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Source: Tropical Conservation Science, 14(1)

Published By: SAGE Publishing

URL: <https://doi.org/10.1177/19400829211026775>


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Tropical Conservation Science
Volume 14: 1–16
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DOI: 10.1177/19400829211026775
journals.sagepub.com/home/trc


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Abstract

Human-elephant conflict (HEC) poses a serious problem in Africa for both local livelihoods and elephant conservation. Elephant damage is the price local people pay for coexisting with this species, and is assumed to reduce tolerance for elephants. However, conservation-related projects, through the benefits they offer may enhance local tolerance toward elephants. This study aimed to examine how crop damage by elephants and the benefits gained from conservation activities affect local people's tolerance toward elephants around Moukalaba-Doudou National Park in southwest Gabon based on long-term ethnographic research and interview surveys in two periods (2010 and 2019). Based on the results, crop damage by elephants had a significant negative impact on the local social economy, leading to a decrease in human population in the area and making local people highly resentful of elephants. However, in one of the villages where employment from research and conservation activities was concentrated, many acknowledged the benefits associated with wildlife and expressed high tolerance for elephants. These findings suggest that benefits from conservation activities can increase tolerance toward elephants, which is negatively affected by the crop damage they cause. However, it should also be noted that externally generated projects have limitations and drawbacks. It is important to establish a system in which the benefits of conservation are shared widely and distributed appropriately, and wherein income resources are diversified. Multisectoral interventions focusing on local socio-ecological vulnerability are needed to mitigate human-elephant conflict and advance the conservation of African elephants.

Keywords

Central Africa, human–elephant relationship, crop-raiding, conservation, local socio-economy, multi-sectoral approach

Human-wildlife conflict (HWC) is a growing global challenge with adverse effects for both local people and wildlife conservation (Dickman, 2010; Nyhus, 2016). In particular, large mammals can cause massive damage to local people, leading to negative perceptions about that species (Kansky & Knight, 2014; Naughton-Treves & Treves, 2009). Such negative perceptions can undermine conservation efforts by increasing revenge killings or support for poaching (Epanda et al., 2019; Roe & Booker, 2019). Therefore, understanding the relationship between HWC and local perceptions regarding wildlife is crucial, especially in rural areas of developing countries, because

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Received 13 January 2021; Revised 29 May 2021; Accepted 2 June 2021

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people are highly dependent on natural resources, and HWC undermines the wellbeing of local communities in the areas (Barua et al., 2013; Hill, 2004).

Human-elephant conflict (HEC) is a serious problem in Africa, posing a major concern for elephant conservation (Shaffer et al., 2019). African elephants (savannah elephants (*Loxodonta africana*) and forest elephants (*L. cyclotis*)) cause serious crop damage in many countries (Hoare, 2015; Shaffer et al., 2019; Virtanen et al., 2020). Such damage also indirectly leads to increased poverty, food insecurity, labor shortage for crop cultivation, and physical as well as mental health problems among local people (Barua et al., 2013; Walker, 2012). Such direct and indirect damage generally reduces locals' tolerance toward elephants (Hariohay et al., 2018; Hill, 2004; Nsonsi et al., 2017) and could potentially increase poaching (Compaore et al., 2020).

Although "tolerance" is used in various contexts in conservation literature (Knox et al., 2021), in this study, it is defined as "the ability and willingness of an individual to absorb the extra potential or actual costs of living with wildlife" (Kansky et al., 2016: 138, see also Virtanen et al., 2020). The net perceived costs and benefits for a person resulting from the presence of a species in the area can be the main factors in determining tolerance toward the species (Kansky et al., 2016; Kansky & Knight, 2014). Here, costs include not only direct monetary losses but also indirect costs perceived by the person, such as the psychological costs of fear and danger or risk (Bruskotter & Wilson, 2014; Kansky & Knight, 2014).

Protected areas (PAs) can have both positive and negative impacts on local tolerance toward elephants because there are both gains and losses associated with living with elephants. First, PAs can augment the cost borne by local people through a double burden: high risk of damage by elephants in adjacent areas (Graham et al., 2010; Hariohay et al., 2020) and limited resource use because of regulated or prohibited human habitation and natural resource use within PA boundaries (Brockington et al., 2006; West et al., 2006). Alternatively, PAs can provide benefits that improve local livelihoods, such as the economic benefits and infrastructure development, through tourism and/or research activities related to nature conservation (Lahm, 1996; Naughton-Treves et al., 2005; Oldekop et al., 2016; Wittemyer et al., 2008). If such benefits can offset the costs of living with elephants, locals may develop tolerance toward them (Nsonsi et al., 2017; Ntuli et al., 2019).

Understanding the complexity of HEC and the effects of conservation activities on local tolerance for elephants requires a transdisciplinary approach including sociological points of view (Dickman, 2010; König et al., 2020). It is important to examine local socioeconomic contexts, such as natural resource usage by local people, income

opportunities, availability of infrastructure and public services, and population changes, based on long-term field research.

Gabon, a country in Central Africa (267,600 km²), is estimated to be home to half of the world's remaining forest elephant population (Maisels et al., 2013). It is estimated that about 63,000–76,000 elephants inhabit the country (Thouless et al., 2016). Gabon has actively engaged in biodiversity conservation, building 13 national parks in 2002, establishing logging concessions, and developing eco-tourism (Yobo & Ito, 2016). Owing to such efforts and low human population densities, Gabon has maintained a high level of forest cover, at 91% of the country's land (Food and Agriculture Organization, 2020).

While such high level forest cover with low human population densities contribute to elephant conservation (Barnes et al., 1997; Breuer et al., 2016; Fairet, 2012), HEC is a serious concern in rural Gabon, where local people experience crop damage, economic loss, and increased labor costs because of elephants, leading to resentment and sometimes intolerant behavior toward them, such as illegal killing (Fairet, 2012; Lahm, 1996; Walker, 2012). In recent years, while research on HEC in Gabon has increased (Fairet, 2012; Fairet et al., 2014; Ngama et al., 2016, 2018, 2019; Walker, 2012), it remains limited to specific study sites. Further, few studies have examined local tolerance toward elephants in consideration of the benefits of wildlife conservation.

The aim of this study, therefore, is to examine how crop damage by elephants and the benefits gained from conservation activities affect local people's tolerance toward elephants around Moukalaba-Doudou National Park (MDNP) in southwest Gabon. First, we review the socioeconomic situation and its changes in the area over a decade, considering the effects of conservation and the research projects conducted there. Second, we examine the general situation of crop damage and local perceptions in the study area using interview surveys. Third, we compare local tolerance toward elephants between the villages adjacent to the park, where conservation-related activities have been actively conducted to other villages, where these activities are significantly limited. Based on the results, we discuss the socioeconomic aspects of HEC in rural Gabon and the effects of conservation projects on local tolerance, suggesting the importance of a multisectoral approach to HEC mitigation.

Methods

Study Sites

This study targeted the eastern border area of MDNP, covers 5,028 km², located in the southwest of Gabon

(Nyanga province) (Figure 1). In the area, several villages exist along a road from the nearest town to the park gate, and human activities have been persistent over the years. The area was established as a forest reserve in 1962 and upgraded to a national park in 2002. The landscape of the area is characterized by forest-savannah mosaic with diverse habitats and rich biodiversity including large mammals, such as elephants, western lowland gorillas (*Gorilla gorilla gorilla*), and common chimpanzees (*Pan troglodytes*) (Nakashima, 2015; Yumoto et al., 2015). The annual rainfall at the study site during 2002–2013 was 1,176–2,043 mm (Hongo et al., 2018). There is a dry season (typically from May to September) and a rainy season (from October to May) with variations in timing and duration (Takenoshita et al., 2008).

The area's socioeconomic characteristics include low human population density and limited income generation activities. The villagers practice shifting cultivation as a principal subsistence activity and depend highly on agricultural products (Matsuura & Moussavou, 2015), of which cassava and plantain banana are the two

primary crops. Other crops such as maize, sugarcane, taro, yam, and peanuts are also cultivated. Local people collect firewood and other natural resources such as edible wild plants, mushrooms, and honey from the forest and savannah. Hunting and fishing are supplementary subsistence activities to obtain animal protein (Matsuura & Moussavou, 2015; Van Gils et al., 2019). Owing to the area's distance from the city, opportunities for cash income from the sale of agricultural crops (mainly plantain bananas) and forest products are scarce.

The socioeconomic conditions of the area have been considerably influenced by various external activities introduced to take advantage of the abundant natural resources and wildlife. From the 1960s to the 1980s, commercial logging was conducted, and many workers migrated to the area. This was also a source of job opportunities for local people. However, the closure of the logging base in 1989 led to a sharp decline in the human population and the abandonment of infrastructure.

Since the late 1990s, many research and conservation projects have been developed (Table 1), providing job

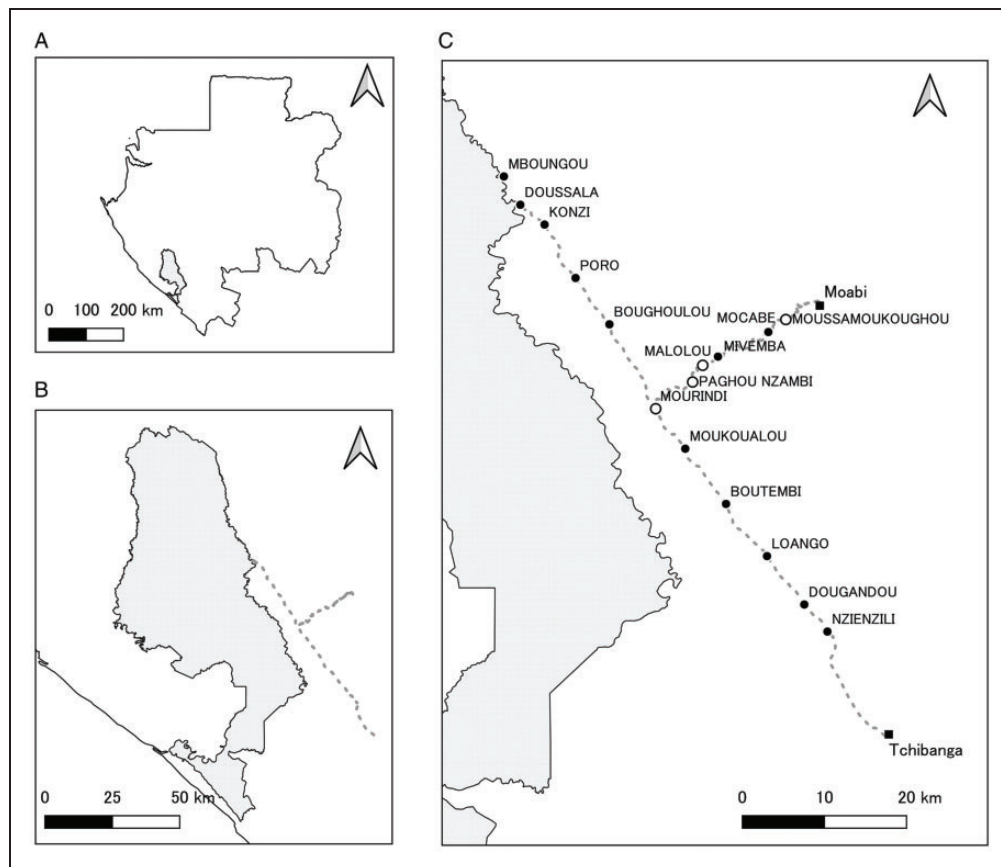


Figure 1. Map of the Study Area. Map (A) shows the location of the Moukalaba–Doudou National Park in Gabon. Map (B) shows the location of the study area around the Park and map (C) shows the locations of surveyed villages. Three villages—Mboundou, Doussala, and Konzi—are counted among those adjacent to the park in this study. Two of them, Mboundou and Konzi, do not currently exist (see Methods).

Table 1. History of Research and Development Activities Around the Study Area Since 1999 (Ando et al., 2008; Matsuura & Moussavou, 2015; Takenoshita, 2015).

Year	Events
1999	Research on western lowland gorillas began (ongoing as of 2021)
2002	(Establishment of the MDNP) A research base was constructed in Doussala.
2003	Habituation of western lowland gorillas began. A group of western lowland gorillas was habituated after several years.
2004	A locally based NGO (PROGRAM) was established and has promoted ecotourism.
2008	Socioeconomic study of local communities began (ongoing as of 2021)
2009–2014	A large-scale research project (PROCOBHA) was conducted.
2015	A research station was constructed in Doussala (as a part of PROCOBHA)
2015–2020	Ecotourism development project was conducted in collaboration between the research team and NGOs.
2016	Private tourism operators began operations.

opportunities mainly to people in the villages adjacent to the protected area (Mboundou, Doussala, and Konzi; Figure 1). In particular, research on great apes, jointly conducted by Japanese and Gabonese researchers, has continued since 1999. Almost all villagers had employment opportunities, at least in a temporary capacity, as staff for gorilla tracking or maintaining the infrastructure. Some villagers have also been permanently employed as research assistants.

The successful habituation of a group of western lowland gorillas and implementation of local development projects in the area have provided direct employment and job opportunities to local people (Ando et al., 2008; Matsuura & Moussavou, 2015; Takenoshita, 2015). A locally based non-governmental organization, *Protectrice des Grand singes de la Moukalaba (PROGRAM)*, founded in 2004, has also engaged in conservation and development activities by promoting ecotourism. Under the ecotourism development project conducted by researchers and tourism professionals with the support of the Japanese government since 2015, some people including research assistants and PROGRAM staff have been trained as ecotourism guides. A community center was established in Doussala, located next to the park, as an ecotourism hub. Along with such activities, private tourism operators also began operations, bringing tourists to the area; some villagers earn an income by serving as guides and providing other services. While such activities related to research, conservation, and ecotourism have resulted in income generation, a significant improvement of the socioeconomic situation has not yet been observed in the area (Matsuura & Moussavou, 2015; Van Gils et al., 2019).

Data Collection

We examined socioeconomic changes in the study area considering the effects of conservation projects, situation of crop damage by wildlife and the related protection measures through participant observation and interview

surveys. We also examined local people's tolerance toward elephants through interview surveys. The study was conducted with the approval of the Centre National de Recherche Scientifique et Technologique and by the Agence Nationale des Parcs Nationaux. Prior to the observation and interview, the participants were fully informed of the study's purpose, and verbal consent was obtained.

Socioeconomic Changes and Conservation Projects.

Socioeconomic changes and the effects of conservation-related projects conducted in the study area were studied by long-term participant observation and interview surveys.

The last author (NM) has conducted ethnographic research in the area from 2008 to 2020. NM and the third author (GMM) have also been involved in a large-scale research project for biodiversity conservation and local development, titled "Conservation of Biodiversity in Tropical Forest through Sustainable Coexistence between Human and Wild Animals (PROCOBHA)," conducted from 2009 to 2014, and in an ecotourism development project conducted from 2015 to 2020. NM regularly visited the study area mainly for the project activities and stayed there for approximately one year in total: August–September 2008, February–March 2009, September 2009–January 2010, August 2010, January–February 2011, December 2011–January 2012, August 2012, April 2013, April 2014, December 2014, December 2017, December 2018, and December 2019. GMM visited the study area several times a year between 2010 and 2019 for project activities. The authors observed socioeconomic changes in the area through their participation in projects and assessed the impact on the local community focusing on population changes, income opportunities and local economic development, and the availability of infrastructure and public services. In particular, information in three villages adjacent to the park (Mboundou, Doussala, and Konzi; Figure 1) was collected intensively based on ethnographic research. NM conducted the research in French, which

is the official language; most villagers including elders can speak it. As GMM is a native from the study area, his portion of the research was mainly conducted in the local language (*ipunu*).

To examine the socioeconomic situation of the area extensively, focus group interviews at villages between the border of MDNP and the two nearest cities (Tchibanga and Moabi; Figure 1) were also conducted twice: 12 villages in September 2010 (by NM), and 10 villages out of the 12 between December 2019 and January 2020 (by the first author (ST) and NM). The number of villages surveyed decreased in the second survey because the inhabitants of the two villages adjacent to the park, Mboungou and Konzi, had all relocated. At each village, we explained the objectives of our study to the village chief and then started a focus group interview with the chief and a few village representatives selected by the chief after confirming his or her consent to participate. In most cases, both men and women participated in the focus group interview.

In the focus group interview, we confirmed the population of the village and the existence of social infrastructure (schools and clinics). If schools and/or clinics existed, we also sought to determine whether they were functional. General comments on living conditions were recorded if any were made. All interviews were conducted in French by NM, with translations into the local language made by a local research assistant when necessary.

Damage by Elephants and Related Measures. To examine the situation of crop damage caused by elephants and the preventive measures taken, we asked for participants' comments on them during the focus group interviews in 2010 and 2019–2020. In the 2019–2020 survey, we also conducted semi-structured individual interviews after the focus group interview. As respondents for the semi-structured interviews, from among the participants of the focus group interview, we selected adult farmers from different households who possessed a house in the village. In Doussala, a village adjacent to the park, we interviewed seven respondents: one person from every household. In other villages, we interviewed one to six representatives. Although we were interested in obtaining responses from a variety of age groups, more than half of the respondents were over 60 years old, corresponding to the actual proportion of members in each age group that we encountered during the survey. Individual interviews were also conducted in French, supplemented with translations into the local language.

In the semi-structured interview, we asked the respondents to rank the top three problematic animal species and rate the damage by each on five levels (1: no, 2: small, 3: medium, 4: large, 5: very large) in order to understand the impact of damage by elephants and

compare it with that by other animals. To understand their recognition of changes in the damage caused by elephants, we asked the participants to rate: (1) changes in the extent of elephant damage over the years (a: increasing, b: stable, c: decreasing, d: don't know, e: others), (2) time of day during which visits by elephants were most frequent (a: daytime, b: night, c: anytime), and (3) the seasonality (a: dry season, b: rainy season, c: no particular season, d: others). We also asked about the measures taken to prevent damage by wildlife, proven effective measures that had not yet been implemented, responsible persons or authorities in charge of dealing with damage by wildlife, and the expectations that they had of them.

Recognition of Conservation Benefits and Tolerance Toward Elephants. To understand local perceptions of coexistence with elephants and the effects of conservation activities on these perceptions, through the semi-structured individual interviews conducted in 2019–2020, we examined (1) the benefits locals derived from conservation of wild animals including elephants and (2) participants' tolerance toward living with elephants. Based on prior experience, we were aware that if we asked only about elephants, locals would tend to focus only on crop damage, making it impossible to examine their potential positive perceptions of or tolerance toward elephants. Therefore, we expanded the scope of the questions from elephants to wild animals in the first item.

Participants were questioned on the following three types of benefits: (1) wild animals, (2) parks, and (3) tourism. Regarding their tolerance toward living with elephants, we sought to determine the following: (1) whether the participants accepted living near wild animals (including elephants) and (2) whether they accepted that elephants were killed to protect their crops. The responses to the above five questions were rated as "Yes" or "No." When respondents struggled to understand the meaning of the question and could not answer clearly, the responses were excluded from the data set. As for the perceptions related to the benefits of wildlife conservation and tolerance toward elephants, we also used qualitative information from comments during the focus group interviews.

Results

Changes in Socioeconomic Situation

Research, conservation, and development activities have affected the socioeconomic condition of the study area for a long time. The large-scale research project (PROCOBHA) was particularly notable in terms of socioeconomic impact. Almost all the people in the villages adjacent to the park were involved in the project and

Table 2. Changes in Population and Public Facilities of Villages in a Decade Around MDNP.

Village	Population*		School		Clinic	
	2010	2019/2020	2010	2019/2020	2010	2019/2020
Mbougou**	20–30	—	N	—	N	—
Doussala	100–120	30–40	Y	N (CI)	Y	N (CI)
Konzi**	10–20	—	N	—	N (CI)	—
Poro	10–20	<10	N	N	N	N
Boughoulou	10–20	<10	N	N	N	N
Moukoulou	30–40	20–30	N (CI)	N (CI)	Y ****	Y
Boutembi	30–40	10–20	Y	N (CI)	Y	Y
Loango	100–120	100–120	Y	Y	Y	Y
Dougandou	100–120	20–30	Y	N (CI)	Y	Y
Nzienzili	100–120	50–60	Y	N (CI)	N (CI)	N (CI)
Mivemba	30–40	30–40	Y ***	N (CI)	Y ****	Y ****
Mocabe	140–160	100–120	Y	Y	Y ****	Y ****

N(CI): once set but closed at the research.

*Populations represent the number of all individuals despite age in the village.

**Village did not exist in 2019.

***Non-functional school because of absence of teachers.

****Clinic without nurses and medicines.

derived the direct benefit of employment opportunities. While most benefits were concentrated in Mbougou, Doussala, and Konzi, other villages also indirectly benefited in several ways. First, income opportunities increased in many villages even without direct employment from the projects. The research activities activated the local economy and stimulated the flow of people and commodities. Research and conservation projects also led to the maintenance of roads and bridges, with project vehicles occasionally providing the locals with transportation from and to cities. Although school supplies, medicines, materials for mitigation of crop damage, and support for local agricultural development projects were provided mainly for the three villages adjacent to the park, there were partial benefits to other villages as well.

However, in the past decade, negative socioeconomic changes have been observed in the whole study area, partially influenced by the termination of the PROCOBHA. Based on the surveys conducted in 2010 and 2019–2020, the changes in population and public facilities (schools and clinics) in villages around MDNP are shown in Table 2. First, it is noteworthy that two villages (Mbougou and Konzi) disappeared in this period. Second, the population in most other villages, particularly in Doussala, declined significantly.

The change in Doussala's population from 2010 to 2019–2020, based on the ethnographic research in each year, is shown in Figure 2. The population of Doussala increased during PROCOBHA implementation (2009–2014), peaking in 2012 because several outsiders, mainly those in their twenties and thirties who had relatives in Doussala, came there in search of employment. Some came with their families and others got married in

the village. In addition, some people living in Tchibanga sent their children to live with their relatives in Doussala who had a stable income, because of the economic difficulty of raising children in town. Thus, the proportion of young people and children in the population also increased (Figure 2). On the contrary, the populations in Mbougou and Konzi declined owing to rapid migration to Doussala during the project period; this was because many people and goods were accumulated only in Doussala and it was convenient to work in the project. Consequently, there were no inhabitants left in Konzi (in 2013) and Mbougou (in 2015).

After the termination of the PROCOBHA, employment opportunities drastically decreased, causing a considerable population decline and adverse socioeconomic effects in Doussala. The population of Doussala in 2014, the year of the termination of the PROCOBHA, was 127 persons, which was more than that in 2009, when the project launched, but it has declined sharply since then (Figure 2). Compared to the peak in 2012, there was a nearly 80% decrease by 2016 and little change in January 2020 (Figure 2). The decline occurred because outsiders left Doussala in search of other job opportunities. In addition, many people who had lived in Doussala, particularly those of working age and their families, moved to local cities. Owing to the population decline, the primary school closed and the clinic stopped functioning because of the absence of nurses in 2016 (Table 2). Only a few families of the research assistants regularly employed by the ongoing project and some elders remain in the village. As population aging continues, economic activities have also shown a significant decline.

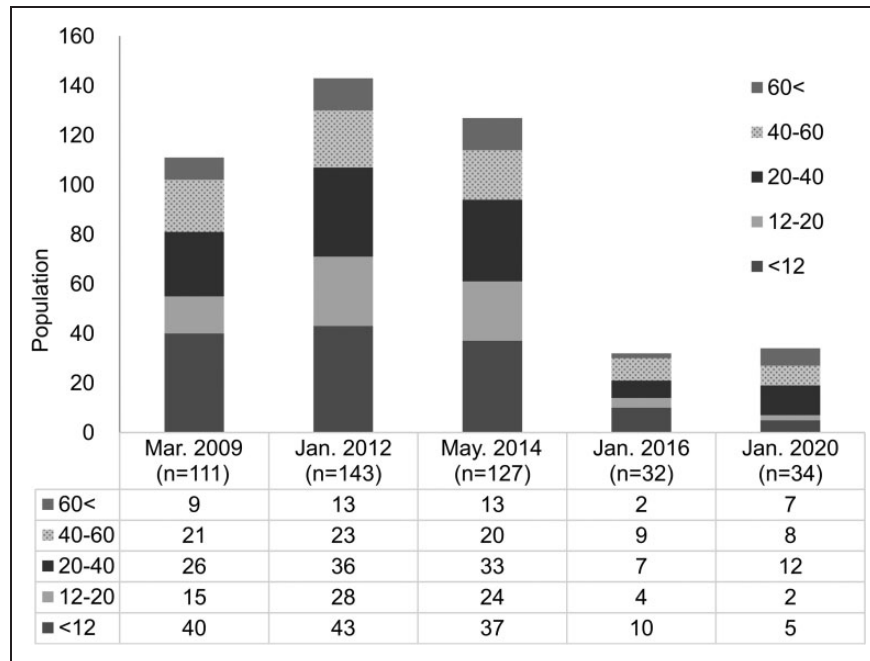


Figure 2. Changes in the Population of Doussala Village.

Significant population decline and deterioration of public facilities occurred in other villages as well (Table 2). Schools functioned at only two large villages out of the ten surveyed in 2019–2020, while half of them functioned in 2010. Transportation infrastructure has also deteriorated owing to a lack of maintenance after the project. While there has been public restoration of roads and bridges in some places, road conditions have been gradually worsening, and car traffic has decreased. In the 2019–2020 survey, most people we observed in almost all villages were older adults. In focus group interviews at the villages, there were discourses such as “all families with children have left in order to send their children to school” and “only older adults remain in this village,” suggesting that rapid population aging is occurring throughout the area.

Recognition of Damage by Elephants

The two focus group interviews, in 2010 and 2019–2020, revealed that crop damage by wild animals has occurred continuously for a long time, with no other HWC such as infrastructure destruction and injuries to humans being reported. The following animal species were mentioned as problematic by many respondents in both surveys: elephants, greater cane rats (*Thryonomys swinderianus*), African brush-tailed porcupines (*Atherurus africanus*), gorillas, chimpanzees, and monkeys including red-capped mangabeys (*Cercocebus torquatus*). No clear differences in crop-raiding animal species were found between the survey periods.

Both qualitative and quantitative results showed that crop damage by elephants has remained the major problem within HWC in the area over the decade in question. Respondents often complained: “Elephants cause the most severe damage” and “Something should be done about it.” Some said that elephants destroy “everything” in the field when they visit. In the semi-structured individual interviews in 2019–2020, 93.0% of the 31 respondents ranked elephants as a problematic animal, followed by cane rats (71%), porcupines (29.0%), and gorillas (19.8%). In Doussala, all seven respondents ranked elephants as the first, while in Mocabe, the farthest village from the border of the park, three of six respondents answered “no damage by elephants yet.” Moreover, most respondents (80.6%) evaluated damage by elephants as “very large,” while only 6.5% evaluated damage by cane rats as “very large” and no one evaluated damage by gorillas as “very large” (Figure 3). Thus, elephants were recognized as the most problematic wildlife in the area because of large-scale crop damage.

Regarding the pattern of crop damage by elephants, the majority (54.8% of the 31 respondents) selected “no seasonality,” while 22.6% believed it occurred more frequently in the “rainy season.” However, regarding the daily pattern, most respondents (74.2%) answered that elephants visited their fields “during the night” more frequently, and some people (n=6) answered “anytime.” Regarding the change in damage over the years, most respondents (67.7%, n=21) selected “increasing,” while three respondents answered “stable”

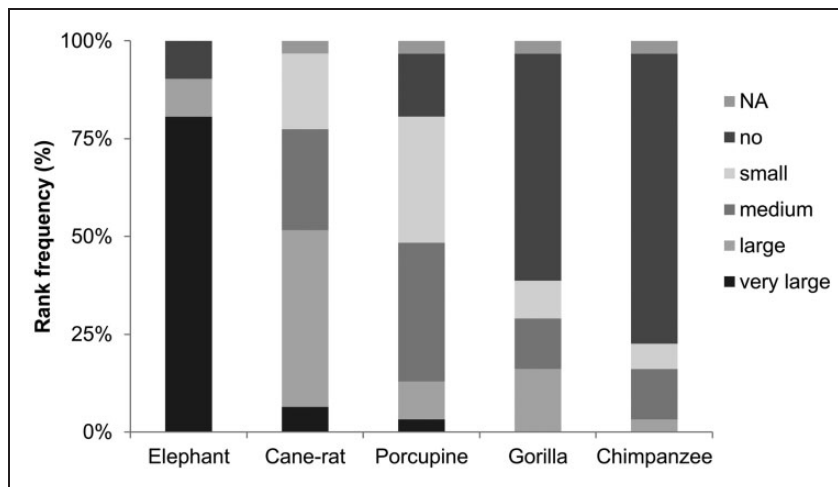


Figure 3. Local People's Ratings of Damage Caused by Each Wild Animal Species. Ratings by 31 respondents from ten villages around the MDNP in the survey in 2019–2020. (Doussala is included but Mbougou and Konzi are not because they no longer existed).

(including “always large”). Only two respondents said that as a result of changing the location of their fields, the damage was “decreasing.” Some respondents mentioned that it varied from one year to another.

Discourses in the two surveys revealed that such continuous crop damage by elephants had had a significant negative impact on the socioeconomic situation in the region over a decade. Particularly frequent in the second survey was the mention of the loss of cash income sources, with respondents making the following statements: “Because of elephants, we can no longer sell our crops” and “We used to sell bananas, but now we can't.” One participant stated, “I have a field, but no crops grow this year because of severe damage by elephants.” Some even mentioned that they did not want to live in the village anymore; instead, they desired to move to the town where their relatives lived because of the difficulties they faced. Such discourses suggest that the damage by elephants to crops and the resulting reduction of income sources contribute to the population exodus from rural areas.

The severity of elephant damage was also confirmed in ethnographic research in Doussala. The authors observed that some households lost almost all their crops because of elephant damage and were forced to depend highly on purchased foods every year from 2008 to 2012. Households of research assistants, in particular, tended to experience much damage because they lacked the human resources to protect their field while they participated in research projects. Owing to continuous damage, most villagers have recently begun living mainly in camps in their fields throughout the year to protect their crops. Normally there are only a few people remaining in the village, and sometimes the village becomes empty. The sharp population decline in

Doussala mentioned above (Figure 2) is closely related to the difficulty of living in conditions characterized by severe crop damage by elephants.

Protection Measures Against Elephant Damage

The statements obtained from the focus group interviews in both surveys indicated that simple measures had been taken to prevent wildlife crop damage, with no significant improvement in the situation over a decade. The measures implemented were fencing using lianas or metallic cables with noisemakers such as cans and metal sheets (only if available) and staying on guard by living in camps in the fields. When elephants approached guarded fields, they were chased away using noise, fire, and/or the light of torches. As protection measures against smaller mammals, short fences with lianas and cables or metal plates sometimes combined with cable snares were installed.

According to the individual interviews in the second survey, most respondents (74.2% of the 31) took measures to protect their fields against elephants, while others only implemented measures against small animals (all six respondents in Mocabe, one respondent each in Nzienzili and Mivemba). When we asked the respondents about measures they considered effective to protect fields from elephants but that they had not yet implemented, many people (51.6% of the 31) mentioned measures that had already been put into effect by other villagers, such as “metal plate fencing” ($n=7$), “fencing with metal cables” ($n=6$), and “guarding in camps” ($n=3$). On the contrary, some respondents ($n=9$) mentioned measures not practiced currently in the area, such as “killing elephants” ($n=4$), “electric fencing” ($n=3$), and “chasing away with guns” ($n=2$).

Table 3. Local People's Perceptions of Wildlife Conservation Benefits and Tolerance Toward Elephants in 2019–2020.

Questions	Village	Responses (%)		n
		Yes	No	
Benefits of wildlife conservation				
a. Benefits of wild animals	Doussala	42.9	57.1	7
	Others	20.8	79.2	24
	<i>Total</i>	27.6	72.4	31
b. Benefits of park	Doussala	100	0	7
	Others	0	100	21
	<i>Total</i>	25.0	75.0	28
c. Benefits of tourism	Doussala	85.7	14.3	7
	Others	4.3	95.7	23
	<i>Total</i>	23.3	76.7	30
Tolerance for living with wild animals				
a. Acceptance of living near wild animals	Doussala	85.7	14.3	7
	Others	17.4	82.6	23
	<i>Total</i>	33.3	66.7	30
b. Acceptance of killing elephants for crop protection	Doussala	57.1	42.9	7
	Others	100	0	22
	<i>Total</i>	89.7	10.3	29

Some respondents ($n=6$) did not express a clear opinion.

Discourses by local people showed lamentation and resignation over the lack of effective measures and support from authorities against elephant damage despite having made complaints to officials. Some people said “no one helps us” and “elephants are valued more than people in this country.”

Expectations from the authorities regarding protection from crop damage were touched upon in the individual interviews in the second survey. About one-third of respondents ($n=10$) wished the authorities to cull individual elephants that caused crop damage. Otherwise, they were willing to do the job themselves as long as they received permits for killing elephants as well as weapons such as guns, neither of which were easily available. The same number of respondents ($n=10$) wanted the agencies to protect their fields by setting up electric fences or at least providing the materials to build traditional fences. Only two respondents mentioned compensation. Some answered “I don't know what to ask for” and “I want something to be done anyway.”

Perceptions of Conservation Benefits and Tolerance Toward Elephants

Despite locals expressing negative perceptions regarding elephants because of massive crop damage, in the focus group interview from the 2010 survey, some people from different villages explained that conservation activities and the existence of parks are beneficial even though

interventions increase the elephant population. They noted that they could be accepting of conservation activities and parks but wanted something to be done to address the damage caused by wildlife. In the 2019–2020 survey, though the same opinion was expressed in a few villages, overall, the recognition of benefits from wild animals or activities relating to conservation was limited, partly because of the termination of the PROCOBHA.

Responses concerning the benefits of wild animals, parks, and tourism based on the individual interviews in 2019–2020 are summarized in Table 3. For all three questions, less than 30% of total respondents accepted the existence of benefits. Some answered, “They (government and actors from outside) do nothing for us,” and did not expect the benefit at all anymore. Others considered conservation or parks harmful because of the restriction on their activities without any compensation.

However, notable differences in perceptions were observed between Doussala and other villages; most people accepted the benefits only in Doussala (Table 3). First, nearly half of the respondents in Doussala recognized the benefits of wild animals, while this proportion stood at only about 20% in other villages. Second, the benefits of parks were recognized by all respondents in Doussala but by none of the residents of other villages. Third, the majority of Doussala's residents recognized the benefits of tourism while few did so in other villages. According to comments from the respondents, bushmeat obtained from legal hunting (elephants were not included) was regarded as a benefit of wild animals in both Doussala and other villages. On the contrary, research, conservation, and tourism were

recognized as benefits associated with the existence of wild animals only in Doussala. Respondents in Doussala expressed that they or their families could earn an income by being employed in activities conducted in and around the park, as research assistants or in tourism-related activities (gorilla habituation, tour guides for gorilla trekking and village visits, cooks, and other services). On the contrary, in other villages, respondents mentioned that the park and tourism were none of their business, and the benefits from tourism were limited only to some villages adjacent to the park. Even in Doussala, a few respondents noted that only some people could obtain tourism-related jobs.

The tolerance for living with wild animals including elephants clearly differed between Doussala and the other villages (Table 3). Most respondents in Doussala accepted living near wild animals, while such people were in the minority in other villages. Many respondents expressed that they could not accept living near wild animals that cause crop damage. Even if they answered “accept,” they tended to show negative perceptions such as “it is because there is no choice” or “I accept but of course I don’t want to live with crop-raiding animals, especially with elephants.”

Even if there was no actual damage, many locals felt intolerant toward elephants because of the high labor costs of protecting fields from potential damage. The constant risk of crop raiding and the significant mental damage it caused was a frequently expressed sentiment. According to ethnographic research in Doussala, the locals are forced to spend much time in camps in their fields in order to prevent elephant damage as mentioned above. If they leave the fields unguarded for even a single night, they expose themselves to the risk of elephant damage. In fact, the authors themselves observed a few cases wherein elephants caused enormous damage to fields when the locals had returned to the village for a few days around the Independence Day or New Year ceremony.

When asked about killing elephants to protect crops, all respondents in villages other than Doussala accepted this option; in Doussala, however, only half did so (Table 3). Some respondents who did not accept the option in Doussala answered that elephants were necessary for research and tourism. Furthermore, many respondents in both Doussala and other villages mentioned that killing should be adopted only to deal with problematic elephants or in small numbers, despite their frustration and anger toward elephants that damaged their crops. Some respondents commented that killing elephants was impossible regardless of their intentions because requests for permits were rarely accepted, they did not have guns, and there were no hunters in their village.

Discussion

This study found that in the rural areas of Gabon, crop damage by elephants had a significant negative impact on the local social economy and reduced local tolerance for the species. Although research and conservation activities have contributed to local economic development, the impact of the projects has been limited, and infrastructure and public services remain poor. As a result, the population has been declining and aging rapidly in the last decade. In particular, crop damage by elephants is one of the major threats to the local population as it is detrimental to livelihood, which depends largely on agriculture. Today, it is difficult to make agriculture compatible with elephant conservation in the area. However, only in the village where research and conservation activities were concentrated, many villagers perceived the benefits of parks and tourism and expressed negative opinions about killing elephants. It is suggested that benefits from research and conservation could, to some extent, increase tolerance for elephants, which has been reduced by the crop damage they cause.

Situation of Elephant Damage

Elephant damage leads to a negative perception of the species among local people across Africa (Hariohay et al., 2018; Nsonsi et al., 2017). In this study, many respondents stated that elephants can cause damage across seasons and time and that, once they enter a field, they cause widespread destruction. Such specific patterns of damage may increase negative feelings toward elephants regardless of the actual amount of damage (Hill, 2004).

The uncontrollable situation of elephant damage may also strengthen negative feelings by increasing the perceptions of the risk they pose (Hill, 2004). In the study area, almost no progress has been observed with regard to protecting fields from elephants over the last decade. Only traditional and simple methods are being implemented by the locals themselves, consistent with other areas in Gabon (Lahm, 1996; Walker, 2012). Although the Gabonese government aims to install electric fences to counter elephant crop damage (Ngounou, 2019), it is challenging to cover all rural areas and to manage the fences adequately, given the limited infrastructure and manpower (Lahm, 1996; Ngama et al., 2019; Walker, 2012). Although some respondents requested killing and compensation schemes, they have not been developed and implemented well in Gabon yet (Fairet, 2012). Further, studies have pointed out that killing and compensation schemes do not address the root causes of HEC (Hoare, 2015; Shaffer et al., 2019). In the absence of effective measures against HEC, people’s

initial sense of helplessness may be followed, over time, by lower tolerance toward elephants.

Link Between HEC and the Local Social Economy

The damage caused by elephants has worsened the socioeconomic situation and even accelerated rural exodus around MDNP. Crop damage, in particular, has deprived people of not only food resources but also opportunities for cash income through crop sales. Declining transportation infrastructure and vehicular traffic over the last decade have further reduced income opportunities. Furthermore, an increase in agricultural labor because of the implementation of damage prevention measures that depend on manpower, such as guarding the fields overnight, has taken a toll on locals' physical and mental health (Barua et al., 2013; Hill, 2004; Walker, 2012). These long-term hardships have forced people to leave their villages, leading to a population decline, especially among the younger generation. This population exodus, in turn, causes a shortage of human labor to control wildlife damage and a further increase in labor costs for farmers. They are thus trapped in a vicious cycle of elephant damage and rural decline.

This relationship between elephant damage and rural exodus is one of the characteristics of HEC in areas with low human population density and high dependence on agriculture. Lahm (1996) reported that the exodus of villagers may have led to further crop damage by elephants and other animals in rural Gabon (e.g., in the coastal province of Ogooué-Maritime), based on the results of the National Survey of HEC. Through surveys and cost-benefit analyses in several areas of Gabon, Walker (2012) also highlighted that the lack of farm labor is an important factor hindering the introduction of animal damage control measures. Fairet et al. (2014) discussed how the negative spiral of rural exodus has increased vulnerability to poverty and crop damage in Loango National Park in southwest Gabon. The situation around Loango National Park was very similar to MDNP; the main crop damage was caused by elephants, and the exodus of male youth increased the workload on older farmers and threatened subsistence agriculture (Fairet, 2012). Similar challenges may arise in rural areas of other countries with low human population densities and poor industrial development.

Effects of Conservation on Tolerance Toward Elephants

Our study revealed that even in socioeconomically vulnerable areas, benefits to the population from conservation activities can increase local people's tolerance for elephants. Long-term research and conservation activities around MDNP have generated employment and

even contributed to the survival of the village adjacent to the park, furthest away from the local cities. In this village, many people acknowledge the benefits derived from the park and tourism—such as employment—and have a higher tolerance for coexistence with elephants (Table 3). In the context of the Great Limpopo Transfrontier Conservation Area in Southern Africa, it has been reported that positive recognition of park rules or benefits from parks can increase positive perceptions of wildlife conservation (Ntuli et al., 2019). According to a study in Nouabalé-Ndoki National Park in northern Congo (Nsonsi et al., 2017), people engaging in conservation activities and/or living in the area where conservation projects are in place are more positive about elephant conservation. Thus, conservation-related activities can positively influence local people's perceptions of protected areas and elephants.

However, it should also be highlighted that externally generated conservation and development projects have limitations and drawbacks. In general, the areas benefiting from the activities and the beneficiaries vary owing to the extent of budgets, durations, activity types, and project systems and structures. In the MDNP study area, the benefits of research and conservation activities were localized only in the village adjacent to the park, and there was no power to stop the rural exodus from the area as a whole. Most people in other villages did not recognize the benefits of research and conservation activities at all, and even felt resentful of the imbalanced situation. Even in CAMPFIRE in Zimbabwe, a successful case of integrated conservation and development, there was a widespread dislike of and negative attitudes toward lion conservation (Gandiwa et al., 2013). While positive effects of conservation activities on local perception were observed in Nouabalé-Ndoki National Park as mentioned above, conflicts over benefit sharing and stakeholder involvement are inevitable (Nsonsi et al., 2017, 2018). Therefore, it is important to establish a system in which conservation benefits are shared widely and distributed appropriately, and wherein there is support to diversify livelihood activities without depending solely on conservation-related activities (Roe et al., 2020). One extreme example of the risk of depending only on income resources from outside is the drastic decline in tourism revenues caused by the coronavirus disease 2019 pandemic (Dickson et al., 2020; Paxton, 2020; Lendelvo et al., 2020). The development of alternative revenue streams and reconstruction of the existent benefit sharing systems is strongly recommended.

Implications for Conservation

This study showed that benefits from conservation activities around PAs can increase local tolerance for problematic animals, such as African elephants, through

contribution to the local social economy. Poverty alleviation and biodiversity conservation are linked and need to be addressed together (Adams et al., 2004), and elephant conservation should also be balanced with local development (Duffy et al., 2016; Hauenstein et al., 2019; Sampson et al., 2019). However, it is difficult to integrate conservation and development, and there are many projects that have not been very successful (McShane et al., 2011; Wicander & Coad, 2015). Sometimes they can even have negative impacts on the local community because they harm social relations and reinforce social distinctions among local people.

To avoid such negative effects on local communities, it is important for the design and implementation of projects to be rooted in a wider perspective based on a profound understanding of local communities (Bennett et al., 2017; Brooks et al., 2013; McShane et al., 2011). For that, interdisciplinary and long-term research to identify the backgrounds and social contexts of local communities is necessary. In particular, qualitative ethnographic information is powerful in revealing unique local contexts (Fairet et al., 2014; Setchell et al., 2017). Regarding mitigation of HEC as well, a broader understanding of human society—from local socioeconomic conditions to national policy and governance—along with knowledge of elephant ecology and resource distribution is imperative (Hoare, 2015; Shaffer et al., 2019).

The importance of the integrated management of rural landscapes based on a multi-objective and multi-sectoral approach for local development and conservation in Africa has recently emerged (Milder et al., 2014). For mitigation of HEC, therefore, the socio-ecological vulnerability of local people should be addressed through coordination among various related sectors, such as agriculture, local development, conservation, tourism, and even research (Brown, 2003; Fairet, 2012; Thiault et al., 2020). Such an integrated approach is important to formulate interventions to reduce trade-offs and promote co-benefits between development and conservation.

Acknowledgments

We thank Agence National des Parcs Nationaux and Centre National de Recherche Scientifique et Technologique for research permissions. We also thank Institut de Recherche en Écologie Tropicale and members of PROCOBHA and eco-tourism development projects, called ECOLOGIC for supports. We thank Etienne Akomo Okoue, Yuji Takenoshita, Steeve Ngama, Léa Larissa Moukagni, Mayuko Nomoto, Paul Loundou, and Stéphanie Bourgeois for discussions. We appreciate local people for participation in the surveys and their help during our stay.

Declaration of Conflicting Interests


The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by Japan Society for the Promotion of Science (JSPS) KAKENHI (grant Numbers JP19J00938 for Saeko Terada, JP17H04767 for Naoki Matsuura and JP16H02716 for Daiji Kimura) and Japan Science and Technology Agency/Japan International Cooperation Agency, Science and Technology Research Partnership for Sustainable Development (JST/JICA-SATREPS) (for the project, “Conservation of Biodiversity in Tropical Forest through Sustainable Coexistence between Human and Wild Animals” (PROCOBHA), headed by Juichi Yamagiwa).

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