



# Assessing the impact of community-led conservation approach in the preservation of the cryptic gorilla (*Gorilla gorilla*) population in the Ebo forest, Littoral Region-Cameroon

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## Abstract

The Ebo forest in Cameroon, a biodiversity hotspot in the Gulf of Guinea, hosts conservation valuable plant and animal species, including a geographically isolated small gorilla population. Despite its ecological significance, the forest faces threats from unsustainable activities by adjacent communities and newly authorized logging operations. To address threats, the community-led conservation initiative ‘*Club des Amis des Gorilles*’ (CAG) was established in 2012 in three villages near the Ebo gorilla habitat. This study assesses potential changes in communities’ opinions on the Club’s role in biodiversity conservation and household well-being over its 5-year existence. A questionnaire was administered to household heads in 2013 and in 2017 in CAG-affiliated villages. The study revealed that CAG is an effective strategy for engaging local communities in conservation, with about 80% of residents being members during both surveys. The majority of respondents (92% in 2017) maintained positive opinions about CAG, highlighting its importance in biodiversity conservation and community well-being. Despite CAG’s prominent role in education, hunting practices remain prevalent in the region, likely due to the remoteness of the area, which makes hunting a more substantial source of protein and income than agriculture. The situation could worsen following the recent two logging concessions establishment, particularly if these do not adhere to strict conservation measures. In perspective, CAG proposed the establishment of the gorilla habitat as a community-sanctioned ‘no-go-zone’ to human activities to enhance their protection. To ensure the sustainability of this community-led initiative, there is a need for incentive support from stakeholders.

**Keywords** Biodiversity · Hunting · Great apes · Community engagement · Livelihood activities

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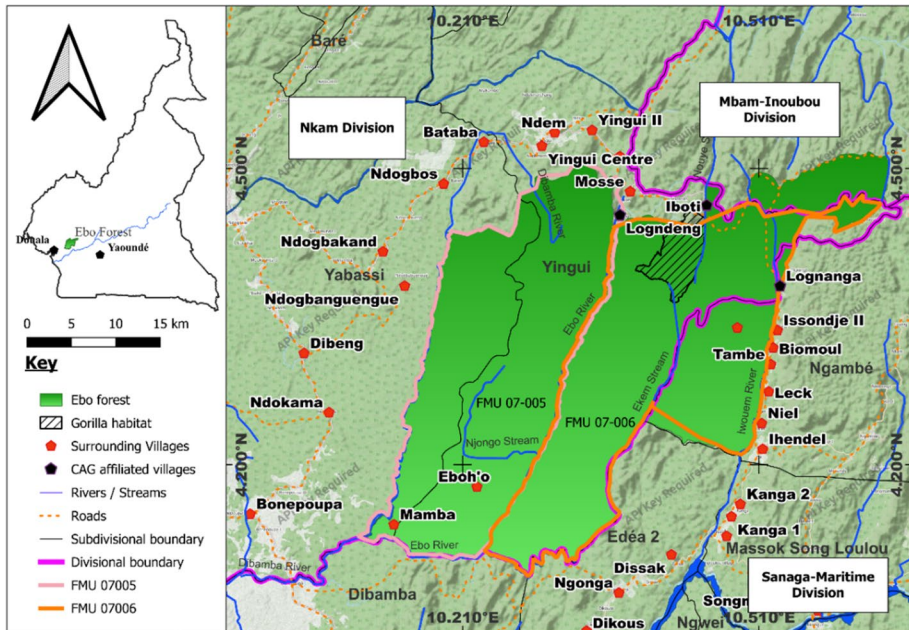
## Introduction

The conservation and sustainable management of biodiversity have become increasingly important on the political agenda of states and institutions in developing countries since the adoption of the Convention on Biological Diversity (CBD) at the United Nations Conference on Environment and Development (UNCED) during the Rio Summit in 1992 (Barber et al. 2014). Protected areas (from national parks to community-managed nature reserves) have been considered the cornerstones of biodiversity conservation (Lopoukhine et al. 2012). Effectively managed protected areas are critical for safeguarding biodiversity, maintaining the health of ecosystems, and building resilience to climate change (Mazaris et al. 2013; Schulze et al. 2018; Nila et al. 2019). Many governments have opted to expand protected areas as a conservation strategy to ensure the long-term availability of natural resources on a global scale (Adams 2004; Colchester 2004; Du et al. 2015). However, a study by Watson et al. (2014) revealed that half of all protected areas worldwide were inadequately managed, resulting in ecological disturbances, vegetation cover depletion, and declining populations of endangered species.

In Africa, the establishment of protected areas during both pre and post-colonial periods followed a paradigm of isolation often characterized by land dispossession and the marginalization of Indigenous peoples or local populations (Adams and Hutton 2007; Sheail 2010; Rights and Resources Initiative 2015). Management and decision-making were primarily centralized, reflecting the inappropriate “top down” approaches (Sournia 1990; Belle et al. 2015; Ndong et al. 2021). While this paradigm has somewhat contributed to the preservation of numerous plant and animal species in Africa (Mulder et al. 2007), including some gorilla populations, it has also presented sociological and financial challenges in the establishment and management of many protected areas (Doumenge et al. 2021). Generating support for protected areas requires strong social and economic arguments (IUCN 2000; Emerton et al. 2006). Typically situated in remote areas inhabited by impoverished populations heavily reliant on forest resources for basic needs, protected areas have sometimes been a source of conflict between local communities and conservationists (Nicholas et al. 2010; Ayivor et al. 2013; van Vliet et al. 2017). These conflicts extend beyond management decisions to encompass issues of resource and land ownership, adversely impacting the conservation goals of protected areas (Grazia 1997; Edwards and White 2001; Nepal 2002). Additionally, institutions responsible for protected areas, such as the Ministry of Forestry and Wildlife (MINFOF) in Cameroon, frequently face a lack of funds, personnel, and logistical resources for effective wildlife protection (Nicholas et al. 2010; Ngoufo et al. 2014). To address these challenges, researchers like Adams et al. (2004) advocate for an integrated conservation plan that considers both biological and social dimensions to achieve mutually beneficial outcomes. Effective ecosystem conservation should be coupled with the collaboration of surrounding local communities, taking into consideration both sustainable ecosystem objectives and the welfare of Indigenous populations (Studer et al. 2023). Therefore, the concept of participatory and inclusive conservation is gaining traction, emphasizing the active involvement of local populations at all levels in biodiversity protection and recognizing local knowledge (Grazia 1997; Hasler 1999; Bennett et al. 2017; Dawson et al. 2024; Petriello et al. 2024). This approach aims to minimize the conflicts between conservation objectives and poverty alleviation within local communities (Shi et al. 2005; Cernea and Soltau 2006; Fisher and Christopher 2006; Pinto et al. 2007). Bennett et al. (2017) have highlighted the importance of understanding local community perceptions to enhance conservation activities.

Participatory conservation has not only helped to protect many species and ecosystems but has also significantly improved the living conditions of local and Indigenous communities (Rakotomahazo et al. 2019; Dawson et al. 2021). For example, Hasler (1999) reported that the CAMPFIRE project in Zimbabwe involved more than 250,000 villagers in protecting 26 areas through monitoring activities, environmental education, and co-management of incomes from ecotourism. The involvement of local communities in conservation activities has significantly contributed to the protection of great apes across Africa (Breuer et al. 2009; Bettinger et al. 2021; Chancellor et al. 2021). In East Africa, gorillas have benefited from ecotourism and research initiatives. Community participation in this region has promoted sustainable conservation practices, leading to gorilla population increases, economic growth, and poverty reduction in local areas (Bush 2010; Nielsen and Spenceley 2010; Bruch et al. 2011; Nielsen et al. 2011; Muresherwa et al. 2020). Mountain gorilla tourism has notably improved the economies of Uganda, Rwanda and the Democratic Republic of Congo (DRC) by creating jobs, providing entrepreneurial opportunities, and enhancing local infrastructures (Muresherwa et al. 2022). However, there are fewer successful examples of local community integration in conservation in Central Africa. A key exception is the co-management of the Lossi Gorilla Sanctuary in the Republic of Congo, which promoted ecotourism and improved living conditions of local populations with new sources of income (Mbété et al. 2007). Nicholas et al. (2010) also reported that the involvement of local groups called “Gorilla Guardians”, initiated by the Wildlife Conservation Society (WCS) at three sites in Cameroon’s South-West Region, has yielded encouraging results in protecting Cross River gorillas (*Gorilla gorilla diehli*). In this region, collaboration with “Gorilla Guardians” in gorilla monitoring helped to record a significantly higher number of nest sites in a more cost-effective and efficient manner compared to using researchers-only survey protocols.

The Ebo forest (~2000 km<sup>2</sup>), administratively located in the Littoral Region of Cameroon, represents one of the most ecologically valuable and intact areas of the Yabassi Key Biodiversity Area (Key Biodiversity Areas Partnership 2024) within the Gulf of Guinea biodiversity hotspot (Morgan et al. 2011). This forest harbours a small gorilla population of unknown taxonomic affinity (*Gorilla gorilla*) inhabiting about 39 km<sup>2</sup> in the northern part of the forest (Morgan et al. 2003; Dunn et al. 2014; Mfossa et al. 2022). Hosting a diverse array of threatened and endemic plant and animal species, the forest Ebo is also home to many emblematic mammal species, including the forest elephant (*Loxodonta cyclotis*), a population of the Critically Endangered Preuss’s red colobus (*Piliocolobus preussi*), one of the largest populations of Nigeria-Cameroon chimpanzees (*Pan troglodytes ellioti*), and drills (*Mandrillus leucophaeus*) (Abwe and Morgan 2008; Morgan et al. 2011; Abwe 2018; Whytock et al. 2021; Mfossa et al. 2022; Murphy et al. 2023). Recognizing its ecological significance and sociological values, the Cameroonian government gazetted approximately 1400 km<sup>2</sup> of the Ebo forest to become a national park in 2006 (Morgan 2010; Dunn et al. 2014). However, the creation of the Ebo National Park has been protracted due to opposition from the local communities that claimed land ownership of the area. In response, the government proposed the establishment of two logging concessions within the originally proposed area of the Ebo National Park (~1400 km<sup>2</sup>) in February 2020 (Abwe and Morgan 2020). Despite significant national and international opposition, this decision was formalized in April 2023 through two decrees, converting the Ebo forest into two Forest Management Units (FMU) covering 650.07 km<sup>2</sup> and 683.85 km<sup>2</sup>, respectively (Fig. 1). This decision poses a risk of biodiversity depletion in the Ebo forest, given the well-established link between logging and forest loss and degradation, particularly when there are inadequate



**Fig. 1** The Ebo forest, including the gorilla habitat (stripped zone), the two Forest Management Units (FMU), and the adjacent communities. Interviews were conducted with local populations in the three CAG affiliated villages—Iboti, Logndeng and Lognanga—located in the northern part of the forest near the Ebo gorilla habitat

control measures on the ground (Curran et al. 2004; Asner et al. 2005; Tchatchou et al. 2015; Rainforest Foundation UK 2021). For instance, among the 600 native tree species found in Cameroon, logging has contributed to 50 of these species being listed as Critically Endangered under the International Union for the Conservation of Nature (IUCN) Red List, while 27 species are considered Endangered, and another 106 species are listed as Vulnerable (Butler 2006; Sra 2021). Alemagi and Kozak (2010) reported that more than 50% of Cameroon's logwoods was harvested illegally from the forest, including forests allocated as concessions. In addition to forest degradation, which negatively affects animals' habitats and food availability, unsustainable logging without strict control measures contributes to the decline of wildlife due to increase of hunting activities and bushmeat trade in the area (Bennett 2000; Bennett and Gumal 2001; Benítez-López et al. 2019). Logging directly and indirectly affects all components of biodiversity, from genes to landscapes (Bertault et al. 1997; Putz et al. 2001; Dauber et al. 2005; van Kuijk et al. 2009). The case of Ebo needs attention, as its classification under the Forest Management Units has raised significant concerns among various stakeholders. For comparison, Stokes et al. (2010) reported that in the Ndoki-Likouala Conservation Landscape in northern Republic of Congo, the densities of large mammals (including elephants, gorillas and chimpanzees) were very low in the logged areas with no anti-poaching measures. Simultaneously, evidence indicates that the Ebo gorilla population, along with the rich biodiversity in the area, faces increased threats from overhunting, illegal wood extraction, and forest degradation (Whytock and Morgan 2010; Dunn et al. 2014; Fuashi et al. 2019; Mahmoud et al. 2020; Mfossa et al. 2022). The situation worsens with the

new logging concessions. When conducted unsustainably, logging exacerbates poverty in local communities and conflicts among stakeholders (Efoua 2002; Oyono et al. 2005; Alemagi and Kozak 2010).

In response to anthropogenic threats affecting the forest, the Cameroon Biodiversity Association (CAMBIO), a local NGO operating in the Ebo forest since 2005 under the auspices of Ebo Forest Research Project (EFRP), recognized the need to empower local communities for conservation efforts. After extensive discussions with local traditional authorities in Logndeng, Iboti and Lognanga—the three villages closest to the Ebo gorilla habitat (~39 km<sup>2</sup>)—, the community conservation association named '*Club des Amis des Gorilles*' (CAG) was established in August 2012 with the approval of local administrative authorities (Abwe and Morgan 2012; Abwe et al. 2014). The initiative behind this community group is to use the gorilla as a flagship species to protect the rich biodiversity of the Ebo forest, including the gorilla population exclusively found in the northern part of Ebo and adjacent to these three villages (Abwe and Morgan 2012; Mfossa et al. 2017, 2022, 2023). CAG's mission involves implementing effective community conservation activities to promote sustainable local development. Each of the three villages (Iboti, Logndeng and Lognanga) has its own CAG group, which is legally registered as an association and operates under a constitution (Abwe et al. 2015; Mfossa et al. 2017, 2018). Although participation is voluntary and open to all community members, individuals are required to pay a registration fee of 500 FCFA (approximately US 1\$) and sign a commitment agreement, attesting their engagement to protect gorillas, their habitat, and the overall biodiversity of the Ebo forest. Since its establishment, CAG has engaged in activities such as sensitization campaigns within and outside its communities, monthly surveys within the gorillas' habitat to update distribution data, reporting anthropogenic threats, and promoting alternative sustainable livelihoods to reduce reliance on the forest (Abwe and Morgan 2012; Dunn et al. 2014; Mfossa et al. 2017, 2018, 2022). To support these activities, CAG receives technical and financial assistance from CAMBIO (e.g., 1,800,000 FCFA annually, with 600,000 FCFA allocated to each CAG affiliated village). This support covers the food costs for volunteer members to participate in monthly gorilla monitoring activities and the expenses for annual livelihood projects within the community (Mfossa 2023).

Based on the perceptions of local populations, this study aims to investigate the contribution of the community-based conservation initiative, supported by the CAG, to wildlife preservation over a 5-year period (2013–2017). Specifically, we assess whether there were significant changes between 2013 and 2017 in people's hunting practices, regarding their opinions on the utility of CAG (particularly in relation to forest biodiversity preservation), and their perceptions of CAG's impact on community welfare. We also assessed the influence of socio-economic variables of the respondents on their opinions regarding CAG conservation activities. We hypothesize that this community-led conservation initiative has contributed to raising local conservation awareness and improving livelihoods, resulting in greater community engagement in conservation efforts within the Ebo landscape.

## Methodology

### Study area

The Ebo forest, situated in a sub-montane lowland region, exhibits a warm and humid tropical equatorial climate characterized by two seasons (dry and rainy seasons) and an annual

rainfall ranging from 2500 to 3000 mm (Letouzey 1982; Morgan 2010; Abwe 2018). Encompassing an area of approximately 2000 km<sup>2</sup>, this forest constitutes a significant portion of Cameroon's coastal forest (Letouzey 1968; Dowsett-Lemaire and Dowsett 2001). The Ebo forest mainly spans into two administrative divisions, including Nkam and Sangha-Maritime, with geographical coordinates ranging between longitudes 10.100° E and 10.620° E and latitudes 04.100° N and 04.520° N (Fig. 1). Despite being the customary land of more than 42 villages of the Banen and Bassa clans, the forest remains largely uninhabited. The current population resides in only 22 surrounding villages (Fig. 1), which are heavily reliant on forest resources for their sustenance (Morgan and Abwe 2006; Mbimbe et al. 2022; Mfossa 2023). Following the displacement of native populations during Cameroon's independence wars in the 1960s (Ndedi and Ndedi 2006; Mouiche 2012; Issekin 2020), repopulation of the area has been gradual. According to the 2005 national census (BUCREP 2005), the total population of the three study villages (Iboti, Logndeng and Lognanga) near the gorilla habitat was estimated at 519 individuals. During our survey period (2013–2017), the *Club des Amis des Gorilles* (CAG) was the only active community conservation initiative in these villages. The Club is organized into two main bodies: the General Assembly and the Executive Bureau. The General Assembly includes all registered Club members and meets quarterly. The Executive Bureau, responsible for managing the daily affairs of the Club, consists of eleven elected members, including the village chief, and is led by a president. The Bureau serves as a renewable 2-year term and meets monthly to discuss the Club's activities and conservation strategies.

## Study method

We reviewed literature related to the community-based conservation approach and the CAG initiative, including relevant documentation from each group in the area, such as constitutions, monthly and annual reports, and other materials related to their activities (e.g., handbooks, newsletters, newspapers; Suppl. Mat. Table S1). Thereafter, we administrated a semi-structured questionnaire in 2013 and again in 2017 to household heads in the affiliated CAG villages (Logndeng, Iboti and Lognanga) (Suppl. Mat. Table S2). The questionnaire aimed to investigate local opinions on CAG's role and impact on conservation and household welfare in the communities. The interviewed communities predominantly belong to the Banen clan in the Yingui subdivision within the Nkam Division (Fig. 1).

We conducted interviews with the heads of 78 households in 2013 and 68 in 2017, representing 92% and 80% of households in the communities, respectively. For both surveys, we targeted all households in the three CAG-affiliated villages (Iboti, Logndeng, and Lognanga). During the survey period, no one in the community refused to participate to the questionnaire survey. The questionnaire collected information on socio-demographic characteristics (i.e., age, civil status, education, religion, and occupation), respondents' CAG membership (i.e., yes or no), and their opinions on the role and impact of CAG (i.e., its importance in (a) biodiversity protection and conservation, (b) members' welfare/benefits, or (c) promoting community development). The age of the interviewees included in this study started at 15 years old, as household heads are defined as individuals responsible for their household, whether they live independently or with family members. Before conducting the survey, we informed respondents about the survey's purpose, the intended use of data, and ensured that survey data would remain anonymous and confidential. Due to the anonymous nature of the questionnaire, we were unable to link the information of participants who took part in both surveys. We obtained verbal consent, following the Free,

Prior and Informed Consent (FPIC) guidelines. Interviews were conducted in French, the predominant language spoken in the region, and when necessary, the questionnaire was translated in *Tune* (the Banen local language) by a native field assistant who also served as an interpreter. Additionally, we considered informal meetings and discussions as part of the information exchange with individuals. The interviewer (D. M. M.) had extensive experience working in these villages for approximately a decade as a CAMBIO staff.

## Data analysis

We conducted all statistical analyses using R version 4.3.1 (R Development Core Team 2023). To assess potential changes over time (from 2013 to 2017) in hunting practices and motivations for joining the ‘*Club des Amis des Gorilles*’ (CAG), we conducted chi-square tests of independence. We then analysed adjusted residuals as a post-hoc test to determine whether observed frequencies significantly differed from the expected frequencies (Agresti 2007). To examine factors influencing respondents’ perceptions of CAG utility and importance over time, we applied a Bayesian Multivariate Generalized Linear Mixed Model (MCMCglmm) using the MCMCglmm package (version 2.36) (Zhao et al 2006; Hadfield 2010, 2024). The response variables, *CAG utility* and *CAG importance*, were binary (coded as 1 = perceived as useful/important, 0 = perceived as not useful/not important). The models included the Year (2013 versus 2017), Age, Education level, Occupation, and CAG membership (coded as a binary variable: 1 = member, 0 = non-member) as fixed effect predictors. A categorical distribution was used to model the multinomial outcome. Respondent ID was excluded as a random effect due to its negligible variance. Each model was run for 10,000 iterations, with a burn-in period of 2000 iterations and a thinning interval of 3 to ensure reliable parameter estimates. We then ran a second MCMCglmm model to assess the influence of socio-demographic variables on respondents’ opinions regarding CAG utility in the community. Here, the response variable was categorized into four levels: (1) the CAG is useful for biodiversity conservation, (2) negative opinion (not useful at all), (3) useful for village development, and (4) useful for CAG members (used as the reference category). The explanatory variables included age, education level, occupation, and CAG membership. To account for data dependency across years and potential repeated measurements (as respondent ID was unavailable), we included Year and respondent ID as random effects. This model was run for 13,000 iterations, with a thinning interval of 10 and a burn-in period of 3000 iterations. For all models, we reported the posterior means of fixed effects with 95% credible intervals (CI) and p-values (pMCMC) for each predictor. The analyses included all respondents from 2013 and 2017 ( $N=146$ ). The Bayesian approach we employed provides advantages in estimating complex hierarchical structures and addressing uncertainty in conservation sciences when analysing opinion-related data from questionnaire surveys (Hadfield 2010; Dingemanse and Dochtermann 2013; Houslay and Wilson 2017; Finn 2024).

## Results

### Socio-demographic characteristics of the respondents

The majority of respondents were males (86% and 88% in 2013 and 2017, respectively), reflecting a male-headed household structure prevailing in these three communities. As

**Table 1** Socio-demographic characteristics of the respondents

Age range	2013 (%)	2017 (%)	Civil status	2013 (%)	2017 (%)
15–30 years old	24.4	33.8	Married	47.4	39.7
31–45 years old	25.6	35.3	Single	38.5	45.6
> 45 years old	50.0	30.9	Widower	14.1	14.7
Religion (church)	2013 (%)	2017 (%)	Education level	2013 (%)	2017 (%)
Christian (Protestant)	53.8	29.4	Primary	51.3	45.6
Christian (Catholic)	17.9	19.1	Secondary	39.7	48.5
Christian (Pentecostal)	14.1	7.4	University	3.8	2.9
Jehovah witness	5.1	2.9	No schooling	5.1	2.9
Muslim	0.0	1.5			
No religion	9.0	39.7			

illustrated in Table 1, the majority of respondents in 2013 were aged over 45 years old, with 47% being unmarried. In contrast, in 2017, the majority fell within the 31 to 45 year-old groups, and 46% were single. The population was predominantly identified as Christian, with a significant affiliation to the Protestant (Anglican) church, accounting for 54% and 29% in 2013 and 2017, respectively. More than 90% of participants received formal education, with only a small percentage having attended university, or higher school (4% in 2013 and 3% in 2017). In the absence of secondary school in the region, respondents with secondary or higher levels of education had prolonged periods of residence in towns prior to resettling in the local villages. The main occupations in these communities are farming and hunting (the latter being associated with bushmeat trade), which are subsequently the primary sources of protein and income.

All respondents were engaged in farming to varying degrees. However, farming was the primary activity for 77% of respondents in 2013 and for 53% in 2017. In contrast, hunting was the primary activity for 9% of the respondents in 2013 and for 41% in 2017 (Suppl. Mat. Fig. S1). Most farmers produced both cash crops (cocoa) and food crops concurrently (54% in 2013 and 43% in 2017), whereas a smaller proportion focused exclusively on food crops (17% in 2013 and 26% in 2017). The majority farmed both for consumption and for sale, constituting 72% in 2013 and 71% in 2017. Farming generated low income with most of respondents (64% in 2013 and 70% in 2017) declaring that they earned less than 100,000 FCFA annually from farming (500 FCFA  $\approx$  \$1 US) (Suppl. Mat. Fig. S2).

Our survey revealed that hunting remains prevalent in this area, with 41% of the respondents in 2017 reporting hunting as their main occupation. Hunters employed various techniques, including snares and guns. Contrary to our prediction, the prevalence of hunting practices, whether conducted by the respondent or a family member, remained stable (51% of respondents in 2013 and 49% in 2017) with no significant decrease over time (chi-squared = 0.11,  $df = 1$ ,  $p = 0.74$ ). Over time, hunting emerged as a more lucrative source of income in these communities compared to farming. The proportion of respondents earning at least 50,000 FCFA per month from hunting raised from 15% in 2013 to 43% in 2017 (Suppl. Mat. Fig. S2).

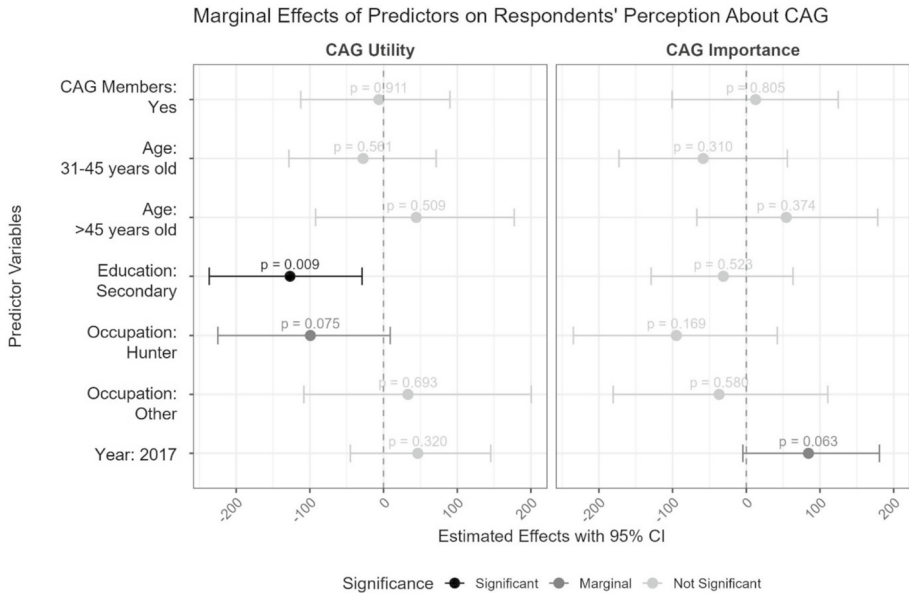
## CAG membership and motivation of members

During the initial phase in 2012–2013, a total of 231 individuals signed the CAG commitment form for membership, with 105 individuals in Logndeng, 76 in Iboti, and 50 in Lognanga, constituting more than 80% of the resident population in these three communities. The proportion of respondents who were CAG members remained stable over time, with 81% of the interviewees in 2013 and 79% in 2017. No socio-economic variable (i.e., age, level of education, occupation) significantly influenced the probability of membership in CAG (Suppl. Mat. Table S3). The motivations for joining the CAG were classified into four categories: (1) conservation purposes, (2) curiosity, (3) personal benefits, and (4) community development. We found that these motivations shifted significantly over the two periods ( $\chi^2=25.15$ ,  $df=3$ ,  $p<0.001$ ). In 2013, 55% of respondents primarily joined CAG out of curiosity, whereas in 2017, 54% joined for conservation purposes (Suppl. Mat. Fig. S3). Additionally, there was an increase over time in the proportion of respondents mentioning personal benefit (from 5% in 2013 to 19% in 2017) and community development (2% in 2013 to 13% in 2017) as reasons for joining the CAG.

## Villagers' opinions regarding the importance of CAG and its contribution to biodiversity conservation and the welfare of the local population

The local population acknowledges ongoing overhunting as a primary factor contributing to wildlife depletion in the forest. In 2017, 73% of respondents reported a decline in wildlife abundance over time. Nevertheless, 92% of respondents expressed a positive opinion about the CAG, and respondents surveyed in 2017 were marginally more likely to hold a positive opinion compared to those surveyed in 2013 ( $p=0.063$ ) (Fig. 2). The Bayesian models revealed that education level and occupation were the key predictors of respondents' perceptions of CAG utility (Fig. 2). Respondents with secondary education were significantly less likely to perceive CAG as useful ( $p=0.009$ ). Additionally, hunters were marginally less likely to view CAG as useful ( $p=0.075$ ). No other or socio-demographic variables had a statistically significant influence on respondents' perceptions of CAG importance and utility.

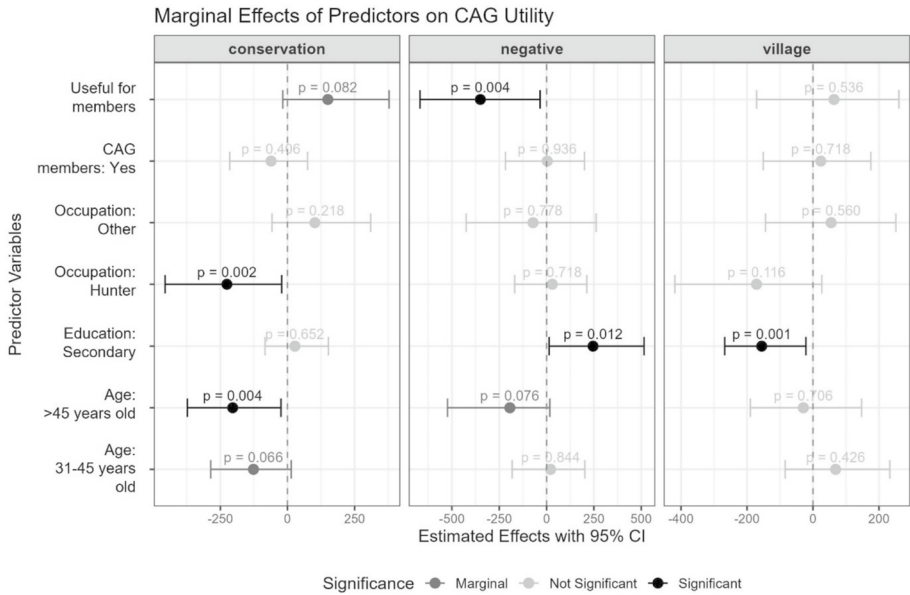
Among the respondents, those who considered CAG important primarily viewed its contribution in terms of forest conservation (35% of respondents in 2013 and 28% in 2017) or village development (40% in 2013 and 37% in 2017). A minority of the respondents believed that CAG was most beneficial for registered members, comprising 18% of respondents in 2013 and 27% in 2017 (Suppl. Mat. Fig. S4). Respondents described CAG's contribution to wildlife conservation as involving monthly wildlife monitoring in the forest, organizing or participating in various meetings, and conducting sensitization campaigns in the communities (Suppl. Mat. Table S5). Conservation was a primary motivation for joining CAG, with 91% of respondents in 2013 and 85% in 2017 reporting regular participation in CAG activities (e.g., monthly and quarterly meetings for the Executive Bureau and the General Assembly, respectively; monthly gorilla monitoring or sensitization campaigns). Ninety-eight percent of respondents recognized CAG as the only conservation association in their area. Many respondents (38% in 2013 and 49% in 2017) attested that CAG played a crucial role in educating themselves or others about wildlife values through sensitization campaigns, with 82% acknowledging that they gained knowledge about gorillas' biology, behaviours, range, and importance



**Fig. 2** Marginal effect plots showing respondents' perception of CAG utility and CAG importance (positive vs. negative) in relation to their socio-demographic characteristics (e.g., occupation, education level, age) and the survey year. Dots represent estimated effects, and error bars indicate 95% confidence intervals. Reference categories: non-CAG members, age 15–30 years, primary education, farmer occupation, and survey year 2013

through CAG activities. For both years, 75% of respondents stated that CAG livelihood projects implemented in their community (Suppl. Mat. Table S4) improved their living conditions, while 12% considered these projects insignificant.

The Bayesian mixed model indicated that all socio-demographic variables, except for CAG membership, significantly influenced respondents' opinions on CAG's utility (Fig. 3). The perception of CAG's usefulness for biodiversity conservation showed a marginal positive trend compared to its benefits for Club members (posterior mean = 150.27, 95% CI: -17.59 to 378.45, pMCMC = 0.082). However, respondents were significantly less likely to hold a negative opinion about CAG's utility compared to its usefulness for members (posterior mean = -349.68, 95% CI: -668.26 to -34.04, pMCMC = 0.004). Regarding CAG's utility for biodiversity conservation, age had both significant and marginal effects. Individuals over 45 years old (posterior mean = -203.97, 95% CI: -372.79 to -24.27, pMCMC = 0.004) and those aged 31–45 years (posterior mean = -126.73, 95% CI: -285.68 to 13.94, pMCMC = 0.066) were more likely to perceive CAG as benefiting its members rather than biodiversity conservation. However, individuals over 45 years old were marginally less likely to have a negative perception of CAG's utility compared to its usefulness for members (posterior mean = -193.81, 95% CI: -522.93 to 17.02, pMCMC = 0.076). Education level also influenced opinions on CAG's utility. Respondents with secondary education or higher were significantly more likely to express a negative opinion about CAG's utility (posterior mean = 245.21, 95% CI: 13.68 to 514.48, pMCMC = 0.012) and were more inclined to perceive CAG as benefiting its members (i.e., personal gain from CAG



**Fig. 3** Marginal effect plots showing the influence of socio-demographic variables (age, education level, occupation, and CAG membership) on respondents’ opinions regarding the utility of CAG in the community. The opinion categories considered are: **a** usefulness for biodiversity conservation, **b** negative opinion (not useful at all), and **c** usefulness for village development, with “CAG is useful for members” as the reference category. Points represent the posterior mean estimates, while the horizontal error bars indicate the 95% credible intervals. Reference categories for the predictors include: non-CAG members, farmer occupation, primary education, and age group 15–30 years

activities) rather than contributing to village development (posterior mean = -155.43, 95% CI: -267.59 to -21.48, pMCMC < 0.001). In contrast, individuals with hunter occupations held a significantly more negative opinion of CAG’s utility for biodiversity conservation (posterior mean = -225.43, 95% CI: -455.63 to -21.70, pMCMC = 0.002) compared to its usefulness for members (Fig. 3).

## Discussion

This study aimed to examine the impact of community-based conservation initiatives, exemplified by the ‘Club des Amis des Gorilles’ (CAG), on local community welfare and their role in conservation efforts through awareness-raising and the promotion of alternative activities. Operating as a voluntary membership group in the three villages (Iboti, Logndeng and Lognanga) close to the Ebo gorilla habitat, CAG promotes conservation initiatives in the landscape. Based on community surveys undertaken in 2013 and 2017, we found that most household heads expressed positive opinions regarding the CAG’s contribution to their communities and overall welfare. These contributions include forest preservation through CAG-led monthly monitoring, community engagement via various sensitization campaigns (Suppl. Mat. Table S5), and local development through sustainable livelihood projects initiated by CAG members over the 5-year study (Suppl. Mat. Table S4, Fig. S4). These findings align with previous studies suggesting that sustained conservation

efforts positively influence populations attitudes towards conservation, thereby promoting participation of local community in the management of their natural resources (Breuer and Mavinga 2009; Roe et al 2009; Nicholas et al. 2010; Tranquilli et al. 2014; Akenji et al. 2019; Tarimo and Mgomia 2018; Marzo et al 2023). Further analysis of our data suggested that socio-demographic variables, such as education and occupation, play an important role in shaping respondents' opinions about the utility of CAG for biodiversity conservation and village development. However, we recognize that future studies should consider incorporating longitudinal tracking of respondents to better assess individual changes in perception over time and community-level influences on responses. Additionally, other authors have highlighted the role of environmental education and sensitization campaigns in fostering positive attitudes and perceptions towards conservation among local populations (Marchini and Macdonald 2020; Yousefpour et al. 2022).

Besides the positive impacts of the CAG on community welfare, hunting activities (snaring and/or gunshot) remained prevalent in the three villages over the years. Many respondents reported a decline in wildlife abundance within their forest; however, this depletion is not limited to the gorilla habitat (~39km<sup>2</sup>) but extends to the entire Ebo forest (~2000km<sup>2</sup>). Nevertheless, there is optimism that sustained conservation efforts in these communities could help alleviate hunting pressures on the gorilla habitat. Informal discussions with local residents suggest that great apes, particularly gorillas, are no longer a target for hunting. In fact, gorillas are now considered as a source of pride for many community members. Furthermore, based on our ongoing fieldwork and observations in the region, hunting activities appear to have shifted towards other species, such as duikers, porcupines, red river hog, and likely guenon monkeys. Many hunters also report that hunting has become increasingly difficult. Regarding this context, the persistence of substantial hunting activity could be attributed to the remote location of these village, typically to areas where hunting and bushmeat trade are often key sources of income and animal protein for many households (Bahuchet and Ioveva 2000; Abernethy and Obiang 2010; Brasharesa et al. 2011; van Vliet et al. 2014; Foerster et al. 2012; Walelign et al. 2019). In the Ebo landscape, the poor maintenance of roads, which deteriorated further after 2013, significantly limited vehicular access. This led to increased difficulties in transporting farming products to city markets, likely resulting in a greater dependence on natural resources for food supply and income generation over the years. The poor road conditions were commonly cited as the key reason for abandoning agriculture in favour of hunting, a finding supported by Mbimbe et al. (2022), who identified inadequate road infrastructure as a major challenge for local communities in the Ebo landscape. A majority of respondents in both years (64% in 2013 and 70% in 2017), reported earning less than 100,000 FCFA per year from farming, whereas hunting and bushmeat trade can generate over 50,000 FCFA per month (Suppl. Mat. Fig. S2). However, the probable increase in the proportion of respondents earning at least 50,000 FCFA per month, from 15% in 2013 to 43% in 2017, could be a consequence of the rise in bushmeat prices rather than an increase in hunting efforts. For example, during the rainy season in the Ebo landscape, bushmeat like porcupine or duiker carcass can generate significantly higher income (approximately 1250 FCFA per kg) compared to cocoa beans (maximum 800 FCFA per kg), making it a more lucrative option with less effort. Farming alone cannot meet the basic needs for farmers throughout the year in this area, as their income is significantly below the Inter-professional Guaranteed Minimum Wage (SMIG) recommended by the Cameroon government (41,875 FCFA per month). Despite a desire to participate in conservation activities, the precarious living conditions in these remote areas, coupled with insufficient support from agricultural technicians and limited economic opportunities, may lead local populations to opt for more immediately rewarding

but less sustainable practices, such as hunting. To reverse this trend, the government and NGOs could invest in improving the road network, as recommended by local stakeholders (Mbimbe et al. 2022), to facilitate the transportation of local farmers' products beyond the villages. However, any road project within the Ebo landscape should be managed with strict prior environmental impact assessments and regular anti-poaching patrols to mitigate wildlife depletion (Quintero 2012; van der Grift et al. 2017; Boruszko et al. 2018; Moore et al. 2018; Sakar et al. 2022; Mulero-Pázmány et al. 2023; Paemelaere et al. 2023). Furthermore, as the logging concessions are now authorized in the landscape, traditional authorities, CAG members, and local NGOs should deploy greater efforts in forming vigilance committees, sensitizing, and raising awareness among local communities. Opening new roads for logging will likely lead to easier access of hunters coming from other regions of Cameroon.

Conversely, several elements suggested an enduring trust in the CAG over time, reflecting resilience in long-term conservation efforts in the region. These indicators included the sustained membership and the acknowledgement by 75% of respondents that CAG contributes to improving the welfare of the villagers through job opportunities, outreach programs (Suppl. Mat. Table S5), or livelihood initiatives. Although CAG's investments span various community domains (i.e., education, community building, farming input, etc.), elders, educated individuals, and hunters expressed that CAG was more beneficial for its members rather than for the broader community. Respondents with secondary or higher education levels viewed the contribution of CAG less positively than those with only primary or no formal education. These findings are consistent with previous research in the region showing that hunting prevalence increased with higher levels of educational attainment (Whytock et al. 2018). In our survey, many higher-educated villagers had lived in urban centers for extended period of time, either to attend secondary schools or due to their family's relocation during the independence period. As a result, they became accustomed to urban lifestyles and perceived conservation efforts as an opportunity to maintain or improve their standard of living. Such individuals often have abstract perceptions of conservation values, hold unrealistic expectations from conservationists, or exhibit conflicting aspirations that are at odds with conservation goals (Redpath et al. 2013). Kato et al. (2019) similarly reported that urban individuals in Japan, presumed to have higher education levels, lacked a comprehensive understanding of wildlife values. Therefore, we hypothesize that in the Ebo region, individuals with higher education levels may have less specific knowledge about the natural resources, and consequently, show less interest in biodiversity preservation. Further research should investigate why high educated people appear to underestimate conservation impacts in the region.

Local community involvement in biodiversity conservation and sustainable resource management was demonstrated through the voluntary participation of CAG members in wildlife surveys, as well as various capacity-building initiatives and awareness campaigns. The CAG monitoring team regularly reported their findings, including gorilla sighting, evidence of hunting, and other illegal activities, to traditional authorities and local stakeholders on a monthly basis. This reporting often prompted enforcement actions, such as sanctions for offenders and alerts to the administrative officials when necessary. Drawing on their knowledge of gorilla distribution, CAG members and local communities, in collaboration with traditional authorities (village heads and elders), designated the gorilla habitat and proposed it as a 'no-go-zone' (Fig. 1) for hunting or other illegal activities (i.e., zone where hunting or any illegal activity is prohibited), with predefined penalties for violations. This 'no-go-zone' proposal, alongside regular meetings, participation in local events, and sensitization campaigns (e.g., sporadic visits in primary schools, workshops), all indicate a progressive establishment of a long-term

conservation program in the region. Through the “no-go-zone” approach, traditional authorities, villagers, and stakeholders should collaborate to define permitted activities within the gorilla habitat and establish penalties for various violations. This approach aligns with Studer et al. (2023), who emphasized that effective forests and natural resource conservation relies on fully integrating local communities, while balancing ecosystem sustainability with the welfare of indigenous populations. However, despite the generally positive opinions from the communities, further efforts are needed to ensure the preservation of the Ebo forest’s wildlife, as the majority of respondents reported a significant decline in wildlife abundance due to overhunting in the area.

It is widely known that providing community-based incentives are among the most effective approaches to reduce local pressure on natural resources (Bulte and Damania 2005; Melinda et al. 2020; Meeks et al. 2024). Our investigation revealed that CAG made tangible contributions to the welfare of local communities, supported by financial aid from the NGO-CAMBIO. Annually, CAG benefited 1,800,000 FCFA (approximately US \$ 3,600) from CAMBIO, which supported monitoring activities (including food cost and needs of the CAG members during wildlife monitoring), and small livelihood projects in the three villages near the Ebo gorilla habitat. The remaining funds were used for community development outreach projects, including infrastructure improvements, road maintenance, educational support, and creation of community plantations (Suppl. Mat. Table S4). In addition to financial support, CAG members received training in various skills (e.g., the use of research equipment such as GPS and camera trap for monitoring, data collection techniques during gorilla survey, fabrication of soaps, and sustainable techniques for collecting non-timber forest products). They also participated in conferences and workshops, enhancing their understanding of biodiversity and sustainable resource management. Despite these achievements, local expectations include a desire for permanent employment or substantial income from farming or livestock activities. The recent establishment of two logging concessions poses a significant threat to the Ebo forest if strict conservation measures are not implemented. Logging roads are likely to provide easier access for hunters from other regions, and the presence of logging companies offering job opportunities may attract migrant workers, potentially undermining conservation efforts. To mitigate these risks, it is crucial to designate the gorilla habitat and other key biodiversity areas within the forest as conservation zones in the management plans of both Forest Management Units. Community conservation groups, such as CAG, along with traditional authorities and NGOs, must intensify efforts to increase livelihood activities, raise awareness, promote education, and ensure the sustainable management of natural resources among stakeholders, including local communities.

This study focused on the opinion of household heads, revealing the patriarchal structure of households in the region, as the majority of our respondents were men. This generated some limitations given the diverse composition of these communities. Therefore, future surveys should adopt a more inclusive approach, targeting all population segments, including a significant proportion of women and youth, to provide a more representative sample.

## Conclusion

The Ebo forest, harbouring significant biodiversity, necessitates urgent preservation efforts. The ‘*Club des Amis des Gorilles*’ (CAG), a local community conservation initiative, represents an initial step toward actively involving local communities for effective conservation in the Ebo landscape. This study aimed to assess local perceptions of

the CAG initiative and provides a foundation for the development of long-term conservation strategies in the area. Our findings demonstrated the substantial contribution of CAG to raising local community awareness and improving the welfare of local populations between 2013 and 2017. Despite the positive perception of community members towards conservation activities, hunting practices targeting certain wildlife species (excluding great apes) remain prevalent in the region, primarily due to the remoteness of the area and limited livelihood alternatives. Therefore, more concerted efforts are required in the near future to reduce wildlife hunting and mitigate the impacts on gorillas and their habitat. To ensure long-term conservation success, we advocate for the implementation of socio-economic projects in agriculture (such as cash crops farming and agroforestry systems) and livestock (including poultry and pig farming) in nearby villages to reduce poaching pressures. While community participation in conservation planning is widely recognized as an effective strategy, its applicability varies across regions due to differences in traditional management practices, habitat characteristics, and community backgrounds. Hence, further investigation into the socio-economic significance of wildlife resources, particularly gorillas, for communities near the Ebo forest is essential. Future surveys should adopt a more inclusive approach, targeting all population components. This research provides valuable insights into local aspirations for natural resources management and strengthens the foundation for ongoing participation in conservation programs. Sustained external financial and technical support from both the government and the international community remains crucial to facilitate outreach activities and ensure the long-term preservation of the Ebo forest and its valuable natural resources.

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**Data availability** Data used in this research are available from the corresponding author upon reasonable request.

## Declarations

**Competing interests** The authors declare no competing interests.

**Ethical approval** Our study was conducted under research permission from the Cameroonian government delivered to CAMBIO. Verbal informed consent was obtained from the community and each interviewee

prior to the start of the interview. Interviewees were informed that the data from this study would be published but their personal information will not be shared with third parties.

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