



## Linking local people's perception of wildlife and conservation to livelihood and poaching alleviation: A case study of the Dja biosphere reserve, Cameroon



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### ABSTRACT

This Paper examines how people's livelihoods and perceptions of wildlife are related to self-reported poaching (here defined as commercial bushmeat hunting) in 25 villages at the northern buffer zone of the Dja Biosphere Reserve, East Cameroon. Using a six-point Likert scale questionnaire among 263 households interviewed from March to June 2017, the following hypothesis were tested: (1) Households with positive perceptions of wildlife are less involved in poaching; (2) Positive perceptions of wildlife are linked to sustainable livelihood improvement of households; and (3) Sustainable livelihood improvement of households leads to poaching alleviation. The study area has been the site since 2010 for a community-centered conservation Program that aims to improve local people's livelihoods (through the creation of income sources based on cocoa-based agroforestry and Non Timber Forest Products (NTFPs) Valorization) and their perceptions of wildlife (mainly through awareness raising and wildlife education) and therefore divert them from poaching. The main findings of the study indicates that positive perceptions of wildlife are linked to lower levels of poaching. Similarly, positive perception of wildlife was positively related to Livelihood improvement of the respondents. However, livelihood improvement alone did not predict poaching alleviation though we reported a significant difference in poaching frequencies of cocoa and non-cocoa producers with the firsts less involved in poaching. The findings of this study recommend more holistic approaches of biodiversity conservation that integrate simultaneously perception and livelihood improvement.

### 1. Introduction

The scale of current hunting is a serious threat to many forest species and ecosystems in the Amazon and the Congo Basin, the two largest and least populated dense forest areas in the world (Nasi et al., 2011). In the Congo Basin, many ecosystems are currently threatened, as it is the case of the Dja Biosphere Reserve (DBR), a World Heritage Site of UNESCO which has been seriously damaged by anthropic activities, of which poaching is the most important. Despite increasing efforts by non-governmental organizations, academics and governments over recent decades, these threats continue to cause species decline and even

extinction (John et al., 2010; Nasi et al., 2008). The problem is now so serious that the illegal wildlife trade has been classified as the third most significant organized crime after terrorism and drug trafficking (UNODC, 2016). Traditional approaches to biodiversity conservation have involved the establishment of protected areas (Hulme and Murphree, 2001) with the objective of effectively protecting, developing and maintaining representative samples of various biotopes in the area where they are located (Vodouhê et al., 2010). Communities have been excluded from protected areas and their rights to access natural resources withdrawn (Guéneau and Jacobée, 2005). This has created frustration among forest living communities who have had to exploit

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natural resources illegally since their livelihoods are tightly linked to the forest (Knapp et al., 2017). Today it is widely recognized that these traditional approaches have not been successful (especially in the Congo Basin) and new approaches seek to give more participation to local communities (Infield and Namara, 2001). Many conservationists believe that conservation efforts not supported by communities living around protected areas are bound to fail (Kumssa and Bekele, 2014). Human beings are now at the center of all conservation practices, and many conservationists think that a better understanding of the human dimensions of environmental issues will improve conservation (Bennett et al., 2017). Understanding human perceptions and the attitudes of local communities has, therefore, been established as an important starting point of any conservation action. Considering that, many researchers (Vodouhê et al., 2010; Eboa et al., 2011; Kumssa and Bekele, 2014; Tichaawa and Mhlanga, 2015; Gandiwa et al., 2015; Epanda and Thalut, 2016) have been measuring the attitudes and perceptions of local communities toward conservation and the factors that determine them. However, knowing how general perceptions are distributed does not necessarily help in the design of interventions to change a specific behavior. Someone may have a positive perception toward conservation, and yet still perform behaviors that are in contradiction (e.g. poach species that are of conservation concern (John et al., 45 2010)). It is therefore important to understand which relationship exists between perception and behavior and to explore other factors that can affect conservation behavior.

This paper therefore seeks to examine using insights provided by the theory of planned behavior the links between local people's perception of wildlife, livelihood improvement and poaching with the specific status of the Dja Biosphere Reserve. The study has been realized in a context where local communities have been involved in a community-based conservation program mainly based on perception and livelihood improvement through education, awareness rising and the creation of alternative income sources. Based on data from the field after seven years of this conservation program, we tested the following hypothesis: (1) households with positive perceptions of wildlife are less involved in poaching; (2) a positive perception of wildlife is linked to sustainable livelihood improvement of households; and (3) sustainable livelihood improvement of households will lead to poaching alleviation.

We tested three hypotheses related to perceptions and livelihoods and their relationships to conservation:

## 2. Material and methods

### 2.1. Study area

The study was conducted at the northern buffer zone of the Dja Biosphere Reserve (DBR) (Fig. 1) in the Messamena sub-division, Upper Nyong Division of the East Region of Cameroon. The DBR is located in southeast Cameroon, between 2°50 and 3°30 latitude north, and 12°20 and 13°40 longitude east. This protected area covers an area of 5260 km<sup>2</sup> and is classified as among the largest protected areas of the Guinea-Congolian tropical rain forests. The study area has an altitude ranging from 600 m to 700 m above sea level. According to the 2005 Cameroon population census, the Messamena sub-division had a population size of 26,153 inhabitants made up of 13,441 males and 12,712 females (BUCREP, 2005). The population density is not high, about 1.5 inhabitants/km<sup>2</sup>. The major ethnic groups, the Badjoue (belonging to Bantu people) and the Baka Pygmies live side by side in and outside the reserve. The climate is of the humid equatorial type with four seasons: a long wet season from August to November, a long dry season from November to March, a short wet season from March to Jun, and a short dry season from June to August (Epanda, 2004). The average annual rainfall is 1563 mm and the average temperature varies between 19.8 °C and 27 °C (Willie et al., 2012). The hydrography is dominated by the Dja River which forms a natural boundary to the reserve from the south, west and north. As in many rural areas in

Cameroon, the local peoples at the northern periphery of the DBR rely for their livelihoods on a mixture of activities such as agriculture, livestock keeping, hunting, fishing, Non Timber Forest Products (NTFPs) valorization, and handicraft (Avila et al., 2017). The main crops grown in the area are cassava (*Manihot esculenta*), cocoa (*Theobroma cacao*), coffee (*Coffeae* spp), cocoyam (*Xanthosoma sagittifolium*), groundnut (*Arachis hypogaea*) and plantain (*Musa* spp). The poor condition of roads is not favorable for the commercialization of agricultural products. As a result, a high proportion of the harvest is mainly for local consumption and the remaining part is sold at a very low price.

## 3. Methods

### 3.1. Data collection

A questionnaire survey administered from March to June 2017 was used as the primary data collection instrument, combined with the personal observations of the researchers. We selected 25 out of 81 villages in the Messamena Sub-division for the survey. These villages had been selected because they constitute the intervention zone of the NGO TF-RD who works in the area on reducing poaching through local people's livelihood and perception improvement. The activities of this NGO therefore give the opportunity to test the links between perception improvement, livelihood and poaching reduction. A total of 263 households (all involved in the conservation program) out of approximately 1159 households in all the 25 villages studied (BUCREP, 2005) were selected, yielding a sampling intensity of 22.69% (see Table 1). Study participants were selected using convenience sampling which is a non-probability sampling technique where subjects are selected because of their convenient accessibility and proximity to the researcher. Interviews were conducted in French because after the local language (Badjoue), it is spoken by the majority of the population. However, to avoid any problems of interpretation, the interviewer was accompanied by a native field agent who served as an interpreter when necessary. In a household, men and women were interviewed together due to the fact that we were interested by the household within which men and women have distinct livelihood activities. Respondents were asked about household demographics, education, employment, and income generating activities. The latent variables of the perceptions of wildlife, sustainable livelihood improvement and poaching alleviation were measured using 23 items on a 6 points Likert-scale (for more information on latent variable construction, see the data analysis section) with semantic differential statements (strongly disagree, disagree, moderately disagree, moderately agree, agree, strongly agree). The questionnaire was pre-tested on a sample of 10 respondents in the villages of Ntoumzok and Kabilone II. As a result of pre-testing and discussion, some questions were improved and others deleted in order to improve clarity. Collecting information on sensitive topics like bushmeat poaching is enormously challenging (Wilfred and MacColl, 2010) not only because of the illegal nature of such hunting activities, but also because people do not always want to reveal real information concerning them. Data collected in such situations are therefore biased. To avoid such bias, the purpose of the study was explained to the participants and they were ensured of full anonymity for any incriminating information they might disclose. In addition, participant observation was carried out to triangulate various information collected. Some authors have been working in the field with the local communities since 2003 and have gained their confidence. With respect to that, no payment of any kind was given to the respondents and all were willing to answer the questionnaire.

The study sampled 263 households but only 251 responded fully to all the questions. Since structural equation modelling is very sensitive to missing values we considered only a sample of 251 and the remaining 12 were discarded from the analysis. Hair et al. (1998) give as a general rule for structural equation modelling to have a ratio of 10 observations per variable in the analysis. In the current study, the

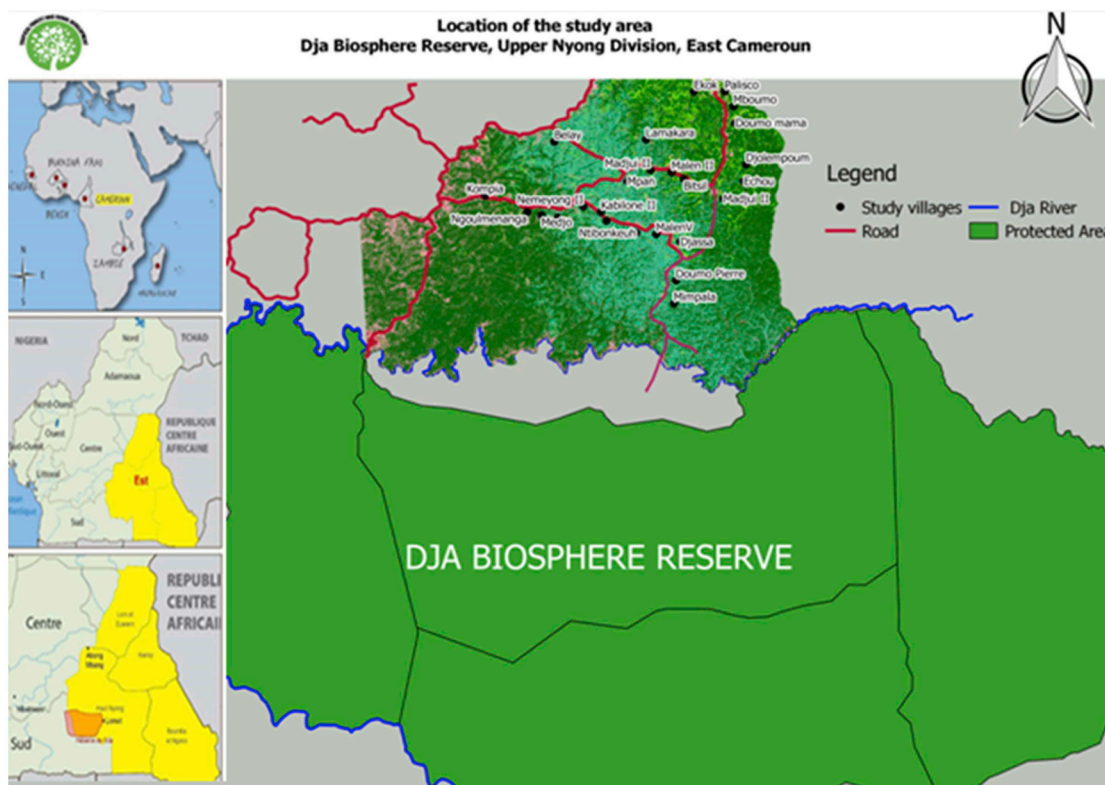


Fig. 1. Location of the study area at the northern buffer zone of the Dja Biosphere Reserve.

**Table 1**  
Village statistics and the percentage of households surveyed in each village.

Village	Estimated number of inhabitants	Estimated number of households	Number of surveyed households (% of household surveyed in each village)
Doumo pierre	90	16	11 (68.75)
Malen V	129	24	17 (70.83)
Djassa	31	6	4 (66.66)
Mimpala	269	49	13 (26.53)
Ntibonkeh	82	15	10 (66.66)
Ntoumzock	292	53	23 (43.39)
Kabilone II	49	9	6 (66.66)
Nemeyong II	323	59	7 (11.86)
Bintsina	145	27	14 (51.85)
Medjoh	126	23	5 (21.73)
Ngoulminanga	131	24	7 (29.16)
Kompia	800	145	11 (7.58)
Mpan	173	31	5 (16.12)
Madjui II	155	28	12 (42.85)
Malen II	90	16	4 (25)
Bitsil	346	63	8 (12.69)
Eschou	413	75	5 (6.66)
Madjui I	193	35	13 (37.14)
Doumo mama	429	78	32 (41.02)
Djolempoum	193	35	12 (22.85)
Ekoh	179	32	8 (25)
Mboumo	1249	227	12 (5.28)
Belay	247	45	12 (26.66)
Lamakara	99	18	5 (27.77)
Palisco	142	26	7 (26.92)
<b>Total</b>	<b>6375</b>	<b>1159</b>	<b>263 (22.69)</b>

Source: From BUCREP, 2005 and extrapolated to study period using the population rate of increase which was 15.6 people per year between 2005 and 2017.

sample size exceeded the cut-off criteria, that is, greater than 230, since we had 23 variables being measured.

### 3.2. Data analysis

Data were analyzed using Student's t-test, factor analysis and structural equation modelling in SPSS 21 and AMOS 21 software. Before running structural equation modelling, data obtained from the field were subjected to cleaning, tests of normality and adequacy. The reliability and validity of the methods used were also assessed by measuring the Cronbach alpha coefficient, and the average variance, respectively. The Kaiser-Meyer-Olkin (KMO) value of 0.785 was satisfactory for conducting a factor analysis. The p-value of Bartlett's test of sphericity ( $p = 0.000$ ), which was below 0.05, was significant at the 99% confidence level. Based on an exploratory factor analysis through Principal Component Analysis (PCA), 9 (out of the 23 items of the measurement instrument) organized into three components, Wildlife Perception (WLP), Sustainable Livelihood Improvement (SLA) and Poaching Alleviation (POA) were retained. Table 2 presents the description of the indicators (with the dimension to which its refers) of each latent construct in the study. Then the reliability of the measurement methods was checked using the Cronbach alpha coefficient which is the measure of the internal consistency of the measurement scale (Cronbach, 1951). Cronbach alpha values for the three latent constructs were all above the cut-off value of 0.7 (Gliem and Gliem, 2003). Average variance extracted for the 3 latent constructs also exceeded the cut-off value of 0.5 showing evidence of convergent validity of the measurement scale. Afterward, Confirmatory Factor Analysis (CFA) was conducted with the goal of validating the instruments and to see how the data fit the hypothesized model. CFA is a structural equation modelling tool (SEM) that deals specifically with measurement models of the relationships between observed measures or indicators (test items) and the latent variables of factors (Brown, 2006).

**Table 2**  
Description of indicators of each latent construct in the study.

	Item (Indicator)	Description	Dimension
Perception of wildlife (WLP)	Item 3	Wildlife rights are essential for the preservation of wildlife	Conception
	Item 5	There is a need to conserve wildlife	Psychological need Fulfilment
	Item 7	The local community should be involved in conservation programs	Community involvement
Sustainable livelihood improvement (SLA)	Item 10	Financial resources generated from cocoa production and NTFP contribute to sustainable livelihood improvement	Financial capital
	Item 18	Now that am working on my cocoa farm I don't still have time to go hunting	Physical capital
	Item 20	now that we are producing cocoa and NTFP we can prepare for the beginning of the school without going hunting	Human capital
Poaching Alleviation (POA)	Item 14	Access to markets (of cocoa and NTFPs) reduces poaching	Access to market
	Item 16	Educating the community in wildlife protection laws reduces poaching	Communication and wildlife awareness
	Item 17	Access to education contributes to reducing poaching	Access to education

**4. Results**

**4.1. Socio-demographic characteristics of the respondents (Table 5)**

The majority (95.6%) of households surveyed were headed by a man. The average household size (Standard Deviation) was 6.6 (4.2) and the average number of children going to school per household was 2.8 (2.7). The majority of the survey participants were married and affiliated to the Christian religion. Most of the respondents (50.6%) were aged between 26 and 45 years. The mean age was 37.6 (13.19) years. All the respondents had received a formal education: 57% of them had acquired primary education while 43% had achieved secondary education. None of them had any higher level of education. Monthly household income was very low as 47.6% of the respondents earned under US \$54 a month. The main occupation of respondents was agriculture with a prevalence of 83%. Twenty seven percent of the respondents were members of the cooperative society of cocoa farmers of the northern periphery of the DBR (SCOOPSPROCAPDJA) while 4% were members of “common initiative groups” of women engaged into the valorization of NTFP. Agriculture was the main income generating

**Table 3**  
Socio-demographic profile of the respondents.

Variables	N	%	Variables	N	%
<b>Gender of the household head</b>		<b>Monthly income (CFA)</b>			
Male	240	95.6	Less than 30000	119	47.6
Female	11	4.4	31000–75000	98	39.0
			76000–150000	30	11.8
			151000–200000	4	1.6
<b>Age</b>		<b>Membership of a villagers' organization</b>			
Less than 18 years	2	0.8	None	162	64.5
18–25 years	45	17.9	Cooperative of cocoa producers	68	27.1
26–45 years	127	50.6	Group of women	10	4.0
46–65 years	62	24.7	Other	11	4.4
More than 66 years	15	59.8			
<b>Education level</b>		<b>Principal occupation</b>			
No formal education	0	0	Agriculture	209	83.2
Primary	143	56.9	Hunting	16	6.4
Secondary	107	43.1	Trading	4	1.6
University	0	0	Formal employment	18	7.2
			Fishing	4	1.6
<b>Marital status</b>		<b>Main income generating activity</b>			
Married	196	78.2	Agriculture	160	63.6
Single	16	6.3	Hunting	58	23.0
Widow (er)	11	4.4	employment	17	7.0
divorcee	28	10.7	NTFP valorization	12	4.8
			Fishing	4	1.6
<b>Religious affiliation</b>		<b>Mean household size (standard deviation)</b>			
Christians	249	99.20		6.6 (4.2)	
Traditional belief	2	0.80			

activity followed by hunting and NTFP valorization.

**4.2. Linkage between perceptions, livelihoods and poaching**

The study investigated the interrelationship between 3 latent constructs by drawing a structural equation model based on confirmatory factor analysis. This statistical tool presents simultaneously the regression patents between constructs and between each construct and its indicators. To evaluate the model fit, we used a number of descriptive fit indices which include the minimum value of the discrepancy between the observed data and the hypothesized model divided by the degree of freedom (CMN/df), the Comparative Fit Index (CFI), the Normed Fit Index (NFI) and the Root Mean Square Error of Approximation (RMSEA). All the fit indices indicated a good fit between the model and the observed data (Table 4).

Then each of our 3 hypothesis was verified by checking the regressions coefficients between latent constructs.

**4.3. Influence of improved perception of wildlife on poaching**

The results from the structural equation model (Fig. 2) reveal that perceptions of wildlife.

Significantly influence poaching. The regression weight ( $\beta = 0.41$ ,  $P = 0.001$ ), between the 2 latent constructs was significant at the 99% confident level. This result was supporting hypothesis 1 of this study that positive perceptions of wildlife in a household will contribute to

**Table 4**  
Tabular presentation of fit indices criteria compared to baseline model output.

Fit Indices	Recommended Threshold	Model Output	Remark
CMINDF	$2 \geq \text{CMINDF} \leq 5$	1,94 Roughly 2	Accepted
P	$P \geq 0.05$	0.004	Accepted
CFI	$\text{CFI} \geq 0.90$	0.937	Accepted
NFI	$\text{TLI} \geq 0.90$	0.883	Rejected
RMSEA	$\text{RMSEA} \leq 0.08$	0.06	Accepted

**Table 5**  
Result from the Student's test of mean comparison of hunting frequencies between cocoa and non-cocoa producers.

Levin's pre-test	F	Sig	t-test for equality of means	t-test for equality of means
			t-value Sig	Mean difference
Equal variances assumed	15.52	0.001	5.369 0.001	4.150
Equal variances not assumed			5.025 0.001	4.150

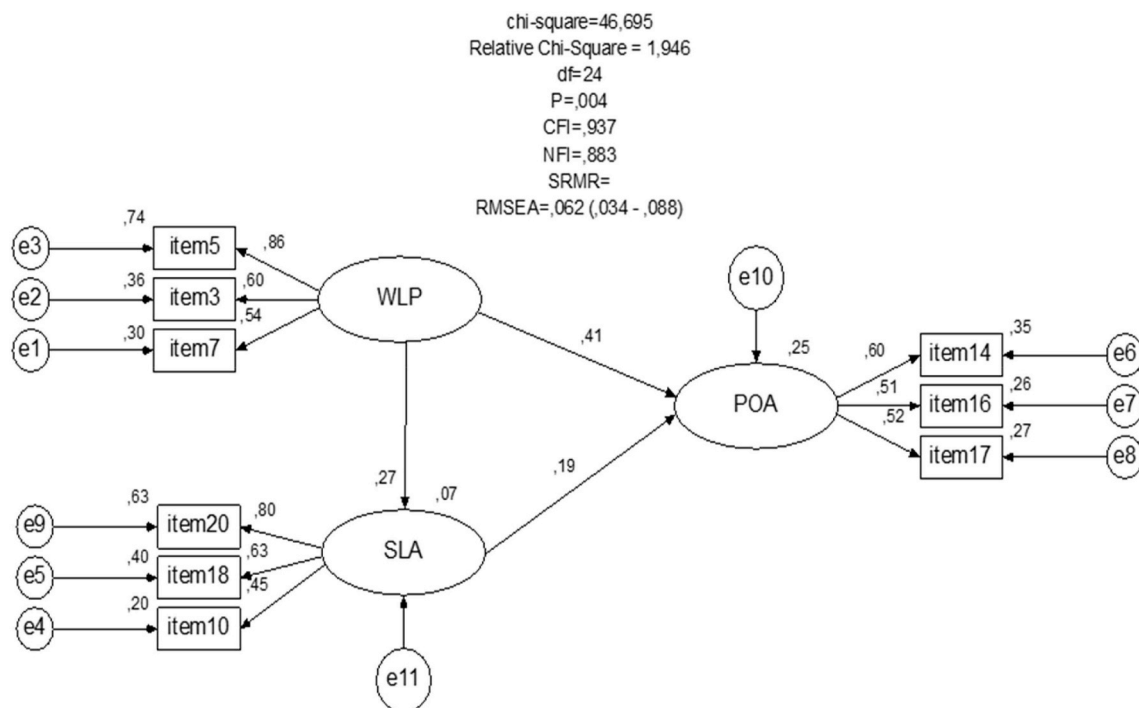


Fig. 2. Structural equation model showing the regression weights between the perceptions of wildlife, the sustainable livelihood improvement and poaching alleviation.

poaching alleviation.

#### 4.4. Influence of improved livelihood on poaching

Sustainable livelihood improvement considered alone was not enough to predict poaching alleviation as the regression between the two latent constructs was not statistically significant ( $\beta = 0.19, P = 0.077$ ). This was not supporting hypothesis 3 of this study. Since livelihood improvement taken as a latent construct did not predict poaching we decomposed it to verify if some of its indicators had any influence on the poaching frequency of household that participated to the study. The explanatory factor analysis revealed that households' livelihood improvement has as an indicator, resources coming from cocoa production and NTFP valorization. Because almost all the households were involved in NTFP valorization, we verified whether cocoa production reduced the likelihood of a household being involved in poaching. A *t*-test (Table 3) was performed to compare the mean monthly poaching frequencies of cocoa producers and non-cocoa producers. The result shows a statistically significant difference ( $t = 5.369; Sig = 0.001$ ) between the two groups, with the cocoa producers less involved in poaching. The mean difference was 4.150. The cocoa producers hunted for commercial purposes approximately five times a month while the non-cocoa producers did so approximately nine times a month.

#### 4.5. Influence of improved perception of wildlife on livelihood improvement

The hypothesis 2 of this study (a positive perception of wildlife is linked to sustainable livelihood improvement of households) was verified since the *p* value of the regression between the two latent constructs, WLP and SLA was significant at the 99% confident level.

### 5. Discussion

#### 5.1. Influence of improved perception of wildlife on poaching

This study suggests that there is a positive correlation between the perception of wildlife and less poaching. This finding contradicts results

from previous studies (Infield and Namara, 2001; Waylen et al., 2009 and Meijer et al., 2015) which found mismatches between perception and behavior and concluded that perception alone is not a good predictor of behavior. Socio-psychological models of human behavior have demonstrated that human behavior is not one dimensional (Ajzen, 1991; Epanda and Thalut, 2016). It is a function of many internal and external factors that interact together. These factors are summarized by the theory of planned behavior to be the perception, subjective norms and perceived behavioral control. The significant effect of a positive perception of wildlife on poaching alleviation in the study area may be explained by the livelihood improvement of households. Perception is central and very important but livelihood improvement is also important. In the study area, livelihood improvement has taken place through the introduction of cocoa-based agroforest enriched with plantain and local fruit trees, and the valorization of NTFPs. The main NTFPs exploited include bush mango (*Ivingia gabonensis*), moabi (*Baillonnela toxispema*) and djansang (*Ricinodendron heudeloti*). All these activities are yielding income to households throughout the year as cocoa and djansang produce from September to December, and moabi and bush mango from July to September. People engaged in these activities are provided with technical support and access to high value markets for commercialization. As people think they can easily turn to agriculture and/or into NTFP valorization, they feel themselves able to abandon poaching. Zubair and Garforth (2006) reported similar findings: according to them, the decision of people to engage or not in tree planting was subject to a certain number of factors including the presence or absence of knowledge of market opportunities and the presence or absence of village nurseries. Those factors were quantified as facilitating factors which increase or decrease the intention to plant trees. Kuriyan (2004) also found that, for conservation to be successful, while improving local peoples' perceptions, conservationists should introduce alternative livelihood activities to meet the day-to-day needs of households. Moreover, people engaged in those alternative livelihood activities were organized through the creation and the legalization of a cooperative society for the cocoa producers, the cooperative society of cocoa farmers of the northern periphery of the DBR (SCOO-PSPROCAPDJA) and eight "common initiative groups" for women

engaged in NTFP valorization. The cooperatives' members are engaged in the production of certified cocoa according to the Rainforest Alliance criteria, one of them being the reduction of poaching. Poaching reduction is, therefore, enforced through the cooperative by the establishment of a hunting management plan, each cooperative member monitoring the hunting activities of others. In the cooperative, there are two types of cocoa: cocoa implicated with poaching, and that without poaching. The cocoa produced by poachers is sold for a cheaper price than that produced by non-poachers, with a very high difference in price per kilogram (about US \$1). This creates an incentive for people to reduce poaching in the study area. The durability of this model has been assured by the integration of the private sector in the value chain of products valorized by local communities. Indeed, there is a business company named Tropical Forest Foods and Cosmetics that is connected to the national and international market and assure the commercialization of products collected by local communities. A share of the benefit of this company is saved in a fund of support to the value chain. This value chain support fund will allow the model to continue to function several years after the project.

### 5.2. Influence of improved perception of wildlife on livelihood improvement

The study further revealed that perceptions of wildlife were positively associated with the sustainable livelihood improvement of households in the study area. Livelihoods of households with a positive perception of wildlife were improved. The indicators of sustainable livelihood improvement were revenues from cocoa production and NTFP valorization. This result therefore suggests that the more positive is the perception of people toward wildlife, the more revenue they have from cocoa production and NTFP valorization. This result can be explained by the fact that people with a positive perception of wildlife are more involved in project activities that are much more lucrative than poaching. So as positive perceptions increase, the acceptability and the adoption rate of alternative activities also increase.

### 5.3. Influence of improved livelihood on poaching

Results of this study suggested that livelihood improvement considered alone was not related to poaching alleviation. People with sustainable livelihoods who did not have a positive attitude to wildlife did not reduce their poaching. Livelihood improvement through the introduction of alternative sources of income should not be considered a panacea to obtain conservation results. Livelihood improvement can only have a positive effect on poaching in cases where people's perceptions toward wildlife and conservation are positively enhanced. Conservationists should always consider the point of view of local people in designing interventions. Many conservation projects have obtained very bad results because they were founded on the assumption that improving economic conditions of local people will automatically bring them to abandon poaching. In some forest areas, traffic in wildlife is dominated by very rich people. They have money to buy firearms and wire snares, and to send people into the forest. Consequently, improving only the economic conditions of households may only increase the number of people having enough resources to invest in high levels of poaching. Coad (2007), for example, reported that the bushmeat trade in Dibouka and Kouagna villages in Gabon was dominated by very rich households. However, the results noticed that cocoa production had a great potential in reducing poaching in the study area since the cocoa producers were less involved in poaching than the non-cocoa producers. This result is in conformity with the findings of Lescuyer et al. (2014) which state that in the years to come, cocoa production could provide an attractive livelihood option for the rural poor that might deter young individuals from commercial hunting or, at least, reduce the time they devote to it. Indeed, although cocoa production is not as flexible as hunting, it is a financially attractive activity. Moreover, taking care of a cocoa farm is demanding of time and energy,

especially during the period of fructification. It is, therefore, clear that cocoa producers will have less time to devote to poaching than non-cocoa producers.

## 6. Conclusion

This study assessed the linkages between the perception of wildlife, livelihood improvement, and poaching alleviation. The results revealed that households with positive or good perception of wildlife were more involved in alternative livelihood activities and ultimately less involved in poaching. This indicates the central role of local people perceptions when designing intervention strategies aimed at curbing poaching in a specific area. The introduction of alternatives to poaching will not solve the problem unless the perceptions and attitudes of local people are improved. Education, wildlife awareness raising and the participation of communities are therefore important as they can be viewed as ways to improve the perceptions of wildlife by local communities. However, improving only perceptions will not contribute to sustainably reduction of poaching. Conservationists should therefore use models that are holistic and that seek to simultaneously improve both livelihoods and perceptions of local people.

### Authors' contribution

Epanda Manfred Aimé, Collected field data, analyzed data and drafted the first version of the manuscript.

Mukam Fotsing André Junior, Collected field data, contributed in data analysis and in drafting the first version of the manuscript.

Bacha Thomas, Revised the manuscript.

Dupain Jef, Revised the manuscript.

Frynta Daniel, Revised the manuscript.

Tchouamo Isaac Roger, Revised the manuscript.

Lens Luc, Revised the manuscript.

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### Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.actao.2019.04.006>.

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