

1
2 **Conservation education promotes positive short- and medium-term**
3 **changes in perceptions and attitudes towards a threatened primate**
4 **species**

5
6 Galicia Fernanda Bernárdez-Rodríguez¹, Mark Bowler^{2,3,4}, Franciany Braga-
7 Pereira^{5, 6, 7}, Maxine McNaughton², and Pedro Mayor^{1,8,9,10*}

8
9 ¹Departament de Sanitat i Anatomia Animals, Universitat Autònoma de
10 Barcelona, Bellaterra, Spain;

11 ²School of Engineering, Science, Arts and Technology, University of Suffolk,
12 Waterfront Building, Neptune Quay, Ipswich, UK;

13 ³Suffolk Sustainability Institute, Waterfront Building, Neptune Quay, Ipswich, UK

14 ⁴Institute for Conservation Research, San Diego Zoo Global, Escondido,
15 California, USA;

16 ⁵Department of Ecology and Systematics, Universidade Federal da Paraíba,
17 João Pessoa, Paraíba, Brazil;

18 ⁶Rede de Pesquisa para Estudos sobre Diversidade, Conservação e Uso da
19 Fauna na Amazônia (RedeFauna), Manaus, Amazonas, Brasil;

20 ⁷Instituto Juruá, Manaus, Amazonas, Brazil;

21 ⁸ComFauna, Comunidad de Manejo de Fauna Silvestre en la Amazonía y en
22 Latinoamérica, Iquitos, Peru;

23 ⁹Museo de Culturas Indígenas Amazónicas, Iquitos, Loreto, Peru;

24 ¹⁰Programa de Pós-Graduação em Saúde e Produção Animal na Amazônia,
25 Universidade Federal Rural da Amazônia, Belém, Pará, Brazil.

26
27 *Corresponding author

28 ✉Email addresses: PM (mayorpedro@hotmail.com);
29 pedrogines.mayor@uab.es)

30
31

32

33 **Conservation education promotes positive short- and medium-term**
34 **changes in perceptions and attitudes towards a threatened primate**
35 **species**

36
37 **Significance Statement:**

38 Although education programmes are a fundamental component of supporting
39 wildlife conservation, their effectiveness is often poorly documented. Fewer still
40 have done so in remote areas where conservation interventions are temporally
41 shorter and less common. Through an educational program we communicated
42 to local inhabitants of a remote area of the Peruvian Amazon that their
43 territories are considered globally important for the uakari, a difficult perception
44 to acquire from a local perspective. So, we evaluated the effectiveness of a
45 community education program for the conservation of the red uakari (*Cacajao*
46 *calvus*), and so inspired local people to become protectors of this endangered
47 species We found that relatively short education programs can have a positive
48 effect on conservation. However, encouraging positive perceptions and
49 attitudes towards a species may be a slow process and, thus, conservation
50 education programs may need continuity in the longer term to achieve lasting
51 positive conservation outcomes

52
53
54 **Abstract**

55 Many wildlife conservation projects aim to change the perceptions of local
56 communities through conservation education programs. However, few
57 assess whether and how these programs effectively promote shifts in
58 community perceptions and attitudes towards wildlife conservation. We
59 designed an educational program focused on communicating to local
60 inhabitants from a remote community in the Peruvian Amazon that their
61 territories are considered globally important for the red uakari (*Cacajao*
62 *calvus*), and inspire them to become protectors and defenders of this
63 endangered species. We aimed to evaluate changes in perceptions and
64 attitudes towards the red uakari monkey after a conservation education
65 workshop. We found that positive attitudes and perceptions towards the
66 red uakari (such as uakari hunting suspension and perception of uakari
67 importance) increased immediately after and in the short-term (two years)
68 following the workshop but diminished in the medium-term (three years).
69 However, attitudes remained better than before the workshop. Our results
70 indicate that conservation education programs are useful in encouraging
71 positive attitudes towards wildlife conservation in the short term, but
72 ongoing environmental education activities may be necessary to have
73 lasting positive effects.

74
75 **Keywords:** *Cacajao calvus*; Conservation; Education Workshop;
76 Perceptions Changes; Red Uakari

77 **Introduction**

78 Wildlife conservation often hinges on local human populations' attitudes and
79 actions (Kellert et al., 1996), and conservation programs usually aim to raise
80 local people's awareness and interest in the sustainable use and conservation
81 of target species (Lee and Priston 2005; Remis and Hardin 2009). Education
82 programs are frequently used to build local capacity, empower communities and
83 develop successful conservation initiatives. While some projects have a long-
84 term presence, use a highly engaging participatory approach (Aguilar 2018) and
85 include longer-term assessments (Horwich and Lyon 2007; Liddicoat and
86 Krasny 2013; Savage et al. 2010), many more are short-term projects funded by
87 small grants or are ephemeral components of ecological research projects.
88 These conservation education programs frequently have a relatively simple 'top-
89 down' pedagogical approach designed around the ease of administration, and
90 they are often delivered by biologists rather than trained educators. Although
91 awareness campaigns and education programmes be a fundamental
92 component of supporting wildlife conservation they are very rarely assessed
93 and their longer term utility remains unclear (Bride 2006). As few examples of
94 evaluation of education programmes focused on primates we could cite the
95 Cotton-top Tamarin (*Tamarin oedipus*) in Colombia (Savage et al. 2010) and
96 the Howler monkey (*Alouatta pigra*) in Belize (Horwich and Lyon 2007); and of
97 research evaluating conservation education and community-based conservation
98 more broadly (Ardoin 2006; Heimlich 2010). These programs incorporated
99 interviews with local people about species at risk, environmental awareness,
100 and research with short and long-term objectives, and involved the participation
101 of the private and governmental sectors. These actions have increased target
102 species populations and improved the life quality of the communities involved
103 (Horwich and Lyon 2007; Savage et al. 2010). However, despite the widespread
104 use of education programs in raising interest in wildlife conservation in rural
105 areas, the few studies describing their effectiveness on local perceptions and
106 conservation (Freund et al. 2020; Horwich and Lyon 2007) limits the
107 understanding of its need, and even its dissemination to inspire other
108 researchers to do the same. Moreover, fewer still have done so in very remote
109 areas where conservation interventions are less common.

110 In this study, we seek to address this gap by evaluating in the short and
111 medium-term the effectiveness of a community education program for the
112 conservation of the red uakari (*Cacajao calvus ucayalii*) in a remote part of
113 Peru. The red uakari is listed as Vulnerable by the IUCN, with populations that
114 declined at least 30% over the past 30 years. This decline was primarily due to
115 hunting and habitat loss, which reduced red uakaris to very patchily distributed
116 populations (Bowler et al. 2009; Veiga et al. 2008).

117 Our study took place in the Yavari Mirin basin, characterized by relatively
118 large populations of red uakari, persistent in part due to the area's remoteness
119 from urban centers and the presence of malaria in the area (Bowler et al. 2013).
120 However, in 2004, the Peruvian government designated forest concessions
121 over the area, subcontracting people from local communities to extract timber
122 (Mayor et al. 2015). Despite concerns about the impact of land-use change and
123 hunting on uakari populations due the forest concessions, subsequent surveys
124 found no evidence of declining primate populations on the Yavari Mirin (Mayor
125 et al. 2015). However, the decline in populations of this species in other areas

126 with logging operations urged precautionary measures to maintain their
127 populations (Bowler et al. 2009). Thus, engagement programs were prescribed
128 by our research group to better understand and change perceptions and
129 attitudes which could threaten local populations of primates.

130 Intending to minimize the effects of wild meat hunting on uakari
131 populations and increase the perception of importance of this species, we
132 provided a conservation education program tailored towards local people in
133 proximity to uakari populations. As part of this initiative, we evaluated the short
134 and medium-term changes in residents' perceptions and attitudes towards the
135 uakari as a result of participating in this education program, using interviews
136 conducted before and after the workshops.

137

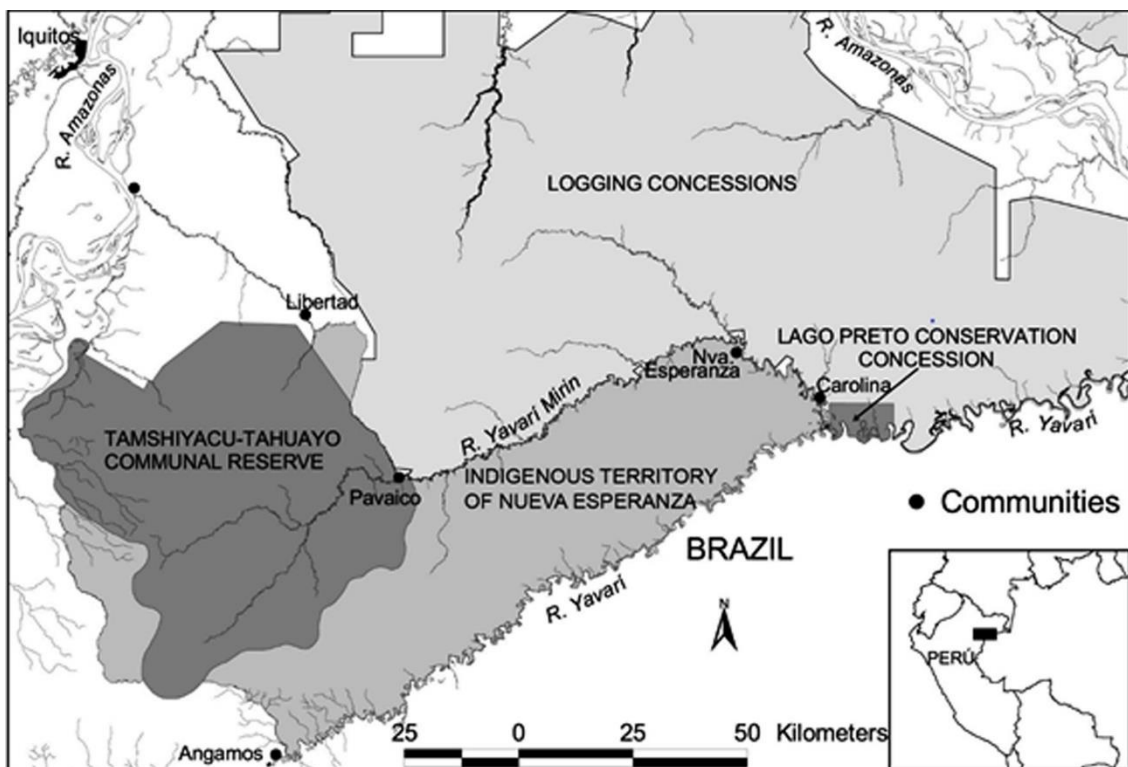
138 **Materials and methods**

139 *Study area*

140 The study area covers 107,000 ha of continuous, predominantly upland forests
141 along the Yavari-Mirin River in the north-eastern Peruvian Amazon (Figure 1).
142 There is only one community within the study area, the Yagua community of
143 Nueva Esperanza, with 329 inhabitants (159 men and 170 women) in 2015.

144

145 **Figure 1.** Map of the Community of Nueva Esperanza, Lago Preto
146 Conservation Concession, and logging concessions on the Yavari and Yavari-
147 Mirin Rivers with other critical areas for the conservation of red uakari.
148



149

150 The Yagua people are distributed in a very dispersed way between the
151 Amazon rivers and tributaries in the Peruvian Amazon. At the beginning of the
152 20th century, the Yagua were forced to labor during the rubber exploitation
153 period. As a result, some groups migrated to other areas, extending their

154 territory to the Yavarí River. In the 1950's, one mixed group of Yagua and non-
155 Indigenous families founded the community of Esperanza, working mainly on
156 the extraction of wild rubber (*Hevea brasiliensis*), the sale of wild animal skins,
157 and the extraction of cedar (*Cedrela odorata*) timber and rosewood (*Aniba*
158 *rosaeodora*) for its fragrant oils. In the 90's, the local residents of the community
159 declined, and those remaining there lived primarily through subsistence
160 activities. In 2004, a logging concession system in the region was approved,
161 and foreign workers arrived, so the community grew demographically from 163
162 inhabitants to 329 inhabitants in 2015. Thus, as of 2015, the community was of
163 mixed origin (42% Yagua and 58% non-Indigenous). Nueva Esperanza is
164 officially designated as a Yagua indigenous community by the Peruvian
165 government because many community members identify as this ethnicity.
166 However, Spanish is the first language of all community members, and few
167 uniquely Yagua traditions are maintained.

168 The villagers currently live through subsistence activities but trade
169 timber, fish, wild meat, and agricultural products opportunistically. Accessibility
170 to urban areas is difficult but has increased with more frequent logging traffic,
171 facilitating the introduction of urban customs that require monetary income,
172 such as electrical appliances. Thus, activities with an economic return, such as
173 timber extraction, are attractive.

174 175 *Conservation education program*

176 We carried out two structured conservation education workshops in April and
177 August 2014 with the voluntary participation of local villagers. The workshops
178 were conducted by hired specialists from the education sector in Iquitos, the
179 main city in the Peruvian Amazon. These educators were previously trained in
180 the local socio-cultural and ecological context. Workshop participants were
181 recruited through announcements at community meetings and over the local
182 public address system used regularly and openly by the villagers. The
183 workshops included a one-hour presentation and a translated (overdubbed from
184 English into Spanish) version of the film: "Uakari: Secrets of the English
185 Monkey" (BBC Natural World 2009). This documentary is focused on the red
186 uakari and conservation issues related to natural resources, and featured the
187 community of Esperanza, presenting them as guardians of the red uakari
188 monkey and their habitat. This film appeared in 2009 on; *The Natural World*,
189 BBC, UK; *Mutual of Omaha's Wild Kingdom*, Animal Planet, USA; *The Nature of*
190 *Things*, CBC, Canada. Before showing the video, our team delivered an
191 introductory presentation, discussing how community members were involved in
192 the film and how the film had been featured on an international platform. Other
193 sections of the workshops were particularly focused on characterizing the main
194 traits of the red uakari, its habitat, distribution, the importance of conservation of
195 primates, and the species' vulnerability to hunting. The workshops were
196 presented in Spanish.

197 The focus group of our study was inhabitants from >16 years old,
198 corresponding to 168 people (proportional to 51% of the community's total
199 population, henceforth known as 'focus group', Suppl. Table 1). From now on,
200 percentages are related to the focus group, or when necessary, to the people
201 interviewed. Sixty adults (36% of the total focus group) participated in one or
202 more activities during the workshop, including 48 men (52% of focus men) and

203 12 women (16% of focus women). Although the invitation to participate in the
204 workshops was extended to the entire community, women attended in a lower
205 proportion than men, possibly due to their daily activities, including childcare.
206 Not enough resources were available to provide childcare, but it was permitted
207 for children to attend with their families so that women could attend the
208 workshops.

209

210 *Interview Protocol*

211 Semi-structured interviews were conducted to evaluate changes in hunting,
212 perceptions, and attitude towards the red uakari following the workshops. In
213 2013, prior to the workshops, we conducted a control interview ($N=43$, 26% of
214 the total focus group). This was followed by interviews immediately after the
215 workshops in 2014 ($N=52$, 31%), 2015 ($N=47$, 28%), and three years later in
216 2017 ($N=32$, 19%) (Table 1). Interviewees were selected randomly by
217 approaching people in the community to assess overall changes in the
218 community. A total of 174 interviews were conducted to 124 people, of which 86
219 (69.3%) were interviewed once, 26 (21.0%) twice, and 12 (9.6%) participated in
220 three or four interviews.

221 From the control interview in 2013, surveys conducted in 2014, 2015,
222 and 2017 explained the educational program's immediate, short- and medium-
223 term effect, respectively. We considered the pool of responses each year as
224 representative of perceptions in the community in that year. Thus, data are
225 compared between years. The number of interviewees each year changed due
226 to the varying availability of community members caused by the period of year
227 in which interviews were conducted. For example, interviews in the years 2013,
228 2014, and 2015 were conducted in July-August. In contrast, the interview in
229 2017 took place in January-February, when logging activities are conducted
230 outside the community for three or four months. This fact explains the lower
231 participation in 2017.

232 **Table 1.** Timeline of the study, including the workshop and the questionnaires conducted in the community of Nueva Esperanza in
 233 the Yavari Mirin basin, Peru.
 234

Timeline	Responses	2009	2013	2014	2014	2015	2017
		Before workshop		Time 0	Immediate effect	Short effect	Medium effect
Number of interviews (% related to the focus group)		68 (40.5%)	43 (25.6%)			52 (30.9%)	47 (28.0%)
Diagnostic questionnaire				Workshop			
Do you think the uakari is in danger?	Yes/No		x				
Do you know that the largest uakari populations in the world are found in the Yavari Mirin basin?	Yes/No		x				
Workshop							
Main questionnaire							
Do you consider the red uakari important?	Yes/No		x		x	x	x
Why do you/don't you consider the red uakari important? ¹	Semi-structured question		x		x	x	x
Do you or any of your relatives hunt the red uakari?	Yes/No		x		x	x	x
When was the last uakari you, or your family members, hunted?	Structured question		x		x	x	x
What benefits could the conservation of conserving the species provide to the local community? ²	Semi-structured question						x
Complementary questionnaire							

Which activities the interviewee prefer to carry out and which ones they generally conduct as sources of income ³	Semi-structured question	x	x	[REDACTED]	x	x
--	--------------------------	---	---	------------	---	---

235
236

237

238 Interviews were carried out by individuals unknown to the local
239 population to reduce social desirability bias. Interviewers were biologists from
240 the city of Iquitos and were external to the research group. In each year, a
241 different interviewer was hired to conduct the interviews. Having interviews
242 administered by people outside the community and not related to the project
243 aimed to allow the interviewees to feel more comfortable giving their opinion
244 without feeling that they were being judged and reduce any perception that
245 responses should be consistent.

246 Participants were made comfortable with our interview process by
247 informing them of the study aims before the interview. Respondents were free
248 to participate in the study or leave it at any time and were informed that we
249 would not disclose their identity. The research protocol was approved by the
250 Research Ethics Committee at the Dirección General de Flora y Fauna Silvestre
251 of Peru (0350-2012-DGFFS-DGEFFS), and we followed the Guidelines for
252 'Applying Free, Prior and Informed Consent' in Buppert and McKeehan (2013).
253

254 The applied questionnaire included sex and age information, diagnostic
255 questions, and the main questionnaire (Table 1). Diagnostic questions were
256 only conducted in 2013 to understand local perception towards de uakari.

257 The main questionnaire measured changes in local perceptions
258 produced by the conservation education program. These questions were
259 conducted before and after the workshop, and included structured and semi-
260 structured questions. Herein we include specific information on semi-structured
261 questions:

262 ¹. 'Why do you/don't you consider the red uakari important?' We grouped
263 responses into four categories: "Ecological importance" included answers about
264 the ecosystem services provided by the red uakari and the importance of
265 conserving their populations. "Food" included answers about the red uakari as a
266 food item. "Personal feelings" referred to answers that indicated emotional
267 attachment, distaste, the intrinsic value of the species, or personal experiences
268 reflected in their answer. Finally, we included the category "Don't know".

269 ². In 2017 only (three years after the workshops), we asked 'What
270 benefits could the conservation of the species provide to the local community?'.
271 This question aimed to understand the perception of the benefits they obtain or
272 want to obtain from the species conservation. Responses to this semi-
273 structured question were grouped in three categories: "Ecological benefit",
274 "Economical benefit" and "No direct benefit".

275 The answers to questions "Why do you/don't you consider the red uakari
276 important?" and "What benefits could conserving the species provide to the
277 local community?" were classified in common themes following Braun and
278 Clarke (2006). Coded responses were summarized, and the frequency of each
279 concept was quantified. This method of open-ended questioning provided the
280 flexibility to explore different topics of relevance if necessary while providing
281 rapid anthropological assessments valid for wildlife monitoring.

282 ³. Some interviewed people expressed the expected economic benefits
283 of conservation activities. To better understand these expected economic
284 benefits, we asked each interviewee which activities they prefer to carry out and
285 which ones they generally conduct as sources of income. This question had

286 already been asked in 2009 for other research purposed; thus, we took
287 advantage of this information to compare results between years.

288

289 *Data Analysis*

290 We performed generalized linear models (GLMs) to examine the effects of each
291 predictor variable on responses to the questions ‘Do you considers red uakari
292 important?’ (henceforth known as ‘importance’) and ‘Do you or any of your
293 relatives hunt the red uakari?’ (henceforth known as ‘hunting’).

294 Our predictor variables comprised (i) year of the interview (2013, 2014,
295 2015, and 2017); (ii) interviewee sex; (iii) interviewee age; (iv) hunting, which
296 was used as a predictor variable only for the importance model; (v) importance,
297 which was used as a predictor variable only for the hunting model. The
298 reference category for the year variable used in both analyses was 2013
299 (control), so if 2014, 2015, or 2017 categories were significant, they were
300 significant compared to 2013. There was no collinearity ($p > 0.05$) among
301 predictor variables. We selected the complete model (all possible predictor
302 variables in the same model) if it had values of $\Delta AIC > 6$ (ΔAIC obtained when
303 the complete model was compared to a null model) (Harrison et al., 2018).

304 To verify the relation of the responses associated to the question ‘Why
305 do you/don’t you consider the red uakari important?’ with the variable
306 ‘importance’; and ‘hunting’, we used linear models. We also used a linear model
307 to test for differences in people’s answers regarding the ‘time since last hunted
308 red uakari’ in pre (2013) and post (2014 and 2017) workshop interviews. In this
309 model we only used data of people who reported hunting uakari. We selected
310 the linear models through the adjusted r^2 , F- value and the degrees of freedom.
311 All analyses were performed in R ver. 3.5.3 (R Core Team 2019) using the
312 ordinal, MuMin e lme4 packages.

313

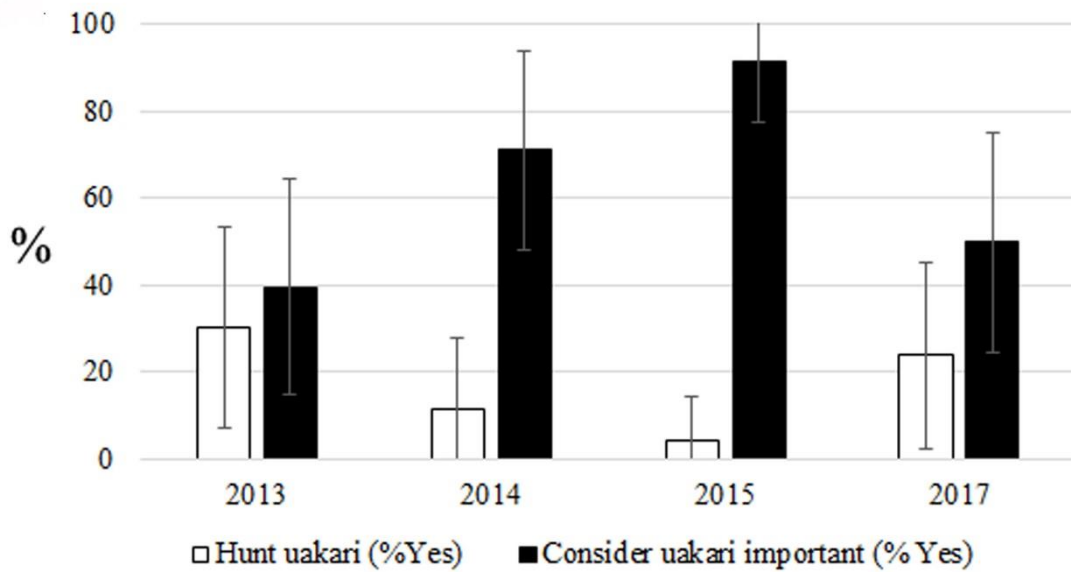
314 **Results**

315 The control interview conducted in 2013 showed that 25.5% of the local people
316 in the Yavari Mirin basin thought that the uakari was in danger, and 16.3% knew
317 that the largest uakari populations in the world are found in the Yavari Mirin
318 basin. In addition, 32.5% perceived that the uakari is important, but 60.5% could
319 not explain why, and 30.2% of families hunted the uakari.

320 When evaluating peoples’ perceptions of the importance of the red
321 uakari, we found an effect of the interview year, with an increase in interviewees
322 that considered the red uakari important in the years post workshop, 2014 ($E =$
323 1.28 ; $p = 0.00583$), 2015 ($E = 3.22$; $p = 6.14E-07$), and 2017 ($E = 1.47$; $p =$
324 0.00382), when compared to 2013 (pre workshop) (Figure 2). Significantly fewer
325 people hunted uakari in 2014 ($E = -1.25$; $p = 0.0322$) and 2015 ($E = -2.32$;
326 $p = 0.00678$) when compared to 2013, before the workshop. Although fewer
327 hunted uakaris in 2017, in this case, the difference was not statistically
328 significant ($E = -0.67$; $p = 0.25672$). The other predictor variables did not show
329 effect on the responses variables (Suppl. Table 2).

330

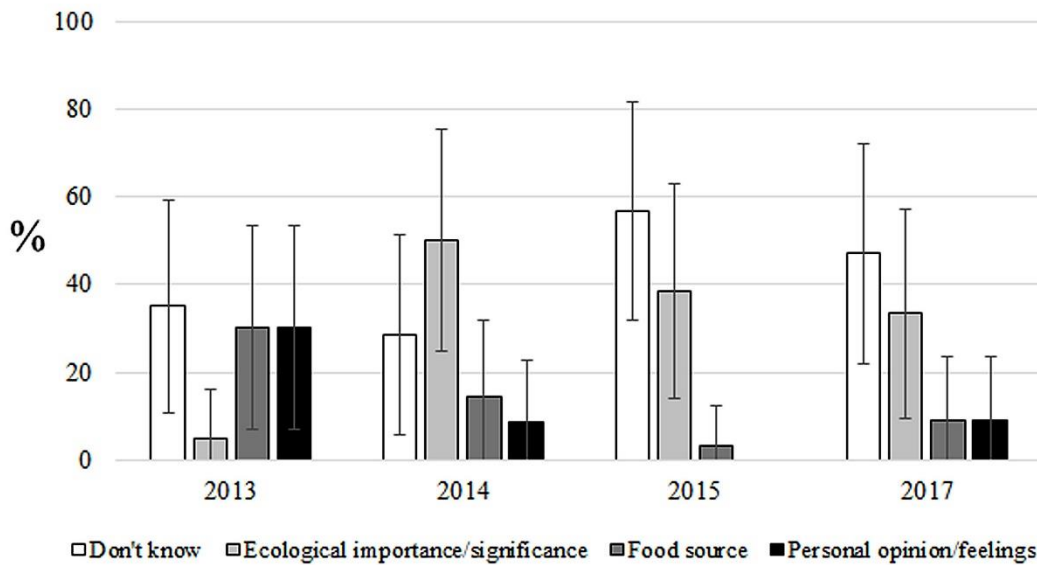
331 **Figure 2.** Percentage (and standard error) of interviewees who indicated that
332 they or someone in their family hunted red uakari and who stated that they
333 considered the red uakari important in 2013 before the educational programme,
334 immediately after the education programme in 2014 and 2015, and in 2017,
335 three years after the programme.



336
 337
 338
 339
 340
 341
 342
 343
 344
 345
 346
 347
 348
 349
 350

When analyzing the relationship of ‘importance’ and ‘hunting’ with the responses of the question ‘Why are the red uakari important?’, we found that most people that said that the red uakari is important did so most commonly because of personal feelings ($E=0.70651$; $p < 2e-16$), followed by ecology ($E=0.6908$, $p < 2e-16$), ecotourism ($E= 0.68364$; $p=6.13E-10$), and food ($E=0.56056$; $p=3.35E-06$). However, among people who hunted uakaris, the uakaris’ importance was significantly only associated with their use as a food source ($E= 0.54507$; $p=4.25E-06$) (Figure 3, Suppl. Table 3).

Figure 3. Responses (in percentage and standard error) to the open-ended question ‘Why do you/don’t you consider the red uakari important?’ asked in 2013 and 2017. Responses were grouped into four categories.



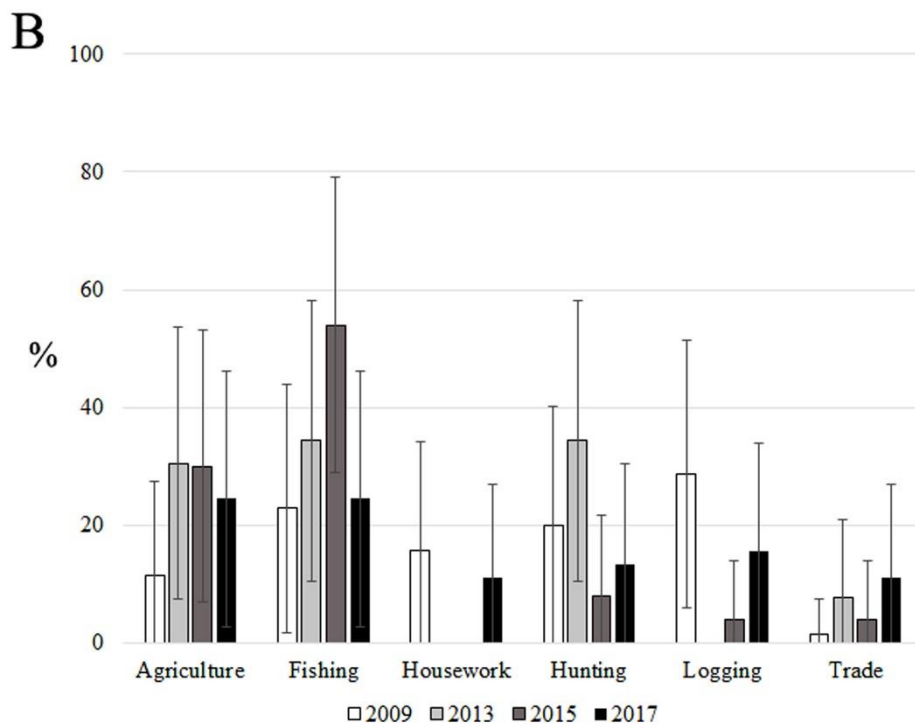
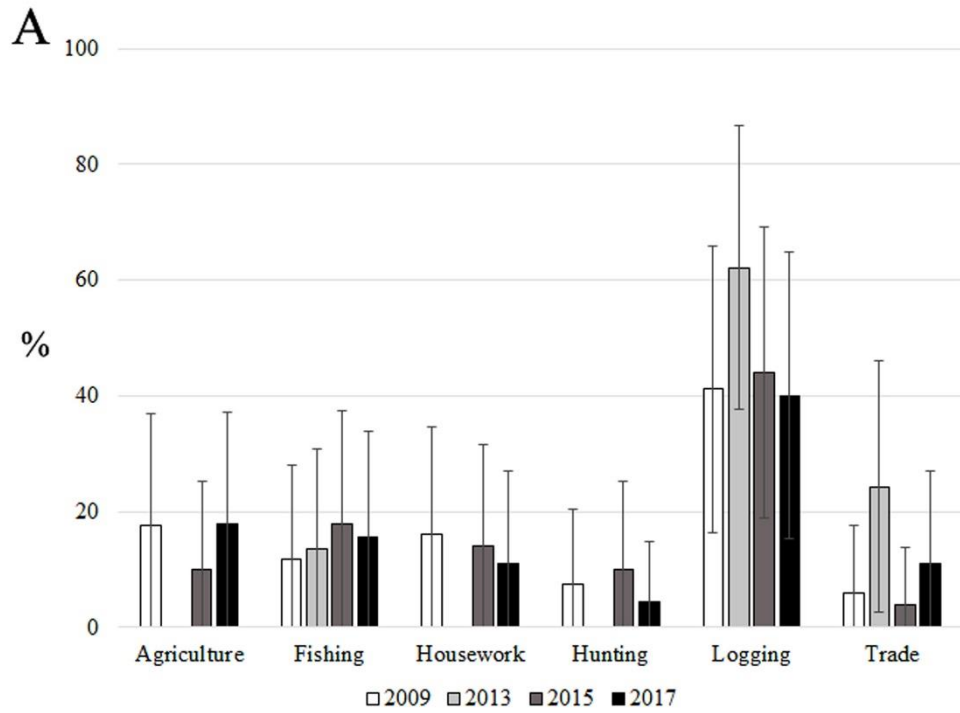
351
 352

353 We found a significant change ($E= 44.84$; $p= 0.0104$) in the time since
354 interviewees reported they last hunted red uakari between 2013 (median= 6
355 months; min=0.75, max=180) and 2014 (median=12 months; min=1, max=240).
356 The proportion of interviewees that had hunted red uakari within over one year
357 diminished from 60.5% in 2013 to 23.0% in 2014. In 2017, the time since the
358 last uakari (median= 24 months; min=0.25, max=204) was hunted was larger
359 than the previous years, and the proportion of interviewees who had hunted red
360 uakari within one year was reduced to 16.7%. During our stays in the
361 community, no uakari was observed hunted, nor was any spontaneous
362 reference to hunting the species recorded. A total of 65.6% (21/32) of
363 interviewed people did not consider the red uakari a good prey because of its
364 unpleasant taste or small size.

365 In 2017, we asked ‘What benefits could the conservation of the species
366 provide to the local community?’. A total of 69% of people interviewed perceived
367 that the program provides benefits for the environment, but only 28% said there
368 was a direct benefit to local people.

369 We evaluated changes in the activities preferred and engaged in by local
370 people to better understand the effect of income generation strategies (Figure
371 4). In 2009, timber extraction was the preferred and economically most efficient
372 activity for local people. From 2009 to 2017, although logging was still reported
373 as the most frequent economic activity (ranging from 40% to 60% of
374 responses), its preference diminished from 29% to 7% of respondents.
375 Meanwhile, traditional subsistence activities, such as agriculture, fishing and
376 hunting, were not frequently reported to generate income (overall averages of
377 11%, 15% and 5% of responses, respectively). However, preference for
378 agriculture and fishing increased considerably from 2009 onwards (from 11% to
379 28%, and from 23% to 38%, respectively), exceeding the preference for logging.
380 On the other hand, preference for hunting remained constant at 20%.

381
382 **Figure 4.** Responses (in percentage and standard error) to the open-ended
383 questions (A) ‘Activities to generate income’, and (B) ‘Activities they would
384 prefer to do as a future alternative’. This question was conducted between 2013
385 and 2017, and also previously in 2009.



386

387 **Discussion**

388 The main goal of our educational program was to communicate to local
 389 inhabitants that their territories are considered globally important for the uakari,
 390 a difficult perception to acquire from a local perspective, and to inspire them to
 391 become protectors and defenders of the species. The most abundant
 392 populations of the red uakari are found in their local area, where the species is
 393 infrequently hunted in the region because it does not provide a good return for

394 the cost of a shotgun cartridge due to its small size relative to other species,
395 such as hystricognath rodents and ungulates (Mayor et al. 2015). The
396 interviews have helped us verify that the red uakari is not under very high
397 hunting pressure in the Yavari Mirin basin despite the presence of logging
398 activity. Many local people reported they would not hunt red uakari. Yet, some
399 did occasionally hunt the species, suggesting hunting of red uakari may be
400 opportunistic and related to the short-term necessity of finding food when hunts
401 for larger prey have been unsuccessful (Puertas and Bodmer 1993). However,
402 the red uakari is a vulnerable species because their populations are highly
403 fragmented and dispersed, and their reproduction is very slow (Mayor et al.
404 2017). In addition, the species has been extirpated from several other remote
405 areas (Bowler et al. 2009), especially where logging operations have occurred.
406 Therefore, this educational program aimed to encourage the residents to
407 maintain practices that favor the conservation of the uakari.

408 The short-term nature of the conservation education program herein
409 assessed is typical of those administered by short-term research and
410 conservation projects. By measuring perceptions before and after implementing
411 a specific educational program, we were able to illustrate the ability of an
412 educational workshop to achieve short-term positive perceptions of a species.
413 However, we found mixed results on medium-term outcomes. Although the
414 educational program was largely typical of those commonly implemented in
415 rural parts of the Amazon, it included a video focused on the red uakari, filmed
416 mainly in and nearby the community, featuring various community members.
417 This video was published on an international platform – a fact that was
418 communicated to the community. The positive change in the behavior towards
419 the uakari may be related to the film providing an opportunity for the local
420 community to be seen internationally as actors in the species' conservation.
421 This external recognition may have increased community members' beliefs that
422 the species is important and that their efforts to conserve it will be valued
423 (Danielsen et al. 2018). Therefore, care must be taken in applying these results
424 to other scenarios and conservation education programs.

425 The changes in perceptions we observed were accompanied by a
426 reduction in the number of people who said they hunted red uakari monkeys. In
427 the medium term, the average period since respondents reported that they last
428 hunted uakaris increased to more than a year. This fact suggests that the
429 changes in hunting observed in the short term slightly diminished in the medium
430 term.

431 Interviewees differed between years, but the bias associated to that
432 could be controlled because the Nueva Esperanza community is small, and
433 information is shared among the inhabitants, so we believe the sample interview
434 is representative of opinions within the community. We recognize that our study
435 was focused on over 16s and had limited uptake by women. We believe it is
436 necessary to engage younger people and women in conservation programs,
437 promoting their incorporation and participation in activities that have not been
438 traditionally directed to them. However, we do think our results are broadly
439 applicable across at least adult demographics. Although there were no
440 significant differences in perception change between age groups, younger
441 adults experienced positive changes after the workshop and maintained this
442 perception in the medium-term. In addition, young adults usually are more
443 open-minded in developing new ideas than older generations (Ruiz-Mallen et al.

444 2010). In Nueva Esperanza young adults represent active stakeholders in the
445 use of natural resources, such as logging and hunting, so conservation
446 programs should aim to engage their participation.

447 We show that relatively short education programs can have a positive
448 effect on conservation. However, encouraging positive perceptions and
449 attitudes towards a species may be a slow process. Thus, conservation
450 education programs may need continuity in the longer term to achieve lasting
451 positive conservation outcomes (Ruiz-Mallen et al. 2010). The decline in
452 positive effects three years after our workshop suggests that it is reasonable to
453 expect further decline through time.

454 Our results are consistent with other conservation education programs
455 that have had an immediate positive impact that decreases over time (Hughes
456 2013), which is likely related to the short life span of the education program in
457 the community. One of the main challenges in education programs is
458 maintaining a channel of communication (Heimlich and Ardoin 2008). This fact
459 has been observed in sustained successful projects like the Cotton-top Tamarin
460 Project in Colombia (Savage et al. 2010), Colobus Spin Kenya (King and Lee
461 1987), or the Conservation Education Program carried out in Kalinzu Forest
462 Reserve, Uganda (Kuhar et al. 2010). All of them had a constant presence over
463 time and demonstrated positive long-term effects.

464 Aligning conservation objectives with the needs of local people and
465 ensuring both the preservation wild species and the development of
466 communities requires a broader approach. We found that people felt logging
467 generated higher incomes when compared to other activities conducted in the
468 area, explaining the prevalence of this activity. Probably because the Peruvian
469 government encouraged logging over the area, this activity was the preferred
470 and most crucial income-generating activity in the earlier operative years.
471 However, preferences later returned to the traditional subsistence activities,
472 such as hunting and fishing, either due to a decline in profitability or resources,
473 or the strength of traditional values (Waylen et al. 2010). Future education and
474 research programs should help the community to search or focus on activities
475 they consider to be well remunerated and compatible with conservation.

476

477 **Conclusions**

478 One of the main criticisms of conservation education is that it emphasizes
479 scientific facts, assuming that this acquisition of scientific knowledge will lead to
480 the care and protection of wildlife (Russell 1999). However, conservation is a
481 social process that engages science, not a scientific process that engages
482 society (Adams and Sandbrook 2014). Therefore, beyond convincing and trying
483 to impose our conservation ideals, our work aimed to inform the community
484 about the broader global perceptions on uakari species and the local area, and
485 understand local people's perceptions and attitudes regarding uakari post a
486 conservation education workshop. The holistic understanding of landscapes
487 and ecosystems by local communities and their local knowledge is relevant for
488 conservation (Reyes-García 2009) but frequently ignored.

489 Our study included an internationally broadcast film that featured
490 community members and their positive behaviors towards the uakari. Local
491 people seeing external recognition of their conservation action may have been
492 key to their attitudinal and behavioral changes towards the uakari; ultimately,
493 this may have improved the outcome of the education program. In addition, the

494 recognition of the value of local knowledge and the demonstration to local
495 populations that their actions are important in conserving uakaris may have
496 enhanced local peoples' desire to take care of this endangered species.
497

498 **Acknowledgements**

499 We thank all the people from Nueva Esperanza who participated in data
500 collection, showing that communal participation is important in the development
501 of wildlife management. We especially thank the National Commission of Science
502 and Technology (CONACyT-342574) of Mexico for the scholarship provided
503 during the investigation. We appreciate the essential help provided by Hani El
504 Bizri and Joaquín Navarro in the review of the manuscript. This publication is
505 funded in part by the Gordon and Betty Moore Foundation through Grant No.
506 GBMF9258 to the Comunidad de Manejo de Fauna Silvestre en la Amazonía y
507 en Latinoamérica (COMFAUNA).
508

509 **Data Availability**

510 The data used to support the findings of this study are available from the
511 corresponding author upon reasonable request.
512

513 **Conflicts of Interest**

514 The authors have no conflicts of interest to declare.
515

516 **Contribution Statement**

517 PM and MB were responsible for idea conception and the study design. PM, MB
518 and GFBR were responsible for the field work. FBP and MM contributed with the
519 statistical analyses. GFBR, PM, MB and FBP contributed with the manuscript
520 preparation.
521

522 **References**

- 523 Adams WM., Sandbook C (2014) **Conservation, evidence and policy**. *Oryx*
524 47:329-335. doi: 10.1017/S0030605312001470
- 525 Aguilar OM (2018) **Examining the literature to reveal the nature of**
526 **community EE/ESD programs and research**. *Environmental Education*
527 *Research* 24(1):26-49. doi: 10.1080/13504622.2016.1244658
- 528 Ardoin NM (2006) **Toward an interdisciplinary understanding of place:**
529 **Lessons for environmental education**. *Canadian Journal of*
530 *Environmental Education* 11(1):112–126.
- 531 Bowler M, Noriega MJ, Recharte M, Puertas P, Bodmer R (2009) **Peruvian red**
532 **uakari monkeys (*Cacajao calvus ucayalii*) in the Pacaya-Samiria**
533 **National Reserve a range extension across a major river barrier**.
534 *Neotropical Primates* 16(1):34-37. doi: 10.1896/044.016.0108
- 535 Bowler M, Valsecchi J, Queiroz HL, Bodmer R, Puertas P (2013) **Communities**
536 **and uacaris: Conservation initiatives in Brazil and Peru**. In: Veiga L,
537 Barnett A, Ferrari S, Norconk M (eds) *Evolutionary Biology and*
538 *Conservation of Titis, Sakis and Uacaris*, eds. Cambridge University
539 Press, Cambridge, UK, pp. 359-367. doi:
540 10.1017/CBO9781139034210.043
- 541 Braun V, Clarke V (2006) **Using thematic analysis in psychology**. *Qualitative*
542 *Psychological Research* 3(2):77-101. doi: 10.1191/1478088706qp063oa

- 543 Bride I (2006) **The conundrum of conservation education and the**
 544 **conservation mission.** *Conservation Biology* 20(5), 1337-1339. doi:
 545 10.1111/j.1523-1739.2006.00544.x
- 546 Buppert T, McKeehan A (2013) **Guidelines for applying free, prior and**
 547 **informed consent: a manual for conservation international.**
 548 Conservation International, Arlington, Virginia, USA.
- 549 Danielsen F, Burgess ND, Coronado I, Enghoff M, Holt S, Jensen PM, Poulsen
 550 MK, Rueda RM (2018) **The value of indigenous and local knowledge**
 551 **as citizen science.** In: Hecker S, Haklay M, Bowser A, *et al.* (eds) *Citizen*
 552 *Science.* UCL Press, London, UK, pp. 110-123. doi: 10.14324/
 553 /111.9781787352339
- 554 Freund CA, Achmad M, Kanisius P, Naruri R, Tang E, Knott CD (2020)
 555 **Conserving orangutans one classroom at a time: evaluating the**
 556 **effectiveness of a wildlife education program for school-aged**
 557 **children in Indonesia.** *Animal Conservation* 23(1):18–27. doi:
 558 10.1111/acv.12513
- 559 Harrison XA, Donaldson L, Correa-Cano ME, Evans J, Fisher DN, Goodwin CE,
 560 Robinson BS, Hodgson DJ, Inger R (2018) **A brief introduction to mixed-**
 561 **effects modelling and multi-model inference in ecology.** *Peer*
 562 *Journal* 6:e4794. doi: peerj.com/articles/4794/
- 563 Heimlich JE, Ardoin NM (2008) **Understanding behavior to understand**
 564 **behavior change: a literature review.** *Environmental Education*
 565 *Research* 14(3):215-237. doi: 10.1080/13504620802148881
- 566 Heimlich JE (2010) **Environmental education evaluation: Reinterpreting**
 567 **education as a strategy for meeting mission.** *Evaluation and Program*
 568 *Planning* 33(2):180-185. doi: 10.1016/j.evalprogplan.2009.07.009
- 569 Horwich RH, Lyon J (2007) *Community conservation: practitioner's answer to*
 570 *critics.* *Oryx* 41(3):376–385. doi: 10.1017/S0030605307001010.
- 571 Hughes K (2013) **Measuring the impact of viewing wildlife: do positive**
 572 **intentions equate to long-term changes in conservation behaviour?**
 573 *Journal of Sustainable Tourism* 21(1):42-59. doi:
 574 10.1080/09669582.2012.681788
- 575 Kellert S, Black M, Rush CR, Bath AJ (1996) **Human culture and large**
 576 **carnivore conservation in North America.** *Conservation Biology*
 577 10(4):977-990. doi: 10.1046/j.1523-1739.1996.10040977.x
- 578 King FA, Lee PC (1987) **A brief survey of human attitudes to a pest species**
 579 **of primate - *Cercopithecus aethiops*.** *Primate Conservation* 8:82-84.
- 580 Kuhar CW, Bettinger TL, Lenhard K, Tracy O, Cox D (2010) **Evaluating for**
 581 **Long-Term Impact of an Environmental Education Program at the**
 582 **Kalinzu Forest Reserve, Uganda.** *American Journal of Primatology*
 583 72(5):407–413. doi: 10.1002/ajp.20726
- 584 Lee PC, Priston NEC (2005) **Human attitudes to primates: perceptions of**
 585 **pests, conflict and consequences for primate conservation.** In:
 586 Paterson JD, Wallis J (eds) *Commensalism and conflict: the human-*
 587 *primate interface.* American Society of Primatologists, Norman,
 588 Oklahoma, USA, pp. 1-23.
- 589 Liddicoat K, Krasny M (2013) **Research on the Long-Term Impacts of**
 590 **Environmental Education.** In: Stevenson R, Brody M, Dillon J, Wals A
 591 (eds). *International Handbook of Research on Environmental Education.*
 592 Routledge/Taylor & Francis, London, UK, pp. 289–297.

- 593 Mayor P, El Bizri H, Bodmer RE, Bowler M (2017) **Assessment of mammal**
594 **reproduction for hunting sustainability through community-based**
595 **sampling of species in the wild.** *Conservation Biology* 31(4):912-923.
596 doi: 10.1111/cobi.12870.
- 597 Mayor P, Perez-Peña P, Bowler M, Puertas PE, Kirkland M, and Bodmer R
598 (2015) **Effects of selective logging on large mammal populations in**
599 **a remote Indigenous territory in the northern Peruvian Amazon.**
600 *Ecology and Society* 20(4):36. doi: 10.5751/ES-08023-200436.
- 601 Puertas P, Bodmer R (1993) **Conservation of a High Diversity Primate**
602 **Assemblage.** *Biodiversity and Conservation* 2(6):586-593. doi:
603 10.1007/BF00051959
- 604 R Core Team (2017) **R: A language and environment for statistical**
605 **computing.** R Foundation for Statistical Computing. Vienna, Austria.
606 <https://www.R-project.org/>. Accessed 14 July 2019.
- 607 Remis MJ, Hardin R (2009) **Transvalued Species in an African Forest.**
608 *Conservation Biology* 23(6):1588–1596. doi: 10.1111/j.1523-
609 1739.2009.01290.x
- 610 Reyes-García R (2009) **Conocimiento ecológico tradicional para la**
611 **conservación: dinámicas y conflictos.** *Revista Papeles* 107:39-55.
- 612 Ruiz-Mallen I, Barraza L, Bodenhorn B, Ceja-Adame M, Reyes-Garcia V (2010)
613 **Contextualising Learning through the Participatory Construction of**
614 **an Environmental Education Programme.** *International Journal of*
615 *Science Education* 32(13):1755-1770. doi:
616 10.1080/09500690903203135
- 617 Russell C (1999) **Problematizing nature experience in environmental**
618 **education: The interrelationship of experience and story.** *Journal of*
619 *Experimental Education* 22(3):123- 137. doi:
620 10.1177/105382599902200304
- 621 Savage A, Guillen R, Lamilla I, Soto L (2010) **Developing an effective**
622 **community conservation program for cotton-top tamarins**
623 **(*Saguinus oedipus*) in Colombia.** *American Journal of Primatology.*
624 72(5):379-90. doi: 10.1002/ajp.20770
- 625 Veiga LM, Bowler M, Silva Jr JS, Queiroz HL, Boubli JP, Rylands AB (2008)
626 ***Cacajao calvus*.** The IUCN Red List of Threatened Species 2008:
627 e.T3416A9846330. doi:
628 10.2305/IUCN.UK.2008.RLTS.T3416A9846330.en. Accessed 14 July
629 2019.
- 630 Waylen KA, Fischer A, McGowan PJK, Thirgood SJ, Milner-Gulland EJ (2010)
631 **Effect of local cultural context on the success of community-based**
632 **conservation interventions.** *Conservation Biology* 24(4):1119–1129.
633 doi: 10.1111/j.1523-1739.2010.01446.x

634
635
636

Supplementary Table 1. Demographic description (in number and percentage) of the focus population of the Yagua indigenous community of Nueva Esperanza, people attending the workshops conducted in 2014, and the people interviewed from 2013 to 2017.

Age Category	Focus group ¹		Workshop participation ²		People interviewed per year ²							
			2014		2013		2014		2015		2017	
Sex	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Adolescent (16-24 years)	27 (8.2%)	28 (8.5%)	16 (59.3%)	6 (21.4%)	5 (18.5%)	12 (42.9%)	11 (40.7%)	6 (21.4%)	2 (7.4%)	4 (14.3%)	2 (7.4%)	5 (17.9%)
Young adult (25-39 years)	38 (11.6%)	31 (9.4%)	20 (52.6%)	4 (12.9%)	10 (26.3%)	8 (25.8%)	19 (50.0%)	4 (12.9%)	14 (36.8%)	7 (22.6%)	10 (26.3%)	7 (22.6%)
Old adult (>40 years)	28 (8.5%)	16 (4.9%)	12 (42.9%)	2 (12.5%)	5 (17.9%)	3 (18.8%)	11 (39.3%)	1 (6.3%)	15 (53.6%)	5 (31.3%)	4 (14.3%)	4 (25.0)
Total	93 (28.3%)	75 (22.8%)	48 (51.6%)	12 (16.0%)	20 (21.5%)	23 (30.7%)	41 (44.1%)	11 (14.7%)	31 (33.3%)	16 (21.3%)	16 (17.2%)	16 (21.3%)

637
638
639
640
641

¹ Percentages with respect to the total population census in 2015 ($N = 329$).

² Percentages with respect to each focus sex-age group.

642
643
644

Supplementary Table 2. Details of the complete model and the null model using *GLM* to verify the influence of conservation education workshop and demographics variables on 'importance' and 'hunting' of red uakari in the Yavari Mirin basin, Peru.

Reponse variable	Predictor variables	Estimate	Std. Error	z value	Pr(> z)		AIC	AIC Null model	ΔAIC
Importance	2014:2013	1.2839	0.46565	2.757	0.00583	**	200.32	228.64	28.32
	2015:2013	3.22802	0.6473	4.987	6.14E-07	***			
	2017:2013	1.47505	0.50999	2.892	0.00382	**			
	female:male	0.62712	0.38682	1.621	0.10497				
	Age	-0.01539	0.01384	-1112	0.2662				
	hunting	0.22581	0.49118	0.46	0.64571				
Hunting	2014:2013	-1.25391	0.585422	-2.142	0.0322	*	150.58	157.19	6.61
	2015:2013	-2.32046	0.857049	-2.708	0.00678	**			
	2017:2013	-0.67261	0.593029	-1.134	0.25672				
	female:male	0.001964	0.475148	0.004	0.9967				
	Age	-0.01243	0.018788	-0.662	0.5081				
	Importance	0.239059	0.492669	0.485	0.62751				

645
646
647
648

649 **Supplementary Table 3.** Details of the *linear models* elaborated to verify the relation of 'importance' and 'hunting' to the responses
 650 of the question (2) 'Why are the red uakari important?' in the Yavari Mirin basin, Peru.

Reponse variable	Predictor variables	Estimate	Std. Error	z value	Pr(> z)	F-value	DF	Adjusted R ²
Importance	Ecology	0.6908	0.0667	1.0357	< 2e-16 ***	41.49	4, 169	0.5155
	Food	0.56056	0.11659	4.808	3.35E-06 ***			
	Personal feelings	0.70651	0.06999	1.0095	< 2e-16 ***			
	Ecoturism	0.68364	0.10413	6.565	6.13E-10 ***			
Hunting	Ecology	-0.06191	0.065593	-0.944	0.34662	10.242	4, 169	0.4261
	Food	0.54507	0.114653	4.754	4.25E-06 ***			
	Personal feelings	0.07385	0.068826	-1.073	0.28481			
	Ecoturism	-0.00108	0.102402	-0.011	0.99157			

651
 652
 653
 654

655 **Figure legends**

656

657 **Figure 1.** Map of the Community of Nueva Esperanza, Lago Preto
658 Conservation Concession, and logging concessions on the Yavari and Yavari–
659 Mirín Rivers with other critical areas for the conservation of red uakari.

660

661 **Figure 2.** Percentage (and standard error) of interviewees who indicated that
662 they or someone in their family hunted red uakari and who stated that they
663 considered the red uakari important in 2013 before the educational programme,
664 immediately after the education programme in 2014 and 2015, and in 2017,
665 three years after the programme.

666

667 **Figure 3.** Responses (in percentage and standard error) to the open-ended
668 question ‘Why do you/don’t you consider the red uakari important?’ asked in
669 2013 and 2017. Responses were grouped into four categories.

670

671 **Figure 4.** Responses (in percentage and standard error) to the open-ended
672 questions (A) ‘Activities to generate income’, and (B) ‘Activities they would
673 prefer to do as a future alternative’. This question was conducted between 2013
674 and 2017, and also previously in 2009.

675