research applies specialised questioning techniques to understand sensitive  
42 conservation behaviours (e.g. Fairbrass et al., 2016; Hinsley et al., 2019; Nuno and St John,  
43 2014; St John et al., 2014, 2012; Travers et al., 2019). These techniques are designed to

44 encourage truthful reporting by protecting anonymity of respondents and ensuring researchers  
45 cannot link behaviour directly to individuals (Nuno and St. John, 2015). Two well-known  
46 approaches are the randomised response technique (Warner, 1965) and unmatched count  
47 technique (Droitcour et al 1991), but a variety of other methods have been developed and  
48 applied in conservation settings (Nuno and St. John, 2015; St. John et al., 2010). Studies  
49 comparing estimates from specialised methods to those resulting from asking questions  
50 directly, offer insight into the performance of different approaches (Razafimanahaka et al.,  
51 2012) and provide evidence that specialised techniques can increase reporting of sensitive  
52 topics (Lensvelt-Mulders et al., 2005; Phillips et al., 2010). However, many specialised  
53 techniques are statistically inefficient, requiring large sample sizes (Hinsley et al., 2019), can be  
54 cumbersome for respondents and enumerators, and require advanced statistical approaches to  
55 analyse and interpret results. If the sensitivity of the activity under investigation is initially low,  
56 specialised techniques may unnecessarily complicate monitoring data, wasting valuable  
57 resources (Hinsley et al., 2019). Further, complex techniques can introduce new sources of  
58 error, such as whether respondents or interviewers follow instructions correctly (Davis et al.,  
59 2019; Lensvelt-Mulders et al., 2005). Nevertheless, specialised questioning methods have  
60 proven effective to understand illegal conservation activities which are otherwise challenging to  
61 measure (e.g. Nuno et al., 2013; Razafimanahaka et al., 2012). Development of straightforward,  
62 low-cost techniques would further enable conservationists to measure sensitive behaviour  
63 across a wider range of settings.

64

65 The bean method, developed by Lau et al (2011), may meet these criteria but to our  
66 knowledge, has yet to be used in conservation. The bean method employs a basic system  
67 whereby respondents report their 'yes' or 'no' answer by placing a bean (or counter) of  
68 specified colour (e.g. black=yes, red=no) into a container which already contains a known  
69 number beans of those colours. Interviewers do not observe participants moving beans but  
70 count the beans after each day or survey block, to obtain group-level estimates. Investigating  
71 sexual behaviour, Lau et al (2011) found the bean method gave prevalence estimates up to 10%  
72 greater than direct reports. The method has limitations, for example it provides only group-  
73 level estimates, so cannot be used to investigate drivers of individuals' behaviour, and its  
74 original formulation allows only a limited number of binary (e.g. yes-no) questions to be asked.  
75 However, it is straightforward and cheap to administer, raw results are easy to interpret, and it  
76 can be appended to questionnaire-based surveys to generate insight into social desirability bias  
77 without significantly increasing data collection costs. Materials can be locally sourced, making it  
78 particularly appropriate for settings where complex approaches are likely to be viewed with  
79 suspicion. The bean method has received little attention since its development (but see Cerri et  
80 al., 2017), but similar approaches have been successfully used to measure sensitive health  
81 behaviours in low-literacy populations (Lowndes et al 2012) .

82

83 Here we apply the bean method alongside direct questions to measure wildmeat hunting and  
84 trading at a conservation project site in Gola Forest, Liberia. Wildlife is hunted across Liberia  
85 providing an income source for hunters, traders who transport dried meat to urban markets,  
86 and marketeers who sell to consumers (Jones et al., 2019). It is widely consumed, particularly in

87 rural areas where it represents a relatively affordable protein source (Ordaz-Németh et al.,  
88 2017). National laws prohibit unlicensed hunting, hunting in protected areas and killing of  
89 protected species (National Wildlife Act, 2016), but are not widely enforced. Hunting-reduction  
90 interventions implemented by conservation projects could be expected to increase under-  
91 reporting of hunting and trading. To explore this, we compare estimates from the bean method  
92 and direct questions, before and after implementation of hunting-reduction interventions, and  
93 for groups that did and did not receive interventions. We extend the method to measure  
94 frequency of activities by allowing answers in more than two categories. This study focuses on  
95 the application of the bean method as a tool to measure behaviour, and evaluation of the  
96 impacts of interventions will be presented elsewhere.

97

## 98 METHODS

99

### 100 **Study site**

101

102 The study was conducted at the site of an ongoing conservation project, GolaMA, implemented  
103 by the Society for Conservation of Nature in Liberia and the Royal Society for the Protection of  
104 Birds. GolaMA aims to reduce wildmeat hunting and trading in community forests through  
105 community-based management, while improving income from conservation-friendly  
106 livelihoods. The project works with two neighbouring administrative units, or clans (henceforth  
107 ‘group 1’ and ‘group 2’), supporting each to establish their own community-managed forest.  
108 The two clans share similar socio-demographic profiles, with subsistence rice farming being the

109 predominant livelihood activity (Supporting Information). At the first round of data collection,  
110 project interventions specifically targeting wildmeat hunting and trading had not been  
111 implemented and project activities had focussed on socio-economic surveys, resource  
112 management workshops, and pilot phases of livelihood support work. By the second round of  
113 data collection, livelihood support programmes had been implemented across all households,  
114 consisting of training to increase agricultural yields, introduction of bee-keeping, small-loans  
115 schemes providing access to low-interest credit, and adult literacy classes. There had also been  
116 initial work supporting small-scale miners to improve revenues. Participants in all livelihood  
117 programmes made formal agreements to refrain from commercial wildmeat hunting or trading.  
118 Workshops and meetings were conducted to inform people about existing hunting regulations  
119 and conservation management. All interventions were applied across the two clans that  
120 participated in GolaMA, with minor differences in timing of implementation. During the study,  
121 non-project conservation activities took place, relating to boundary demarcation of the Gola  
122 Forest National Park, which borders the project site. These included increased ranger patrols  
123 and confiscation of wildmeat at a roadblock along the road to Monrovia. Small-scale mining is  
124 prohibited within the park but mining in community forest is not regulated by park rangers. By  
125 contrast, wildmeat could be confiscated by rangers regardless of where hunting occurred.  
126  
127 Wildmeat hunting and trading were socially acceptable activities about which people spoke  
128 freely (Jones et al., 2019). Nevertheless, some degree of social desirability bias could be  
129 expected given many hunters (45%, n=130) and traders (71%, n=36) reported incurring

130 penalties in the past (Jones et al., 2019a). Small-scale mining was openly practised but often  
131 without legally required licenses.

132

### 133 **Survey methods**

134

135 The bean method was applied alongside direct questions in a single questionnaire administered  
136 to households during face-to-face interviews. The questionnaire was administered during two  
137 time periods: the initial phases of GolaMA (February to July 2017), and the projects' final year  
138 (February to March 2019). The sample in each of the two survey periods comprised a complete  
139 census of all households in villages belonging to two clans that participated in GolaMA (group 1  
140 and group 2), and in three villages in neighbouring, non-participating clans (non-project group).  
141 The same households were targeted in each survey period. The two clans participating in the  
142 golaMA project are considered separately as group 1 (nine villages) and group 2 (six villages) to  
143 give results which are informative for project managers, and to account for differing livelihood  
144 patterns between clans (see Supporting Information).

145

146 The questionnaire measured prevalence for behaviours targeted by conservation interventions  
147 (wildmeat hunting and trading) which could be expected to decrease in prevalence and  
148 increase in sensitivity due to project implementation. A non-target behaviour (small-scale  
149 mining) was also measured, providing a comparison with an activity supported by the project.  
150 Small-scale mining was not expected to become more sensitive or less prevalent during the  
151 study. In contrast to hunting, project activities aimed to support, not restrict, mining activities

152 (see Supporting Information), and law enforcement by park rangers related only to mining  
153 within the protected area which was unlikely to affect miners in our study as these operated  
154 almost entirely within community forests. Frequency of hunting and wildmeat selling were  
155 measured using an extension of the bean method (see below). Prevalence and frequency  
156 estimates obtained from the bean method were compared to those obtained via direct  
157 questions. Further, inconsistency of responses was evaluated to assess minimum levels of  
158 misreporting.

159  
160 The questionnaire was administered to the most senior household member present and had  
161 five sections (Supporting Information). Starting and ending times of interviews were recorded.  
162 Section one consisted of basic socio-demographic questions. In section two, respondents were  
163 directly asked, for each of 12 livelihood activities, whether any household member had engaged  
164 in the activity over the past six months. Activities included hunting, wildmeat trading and  
165 mining alongside other common activities such as farming, charcoal production and fishing. In  
166 section three, the bean method (see below) was applied to ask if any household member had  
167 engaged in hunting, wildmeat trading and mining during the same six-month period. In section  
168 four, a modified form of the bean method (see below) was applied to ask two questions: the  
169 number of days any household member had been hunting during the previous week, and  
170 number of carcasses sold in the previous week up to a maximum of ten. In the final section,  
171 respondents were directly asked the same two questions about frequency of hunting and  
172 carcasses sold. For frequency questions, an important consideration was that counting and  
173 moving beans would become obvious for large numeric responses. A week timeframe was

174 therefore chosen to limit possible hunting days to seven, and carcass sales were capped at ten.  
175 Respondents may be less likely to recall activities over longer time periods, and weekly religious  
176 observances provided temporal reference points.

177

178 Free, prior and informed consent was given verbally by all respondents. Respondents were  
179 informed that the study sought to understand livelihood activities, the answers they provided  
180 would be confidential, and results of the study would be published. Specific permission to  
181 conduct the survey in each village was obtained from clan and village authorities. Ethical  
182 approval for the study was given by Royal Holloway University of London ethics committee.

183

#### 184 **The bean method**

185

186 The bean method was applied as follows. Respondents were asked to provide 'yes' or 'no'  
187 answers by taking a bean of a specified colour/type from a 'selection container' and placing it in  
188 an 'answer container' (Fig. 1). Prior to asking each question, the interviewer demonstrated  
189 which type of bean signified a 'no' answer, which would signify 'yes', and checked the  
190 respondent understood by asking them to demonstrate their choice of bean for a dummy  
191 question about a non-sensitive topic. The interviewer then asked the sensitive question,  
192 turning around so they could not observe the respondent's bean choice. Three questions were  
193 asked with this method, with a different type of bean signifying 'yes' for each question, and the  
194 same type of bean signifying 'no' for any question. One 'answer container' and one 'selection  
195 container' were used for these three questions.

196

197 Locally sourced containers and beans were used (Fig. 1). The ‘selection container’ was a large  
198 (approx. 1 litre) plastic cup, inside which we placed an opaque plastic bag half-filled with an  
199 even mixture of five different types of bean. The cup had a broad opening allowing  
200 respondents to easily see inside to select beans, and the plastic bag allowed them to further  
201 conceal their selection by using it to completely cover their hand. The ‘answer container’ was a  
202 clear plastic jar (approx. 1 litre) with a label around the centre and filled approximately one-  
203 third of the way with an even mix of the five different types of beans. Respondents could  
204 clearly see there were many beans in the jar already, and the label concealed the area in which  
205 a respondent’s bean landed. Five types of bean were used (Fig. 1): red kidney beans (type “a”)  
206 were used to denote a ‘no’ answer to any question; square white beans (type “b”) denoted  
207 ‘yes’ to the first question (‘has anyone in your household engaged in wildmeat trade in the past  
208 6 months’); flat mottled beans (type “d”) denoted ‘yes’ to the second question (‘has  
209 anyone...engaged in hunting’); and pink and white beans (type “e”) denoted ‘yes’ to the third  
210 question (‘has anyone...engaged in mining’). The fifth ‘bean’ was a dark brown seed (type “c”)  
211 of a similar size and was included to indicate method comprehension; the quantity of this bean  
212 in both containers should remain constant as it was not associated with answering questions.  
213 At the start of each day, the answer container held 50 of each type of bean. The selection  
214 container had approximately twice this number.

215

216 Surveys were conducted by two teams of one or two trained interviewers, who were local  
217 residents in one of the study villages. Where possible at least one female interviewer was on

218 each team. Beans were counted by each survey team at the end of each day, and no more than  
219 35 households were surveyed in a day to limit potential mistakes during counting. For small  
220 villages, a survey-day included all households in the village (range = one to 30 households). In  
221 large villages, households were surveyed over multiple days, or by more than one team. To  
222 ensure respondent protection, we do not report data at the village level (St.John et al., 2016).

223

### 224 **The modified bean method for more than two categories**

225

226 We adapted the bean method described above to obtain estimates for frequency of hunting  
227 and selling wildmeat. A separate answer container was used for frequency questions with the  
228 same appearance as the yes-no answer container. The same selection container was used for  
229 both yes-no and frequency questions. Respondents were instructed to answer frequency  
230 questions by moving a number of beans into the answer container, with a separate colour  
231 denoting an answer of 0. For the first question, ‘how many days has anyone in your household  
232 been hunting in the past week?’, 0 answers were denoted by bean type “a” (Fig 1A) and the  
233 number of days was indicated by bean type “b”. For the second question, ‘how many carcasses  
234 has anyone in your household sold in the past week?’, 0 answers were denoted by bean type  
235 “c”, and number of carcasses denoted by bean type “d”. To limit the amount of counting for  
236 high answers, respondents were instructed to move 10 beans for answers of 10 or greater. The  
237 bean method was modified during the first survey period to distinguish between zero answers  
238 given to each frequency question. In the initial version, administered in 2017 in five villages, the  
239 same colour of bean was used to denote zero answers for both frequency questions. This was

240 then changed so zero answers to each frequency question were denoted by different colours.  
241 Proportion of households engaged in hunting or meat selling in the previous week could  
242 therefore not be calculated from the bean method in 2017 for the non-project group and group  
243 1.

244

## 245 **Evaluation of methods**

246

247 Prevalence of hunting, trading and mining across households was estimated in each survey  
248 period as proportion of respondents answering 'yes' to direct and bean method questions  
249 respectively. Prevalence was calculated separately for each clan ("group 1" and "group 2") that  
250 participated in the GolaMA project, and for the non-project group.

251

252 Frequency of hunting and wildmeat selling was measured as number of days any household  
253 member had been hunting in the previous week, and number of carcasses sold by any  
254 household member in the previous week. Average number of days hunting and carcasses sold  
255 was calculated across all households, and among only households that had engaged in the  
256 activity in the previous week. The proportion of households who engaged in either activity in  
257 the previous week was the proportion of non-zero answers.

258

259 For all estimates, 95% confidence intervals were calculated as  $S.E. * 1.96$ . However, for bean  
260 method responses to frequency questions, individuals' answers are unknown. Therefore, mean  
261 response for each survey-day was used to calculate standard errors, and the sample size was

262 taken to be number of survey-days. This approach fails to account for variable numbers of  
263 respondents in each survey-day, so provides only rough approximation.

264

265 To evaluate inconsistency between answers obtained through the bean method and direct  
266 questions, the difference in 'yes' answers from each method was calculated for each survey-  
267 day. For frequency questions, we calculated difference in mean answer per household for each  
268 survey-day. Direct responses for frequency of carcass-selling frequency were capped at ten  
269 carcasses per respondent for comparison with the bean method.

270

## 271 RESULTS

272

273 There were 480 households in total in the study area during the first round of data collection  
274 (2017); 475 participated fully, one household abstained and four gave incomplete answers.

275 During the second round (2019), there were 524 households all giving complete answers. The  
276 same households were targeted in both rounds of data collection, so differences in sample sizes  
277 between years reflect socio-demographic processes (e.g. migration, marriage). Sample sizes  
278 were similar for each of the two clans that participated in the GolaMA project (group 1 and  
279 group 2) and the households from non-project villages (non-project group). In 2017, number of  
280 respondents (households) in group 1, group 2 and the non-project group were 201, 136 and  
281 143 in 2017, and 181, 168 and 175 in 2019. Average respondent age was  $40.7 \pm 14.5SD$  (2017)  
282 and  $41.3 \pm 14.0SD$  (2019), with 49% and 48% male respondents. Household sizes, respondent  
283 ages, gender and marital status were similar across groups and survey periods (Supporting

284 Information). Number of respondents per survey-day ranged from one to 31 in 2017  
285 (mean=15.0) and two to 34 in 2019 (mean=12.8). Lower limits reflect village sizes. The  
286 questionnaire took an average of 9.5 minutes to administer (n=975, SD=3.8).

287

### 288 **Prevalence of hunting, wildmeat trading and mining**

289

290 The proportion of households reporting hunting via direct questions did not change from 2017  
291 to 2019 in the non-project group (Fig. 2), increased slightly in group 1 and decreased in group 2.  
292 Across all groups hunting was reported by 39%[35-44%, 95%CI] of households in 2017, and  
293 38%[34-42%] in 2019. Trading prevalence was lower in 2019 than 2017 in all groups, decreasing  
294 from 36%[31-40%] of all households in 2017 to 20%[17-24%] in 2019. Mining prevalence  
295 changed little overall excepting an increase in group 1, from 23%[17-28%] to 31%[24-38%].

296

297 Responses from the bean method indicated similar prevalence and patterns as direct questions  
298 (Fig. 2). Differences between the methods were inconsistent, varying across groups and years.

299 For instance, in 2017 hunting prevalence appeared lower with the bean method than direct  
300 questions in group 1 but not group 2, whereas in 2019 estimates were similar or lower for all  
301 groups. Methods produced similar mining estimates, excepting group 2 which showed higher  
302 bean method estimates in 2017, then lower in 2019. Frequency of the bean type added to  
303 check question comprehension stayed constant for all survey-days, indicating it was not  
304 erroneously selected by respondents.

305

306 **Frequency of hunting and wildmeat selling**

307

308 Mean days spent hunting during the previous week decreased in group 2 from 1.03[0.73-1.33  
309 95%CI] in 2017 to 0.54[0.36-0.71] in 2019, but changed little in other groups (Fig. 3). Proportion  
310 of households that hunted in the previous week followed the same pattern (Supporting  
311 Information). Among households that hunted in the previous week, mean days spent hunting  
312 decreased slightly across all groups, from 2.79[2.54-3.04] in 2017 to 2.34[2.13-2.54] in 2019  
313 (Supporting Information). Mean carcasses sold per household decreased in all groups from  
314 1.63[1.25-2.01] to 0.76[0.59-0.93], with the greatest change seen in group 2 (Fig. 3). The  
315 proportion of households selling wildmeat in the previous week decreased only in group 2  
316 (from 37%[29-45%] to 17%[11-22%]; Supporting Information). Among households selling  
317 wildmeat in the previous week, average number of carcasses sold was higher in 2017  
318 (5.73[5.02-6.45]) than 2019 (3.13[2.78-3.48]) with the largest difference in group 2 (Supporting  
319 Information).

320

321 Reported hunting and meat-selling frequency was similar for the modified bean method as  
322 direct questions, and differences between methods were inconsistent across survey groups and  
323 years (Fig. 3). This was also the case for the proportion of households that had hunted or sold  
324 meat in the previous week, and average frequencies per household that had hunted or traded  
325 (Supporting Information).

326

327 **Inconsistency between answers to direct questions and the bean method**

328

329 A small percentage of respondents gave inconsistent answers to the same question asked  
330 directly or with the bean method (2 to 6%; Table 1). Inconsistency occurred in both directions,  
331 was similar across questions and slightly higher in 2019 than 2017 for all questions. The highest  
332 proportion of inconsistent answers was 12% (group 2, 2017; Table 1). Responses to questions  
333 about the number of days' hunting and carcasses sold in the previous week showed slight  
334 inconsistency that followed the same pattern as yes-no questions (Supporting Information).  
335 Survey-day differences ranged from 0 to 1.25 hunting days/respondent (2017  
336 mean= $0.08 \pm 0.16SD$ , n=32 survey-days; 2019 mean= $0.07 \pm 0.23SD$ , n=41 survey-days) and 0 to  
337 3.80 carcasses/respondent (2017 mean= $0.23 \pm 0.72SD$ , 2019 mean= $0.03 \pm 0.12SD$ ).

338 DISCUSSION

339

340 This study explored the potential of the bean method as a tool to measure sensitive behaviour.  
341 Results showed no consistent difference between answers given anonymously through the  
342 bean method or directly, either before or after conservation interventions. This suggested that  
343 sensitivity of hunting and trading behaviour remained low, or that under-reporting was similar  
344 across both methods. Both methods indicated a decrease in wildmeat trading across all  
345 households, while hunting changed little overall. As with any approach, accuracy of either  
346 direct questions or the bean method remains unknown and both face several sources of  
347 measurement error. However, our findings highlight useful properties of the bean method: it  
348 was low-cost, quick and straightforward to implement, appropriate for low-literacy populations,  
349 materials could be locally sourced, and raw results could be immediately interpreted without  
350 statistical manipulation.

351

352 Bean method results agreed closely with those from direct questions, for all groups and survey  
353 periods. This could indicate that mistrust and associated under-reporting remained undetected,  
354 or alternatively, that questions were not sensitive. We believe the latter is likely for several  
355 reasons. First, previous work found hunters and traders freely discussed their activities despite  
356 having experienced wildmeat confiscation (Jones et al., 2019). Second, motivation to under-  
357 report behaviour might have remained low: the conservation project did not implement  
358 penalties and questions applied to all household members, not individuals, minimising personal  
359 risks. Finally, interviewers were local citizens, potentially reducing respondents' suspicion or

360 promoting perceptions that falsehoods would be detected (Weinreb, 2006). Given this  
361 apparently low sensitivity of behaviours in our study, a question remains whether the bean  
362 method promotes truthful reporting of sensitive topics. Previous results suggest it can be  
363 effective in some cases: Lau *et al.* (2011) found reporting of risky sexual behaviours increased  
364 with the bean method in four out of five surveys, relative to direct questions, while Cerri *et al.*  
365 (2017) found higher reporting for two out of four illegal fishing activities. Neither study found  
366 reporting to be lower with the bean method.

367  
368 Application of more than one questioning format can generate insight into data quality  
369 (Anglewicz *et al.*, 2013), and the bean method was useful in this regard. Responses were largely  
370 consistent between methods and misreporting showed no systematic patterns, suggesting  
371 inconsistent answers represented background measurement error which may be unrelated to  
372 question sensitivity and could affect either method. Self-reported information can be  
373 influenced by factors such as contextual cues which alter how questions are interpreted, the  
374 cognitive process of recalling information, interviewer-respondent dynamics, the previous  
375 exposure of respondents to surveys and interviewer experience (Burton and Blair, 1991;  
376 Schwarz, 2007; West and Blom, 2017). In our study, direct questions were situated within a list  
377 of livelihood activities while bean method questions were not, potentially influencing question  
378 interpretation. The process of counting beans could positively affect accuracy of answers to  
379 frequency questions. For example, the visual prompt may reduce recall error (Burton and Blair,  
380 1991) or people's tendency to round answers to values ending in zero or five (Vaske *et al.*,  
381 2006). More respondents gave consistent answers in the second survey than the first, and the

382 same households were targeted in each survey round. This is consistent with findings that  
383 response reliability is highest where respondents have previously participated in surveys, and  
384 among interviewers with previous survey experience (Wolter and Preisendörfer, 2013).

385  
386 The bean method could be a useful addition to the range of specialised questioning techniques  
387 used in conservation. Other straightforward approaches, such as the ballot box method, can be  
388 unsuitable in low-literacy settings (Bova et al., 2018), or may require extensive pre-testing, as  
389 for the unmatched count technique (Hinsley et al., 2019). Complex approaches, such as the  
390 randomised response technique, can be time-consuming for interviewers and respondents to  
391 comprehend (Davis et al., 2019), and can create suspicion among respondents (Bova et al.,  
392 2018), whereas we found the bean method was well-received, quick to administer and  
393 interviewers required little additional training. Unlike probability-based approaches, bean  
394 method results can be immediately interpreted which is useful for community-based  
395 management (Turreira-García et al., 2018). Relative to the unmatched count technique or the  
396 randomised response technique, the bean method may be better suited for small sample sizes  
397 or behaviours with low prevalence (Hinsley et al., 2019; Lensvelt-Mulders et al., 2005).  
398 However, unlike these approaches the bean method cannot be used to explore individual-scale  
399 drivers. Additionally, respondent error or counting mistakes have not been evaluated, but these  
400 could inflate estimates of low-prevalence behaviours.

401  
402 Limitations of the bean method include that only a restricted number of questions can be asked  
403 and only group-level estimates are generated. We found that answers of more than two

404 categories can be accommodated but the range of values is constrained since counting large  
405 numbers of beans could become conspicuous and demanding. There also remains the  
406 technically challenging issue of estimating confidence intervals for frequency questions.  
407 Importantly, care is needed to ensure respondents are fully protected (St.John et al., 2016). For  
408 instance, a small village in our study had only one respondent whose answer was identifiable.  
409 Similarly, if all individuals in a survey-day give identical responses then answers are not  
410 anonymous. Ensuring a minimum sample size is reached before beans are counted, and  
411 avoiding generating village-level results, would help address respondent protection issues.  
412 Further work could be usefully directed at quantifying sources of error, improving methods for  
413 estimating uncertainty and assessing how details of survey administration affect results. For  
414 instance, having given a direct answer, respondents may give the same answer with the bean  
415 method in order to maintain consistency, whether or not it was truthful. When we asked  
416 respondents with only one method (either directly of the bean method), behaviour was  
417 reported at similar levels (Supporting Information), but larger sample sizes are needed to verify  
418 this pattern.

419

420 Our study did not aim to assess effectiveness of hunting-reduction efforts. However, insights  
421 from the results are worth highlighting, as both methods indicated wildmeat trading decreased  
422 across project and non-project households. Reports of local residents suggested law  
423 enforcement at a roadblock prompted some traders to abandon their activities. Jones et al.,  
424 (2019a) found a high proportion of traders from project and non-project villages relied on  
425 transporting meat through this roadblock, and cited meat confiscation as a motive for reducing

426 trading activities. Hunters, meanwhile, faced lower financial losses from confiscations and often  
427 sold meat to non-local traders who utilised alternative transport routes (Jones et al., 2019),  
428 possibly explaining why hunting showed little decrease. Notably, villages closest to the  
429 roadblock reported larger declines in both trading and hunting. Bean method results were  
430 useful as additional information to help managers assess the likelihood that these trends were  
431 genuine rather than being due to under-reporting (A. Gardner, *pers. comm*).

432

433 Our case-study illustrates that the bean method is a practical tool which could be valuable for  
434 measuring conservation behaviours. Although questions in our study were not apparently  
435 sensitive, the method provided useful insight into response reliability by revealing consistency  
436 of answers under alternative questioning modes, and helped managers to interpret survey  
437 results. More work is needed to evaluate its performance for measuring sensitive topics.  
438 However, the bean method has practical advantages of being low-cost and straightforward to  
439 implement and we consider there is scope to adapt and extend the method to a wide variety of  
440 contexts.

441

#### 442 Supporting Information

443 Background information about the study site and GolaMA project (Appendix S1), socio-  
444 demographic descriptions of households (Appendix S2), comparisons between responses to  
445 frequency questions given using the modified bean method and direct questions (Appendix S3),  
446 results of frequency questions (Appendix S4), results from separate administration of the bean

447 method and direct questions (Appendix S5) and the survey questionnaire (Appendix S6) are  
448 available online.

449

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546

547 TABLES

548 Table 1. Consistency of answers to yes-no questions when respondents were asked directly and  
 549 through the bean method: the percentage of consistent responses (Same answers); the  
 550 percentage of people reporting 'yes' when asked directly but 'no' to the bean method (Direct  
 551 question high); and the percentage of people reporting 'no' when asked directly and 'yes' to the  
 552 bean method (Bean method high).

	Group 1		Group 2		Non-project group		All groups	
	2017	2019	2017	2019	2017	2019	2017	2019
n households	201	181	136	168	143	175	480	524
<b>Hunting</b>								
Same answers	94%	96%	92%	96%	97%	99%	94%	97%
Bean method high	1%	1%	4%	2%	0%	1%	2%	1%
Direct question high	5%	3%	4%	2%	3%	1%	4%	2%
<b>Trading</b>								
Same answers	97%	98%	88%	98%	91%	97%	92%	98%
Bean method high	0%	1%	8%	0%	6%	1%	4%	1%
Direct question high	3%	1%	4%	2%	3%	2%	4%	1%
<b>Mining</b>								
Same answers	98%	98%	95%	95%	96%	99%	96%	98%
Bean method high	1%	1%	4%	1%	1%	0%	2%	0%
Direct question high	1%	1%	1%	4%	3%	1%	2%	2%

553

554 FIGURE LEGENDS

555 Figure 1. Locally sourced materials used to administer the bean method. 1.A. bean types used  
556 to indicate answers: a = no to any question, b = yes to question 1, c does not indicate any  
557 answer and is included to check for errors in how well instructions are followed, d = yes to  
558 question 2, e = yes to question 3. 1.B. Answer container (left) and selection container (right).  
559 Respondents selected their answer from a mixture of beans inside a plastic bag in the selection  
560 container. The bag provided additional privacy from onlookers. 1.C. Appearance inside an  
561 answer container with a mixture of four bean types.

562

563 Figure 2. Prevalence of hunting, trading and small-scale mining across households at the start of  
564 a conservation project (squares, n=480) and after two years implementation (triangles, n=524).  
565 Values were obtained from the bean method (dashed lines) and direct questions (solid lines),  
566 from a complete census of two groups that participated in the project (group 1: red, 9 villages,  
567 n<sub>2017</sub>=201, n<sub>2019</sub>=181; group 2: green, 6 villages, n<sub>2017</sub>=136, n<sub>2019</sub>=168) and a non-project group  
568 where conservation activities did not take place (blue, 3 villages, n<sub>2017</sub>=143, n<sub>2019</sub>=175). 95%  
569 confidence intervals are shown.

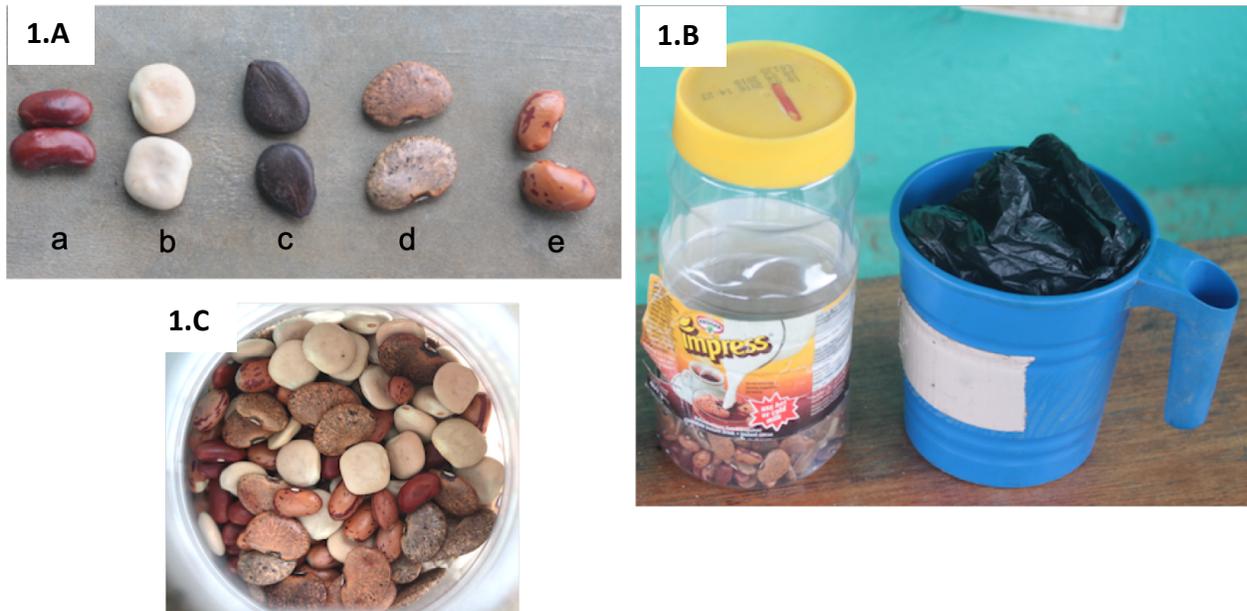
570

571  
572 Figure 3. Frequency of hunting and sale of wildmeat carcasses across households at the start of  
573 a conservation project (squares, n=480) and after two years implementation (triangles, n=524).  
574 Values were obtained from direct questions (solid lines) and the modified bean method  
575 (dashed lines), from a complete census of two groups that participated in the project (group 1  
576 red, 9 villages, n<sub>2017</sub>=201, n<sub>2019</sub>=181; group 2 green, 6 villages, n<sub>2017</sub>=136, n<sub>2019</sub>=168) and a non-  
577 project group where conservation activities did not take place (blue, 3 villages, n<sub>2017</sub>=143,  
578 n<sub>2019</sub>=175). Values for carcasses sold are capped at ten per respondent for both methods. Bars  
579 indicate 95% confidence intervals, approximated for the bean method as 1.96 \* standard error  
580 of mean per household values from each survey-day.

581

582 FIGURES WITH LEGENDS

583



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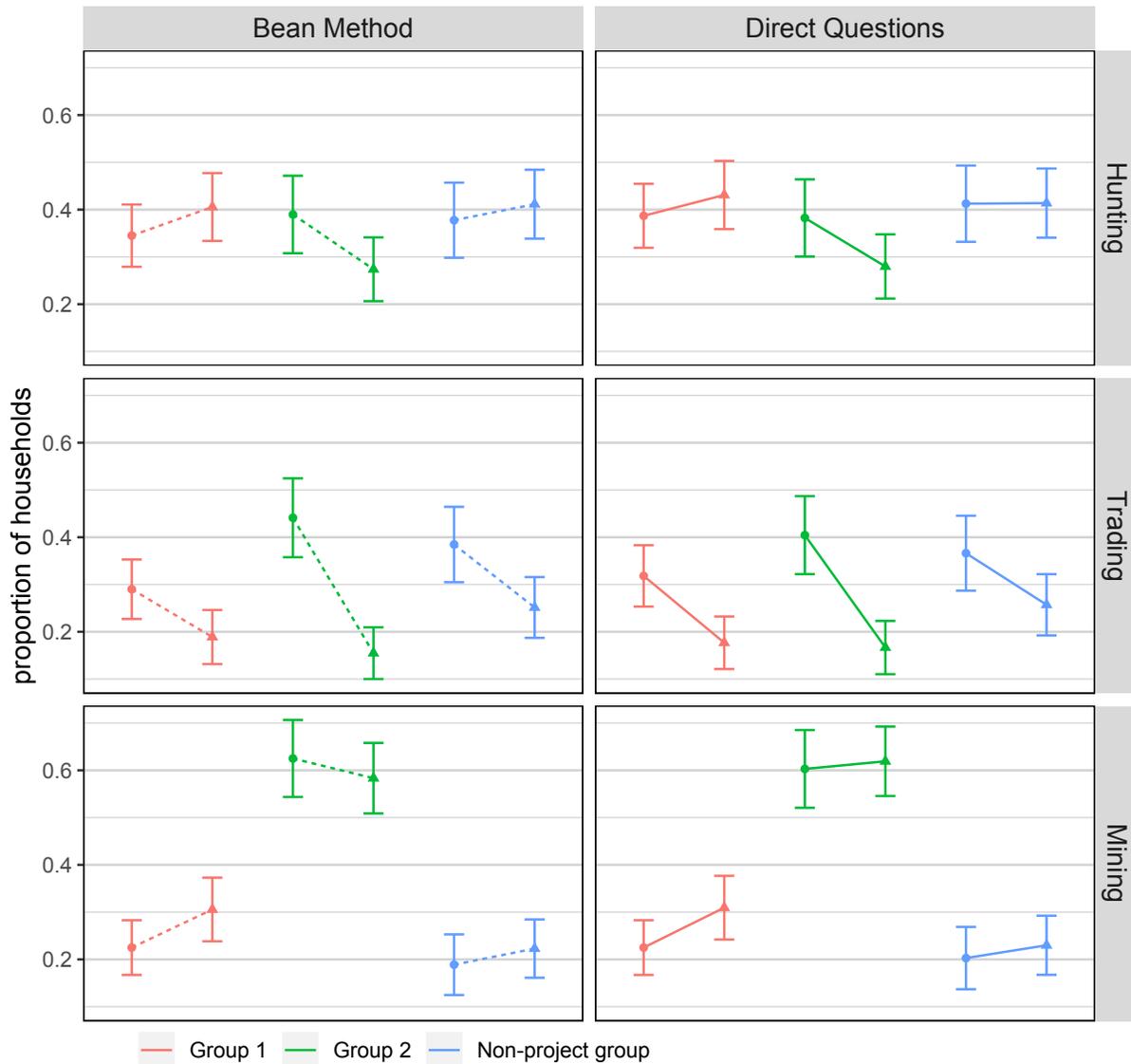
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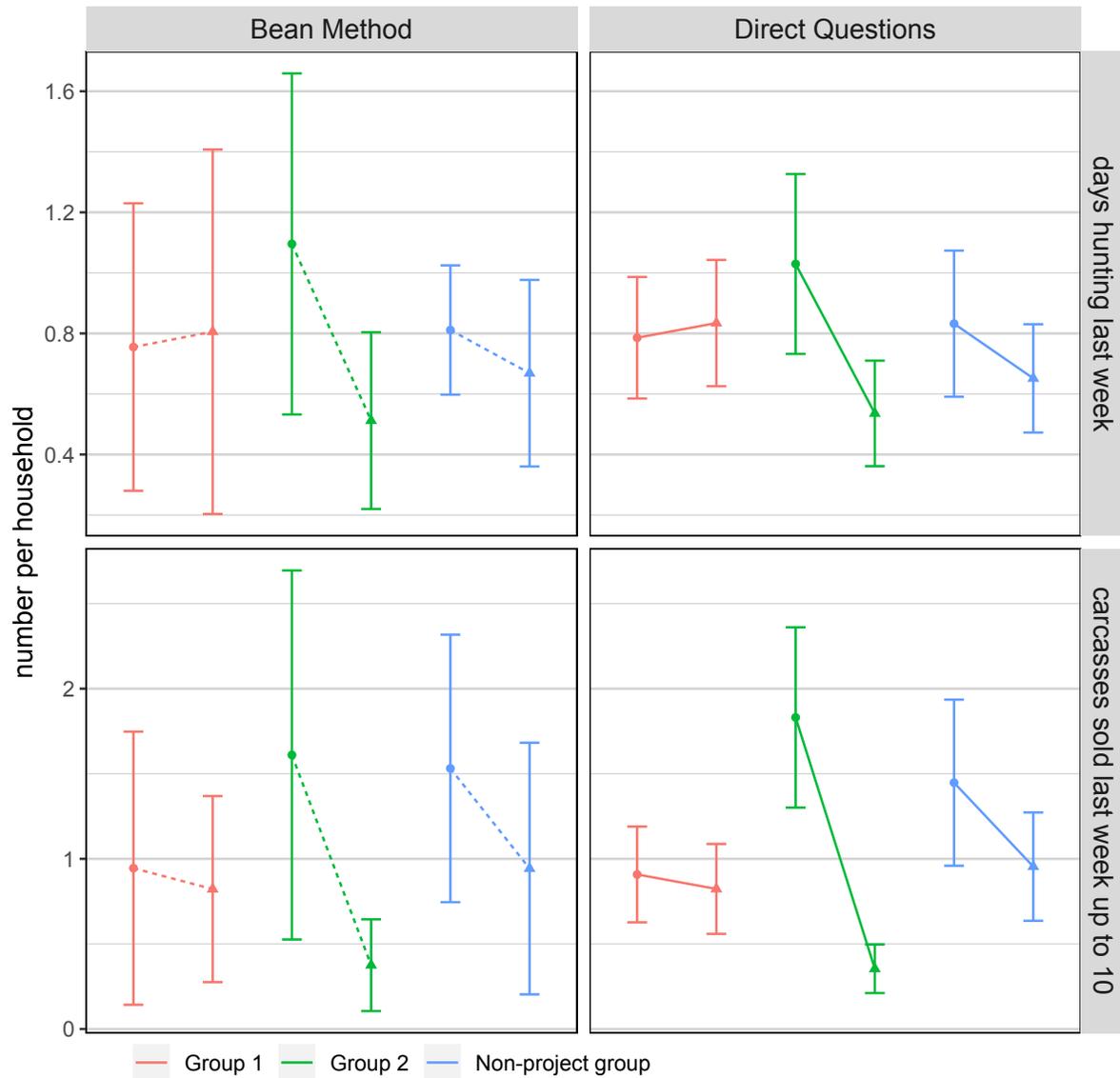
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