# Lions of West Africa : ecology of lion (Panthera leo Linnaeus 1975) populations and human-lion conflicts in Pendjari Biosphere Reserve, North Benin

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# 3 Conservation of carnivore species in West Africa:

## Knowledge and Perceptions of local people towards human-carnivore conflicts in Pendjari Biosphere Reserve, Benin

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**Submitted**


### Abstract

Human-carnivore conflicts are common around fragmented reserves of West Africa. A better understanding of the perceptions of local populations towards carnivores is necessary for an improved management of populations of threatened carnivore species in the region. In this paper we used door-to-door interview surveys to investigate local peoples' knowledge and perceptions of carnivore conservation and conflicts and their predicting factors in the vicinity of Pendjari Biosphere Reserve, Benin. We found that people had a moderate knowledge of carnivores. Despite the fact that general peoples'perceptions of carnivores were negative, people had a generally positive view of conservation and tolerated livestock depredation. Fortunately, few supported retaliatory killing of carnivores and many were willing to see carnivores increasing in numbers despite perceived risks. We found some differences in the perceptions of the various ethnic groups. Berba appeared to be the most negative group while Waama were likely to be more tolerant. Knowledge and perceptions were mainly predicted by the culture and ethnic group of the respondents, their previous experience with carnivores, the nature of their activity, and their age. An approach integrating education, awareness and development of economic incentives is necessary to improve conservation prospects of large carnivores in Benin and West Africa. All actions should be adapted to the different ethnic groups' needs.



### Key words

communities, culture, ethnic groups, human-carnivores conflicts, management, perceptions, West Africa

## 3.1 Introduction

Human-wildlife conflicts are one of the most important threats to carnivore conservation worldwide (Nowell & Jackson, 1996; Woodroffe & Ginsberg, 1998). These conflicts have increased in recent decades due to human population growth and resulting habitat loss and fragmentation. They have been identified as one of the major causes of the decline of several carnivore populations in Africa (Woodroffe, 2001; Ogada *et al*., 2003; Patterson *et al*., 2004; Packer *et al*., 2005). Livestock predation and attacks on humans occurred at different intensities in Africa and involved species such as lions (Ogada *et al*., 2003; Packer *et al*., 2005; Kolowski & Holekamp, 2006; Van Bommel *et al*., 2007). Conflict-related mortality of carnivores along the border of protected areas could be very important (Woodroffe, 2001; Polisar *et al*., 2003; Kolowski & Holekamp, 2006; Kissui, 2008). High numbers of carnivores, mainly lions, are reported killed by herders in Kenya (Patterson *et al*., 2004; Kolowski & Holekamp, 2006; Hazzah *et al*., 2009), Tanzania (Kissui, 2008) and Cameroon (De Iongh *et al*., 2009; Tumenta *et al*., 2010).

Attacks and perceived dangers from carnivores generate negative perceptions and attitudes towards carnivores (Mishra, 1997; Marker *et al*., 2003; Holmern *et al*., 2007; Hazzah *et al*., 2009). A number of studies investigated the characteristics and determinants of human-carnivore conflict in Africa (Ogada *et al*., 2003; Patterson *et al*., 2004; Van Bommel *et al*., 2007; Kissui, 2008) but fewer focused on the social dimensions of this problem (Hazzah *et al*., 2009; Inskip & Zimmermann, 2009; Dickman, 2010). It is generally acknowledged that protected areas and endangered species conservation cannot be successful if local communities are not actively involved and local perceptions, behaviour and needs considered (Fiallo & Jacobson, 1995; Ite, 1996; Mehta & Kellert, 1998; Weladji *et al*., 2003).

Perceptions and attitudes about carnivores vary greatly according to several factors. Understanding and knowledge of individual species have been found to affect perceptions and attitudes towards carnivores and conflicts (Conforti & de Azevedo, 2003; Shivik *et al*., 2003; Lindsey *et al*., 2005). Taboos have existed for millennia (Gadgil *et al*., 1993) and may have an effect on the relationship between societies and their environment (Colding & Folke, 1997; Berg, 2001). The socio-economic situation of respondents also influences perception and attitudes (Oli *et al*., 1994; de Boer & Baquete, 1998; Ericsson & Heberlein, 2003; Lindsey *et al*., 2005; Morzillo *et al*., 2007). Other factors such as distance from protected areas, experience with carnivores, and benefits from conservation can affect how locals perceive carnivores (Zimmermann *et al*., 2001; Williams *et al*., 2002; Ericsson & Heberlein, 2003; Karlsson & Sjöström, 2007; Lindsey *et al*., 2005; Schumann *et al*., 2008) or not (Casey *et al*., 2005). It is difficult to predict perceptions and attitudes based on these factors (Zimmermann *et al*., 2005).

In West Africa, human-carnivore conflicts have been identified as one of the major causes of the drastic decline in populations of carnivores including the lion, which is considered as Regionally Endangered (Bauer *et al*., 2003; Nowell & Bauer, 2004). Few studies have attempted to identify the characteristics and determinants of these conflicts (Garba & di Silvestre, 2008; Sogbohossou *et al*., in press). Little research has investigated the attitudes of local people about biodiversity and conservation (Vodouhê *et al*., 2010) and to date none has tackled the human dimensions of conflicts. This knowledge is necessary in order to organize appropriate actions for conflict mitigation and carnivore conservation in this region.

The purpose of this study was to determine local people in the vicinity of the Pendjari Biosphere Reserve, Benin, perceive carnivores in order to make suggestions for mitigation of impacts and carnivore conservation in West Africa. This includes: (1) the assessment of the knowledge and perceptions of local people towards carnivores and livestock depredation, and (2) the investigation of factors that determine their various perceptions.

## 3.2 Methodology

### 3.2.1 Study area

This study was conducted in the Pendjari Biosphere Reserve (10°30' to 11°30 North; 0°50' to 2°00' East) in north-western Benin (Fig. 1). The reserve is composed of Pendjari National Park (2,660 km$^2$), Pendjari and Konkombri Hunting Zones (respectively 1,600 km$^2$ and 251 km$^2$), and a buffer zone with controlled land-use access for local populations. The climate, typical of the Sudanian area, is characterized by one dry season and one rainy season. Annual rainfall varies from 800 to 1,000 mm. The vegetation is a mixture of dry and gallery forests and savannahs, which are burned every year by the park staff. A variety of wildlife species characteristic of Sudanian savannahs inhabit the reserve including lion, spotted hyaena *Crocuta crocuta*, cheetah *Acinonyx jubatus*, leopard *Panthera pardus* and wild dog *Lycaon pictus* (Delvingt *et al*., 1989).

Pendjari Biosphere Reserve is bordered by two main roads (Tanguieta-Porga and Tanguieta-Batia) along which about 24 villages were established and one main city, Tanguieta. Four main ethnic groups live in the area: Berba and Bourba along Tanguieta-Porga and Waama and Gourmantché along Tanguieta-Batia road axis. There is a fifth group which did not originate in the area: the Fulani or Fufulde. Local people are mostly farmers and secondarily practise livestock husbandry. The Fulani are specialized in cattle husbandry. Mainly nomadic and transhumant in the past, Fulani are nowadays settled in villages and some continue with transhumance during the rainy or the dry season.

The park was first created in 1954, upgraded to a national park in 1961 and to a biosphere reserve with its annexes in 1986. Populations, namely of Berba and Gourmantché, used to live inside the area and the last populations were expelled from the park in the 1980s (DPNP, 2010). Until about two decades ago, local populations were excluded from the park and its management. Currently they are organized in a Local Association for the Management of Wildlife Reserves (AVIGREF in French) which is a partner of the Wildlife Office. About 30% of benefits from sport hunting are paid to this Association every year and are primarily used to build and repair infrastructure in the villages. In return, populations participate in anti-poaching patrols with the park rangers and are associated with several management activities. Populations also receive other benefits from the park through some activities and projects that have been realized in the area because of the presence of the park. On the other hand, however, the proximity of the reserve leads to conflicts with wildlife and to the insufficiency of lands for farming and grazing. Two types of conflicts were observed: crop raiding by elephants and other herbivores and livestock depredation. Some cultures such as yam were no longer planted in some regions due to heavy losses caused by elephants on these crops.

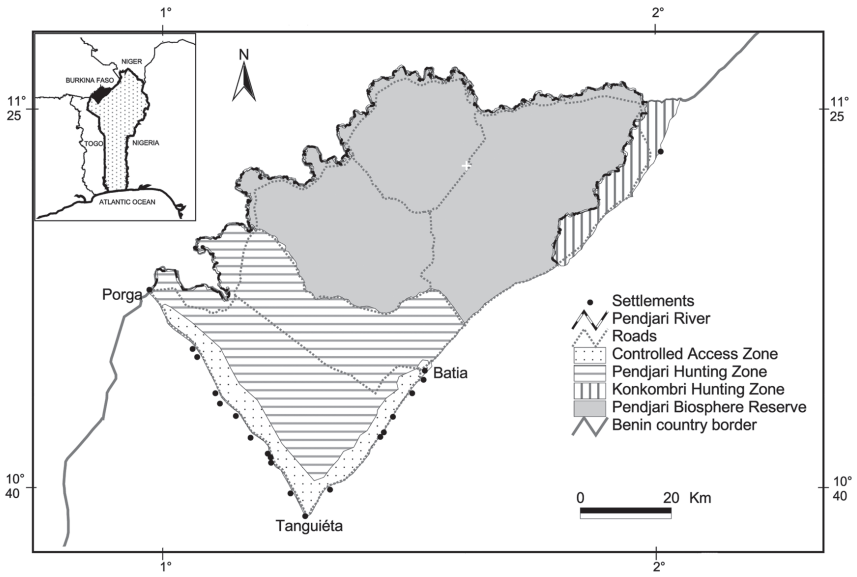


**Figure 1** Map of Pendjari Biosphere Reserve in Benin

### 3.2.2 Interviews survey

In order to evaluate the knowledge and perceptions of local people around Pendjari Biosphere Reserve, we organized a questionnaire survey. Because distance from the reserve and social structure of the villages could have an impact on perceptions, we selected 10 villages around the reserve, based on their geographical

position and the dominant social groups within them. Each village had 80 to 100 households according to the last population census and we randomly chose 30 households per village. Fulani camps were not considered in this survey. We questioned the head of the family (usually a man) in each household. In the rare cases that he was absent, we interviewed his wife or elder son. Interviews were based on a semi-structured questionnaire divided into four sections: (1) socio-demographic characteristics; (2) knowledge of carnivores; (3) livestock husbandry; and (4) perceptions of conflicts and conservation. Data collection took place between October 2007 and October 2008. We focused our study on the six largest species of carnivores existing in the area: lion, leopard, cheetah, spotted hyaena, wild dog and jackal *Canis mesomelas*. A total of 322 respondents participated in the survey. Incomplete surveys were removed, leaving ultimately 293 in the study.

### 3.2.3 Variables

According to the Theory of Reasoned Action by Ajzen & Fishbein (1980), a person's behaviour is determined by his/her behavioural intentions which are a function of his/her attitude towards the behaviour and subjective norms. Attitudes are in turn determined by beliefs and reflect personal experiences and perceptions (Ajzen & Fishbein, 1980; Ajzen, 1991; Infield & Namara, 2001). Here we focused on perceptions and knowledge in order to understand the potential actions of local people living around Pendjari Biosphere Reserve. Understanding these actions can contribute to improved decision-making for mitigation of conflicts. We considered perceptions to be the opinions held by respondents based on Lucherini & Merino (2008). We distinguished perceptions related to carnivore species, to conservation in general and to depredation. As culture plays an important role in West Africa, we considered the role of totems attributed to carnivores and social knowledge related to carnivores. For the purpose of our study, a totem is a species affected by species-specific taboos as defined by Colding & Folke (2001). Knowledge here mainly refers to the recognition of species and socio-cultural knowledge. The dependent variables knowledge and perceptions were considered to be the sum of certain factors presented in Table 1. Independent variables (Table 2) were selected based on the analysis of diverse studies and the conditions in the study area. They related to socio-economic and demographic characteristics of the respondents.

**Table 1** Independent variables used as descriptors for stepwise regressions

| Variable | Variable description | Value |
|---|---|---|
| Distance | Mean distance from the village to the park | Continuous values |
| Age | Age of the respondent | Continuous values |
| Sex | Sex of the respondent | Score (1 , 2) |
| Ethnic group | Ethnic group to which the respondent belongs | Score (1, 2, 3, 4) |
| Main activity | Main activity of the respondent (agriculture, other) | Score (1, 2) |
| Activity related to park | Relatedness of main or secondary activity to conservation | Score (1, 2) |
| Household size | Number of members in the household | Continuous values |
| Husbandry | Livestock husbandry or not | Score (1, 2) |
| Total Livestock | Number of livestock owned (poultry, sheep, goat, pig, dog, donkey, cattle) | Continuous values |
| Total Cattle | Number of cattle owned | Continuous values |
| Cotton production | Cotton production or not | Score (1, 2) |
| Harvest months | Number of months harvest is consumed | Continuous values |
| Totem | Association of a carnivore as totem | Score (1, 2) |
| Socio-cultural knowledge | Knowledge on the uses of animal parts | Score (0, 1) |
| Depredation | Has the interviewee ever had livestock attacked by carnivores | Score (1, 2) |
| Crop raiding | Has the interviewee ever experienced farm damage by wildlife | Score (1, 2) |
| Human attack | Has the interviewee ever heard of carnivore attacks on humans or not | Score (1, 2) |
| Trend | Trend of livestock depredation (increase, decrease, stable) | Score (1, 2, 3) |

### 3.2.4 Data analyses

Analyses were conducted with SAS® 9.1. software (SAS Institute). Descriptive Statistics were used to estimate frequencies and means of categorical and continuous variables. Percentages for each response were calculated based only on those respondents who answered the respective question. Values are expressed as means with standard deviations (SD). To assess the perceived threat to people and their livestock, we asked participants to give a score from 1 to 3 of the three most dangerous carnivores among the six carnivore species studied. For each species, the sum of scores gives the total score for the species.

**Table 2** Dependent variables used for analysis

| Dependent variable | Sub-variables used | Values | Total value |
|---|---|---|---|
| Knowledge | Number of carnivore species seen at least once | 0 to 6 | 0 (none) to 15 (higher value) |
| | Number of carnivore species recognized from pictures | 0 to 6 | |
| | Number of carnivores that live in the region among the six | 0 to 6 | |
| | Lion spoor recognition | 0 or 1 | |
| | Hyaena spoor recognition | 0 or 1 | |
| Perception of depredation | If it possible to avoid depredation or not | 0, 1, 2 | 0 (positive) to 6 (negative) |
| | If compensation is a possible solution to livestock depredation | 0, 1, 2 | |
| | Relative importance of livestock depredation and crop raiding | 0, 1, 2 | |
| Perception of carnivore | Advantages of the presence of carnivores | | 0 (positive) – 1 (negative) |
| Perception of conservation | To whom do the parks belong (people, government, other) | 1, 2, 3 | 5 (positive) to 12 (negative) |
| | Is the park useful? | 0,1 | |
| | Does the interviewee think the park is useful for individuals | 1, 2 | |
| | Does the interviewee think the park is useful to communities | 1, 2 | |
| | Opinion about the wildlife office (CENAGREF) | 1, 2 | |
| | Opinion about the local organization (AVIGREF) | 1, 2 | |
| Methods used | Methods used to avoid livestock depredation | 0 (none) to 2 (max) | |
| Will | Would the respondent like carnivore populations to increase | 0 (yes) to 2 (no) | |
| Lethal control | Respondents think a solution to depredation is to kill carnivore or not | 0 (no) to 2 (yes) | |

With each dependent variable and all independent variables, we ran a descending stepwise regression with Akaike Information Criterion (AIC). The goal was to find the independent variable or the combination of independent variables which better predict the knowledge and perceptions of local people. For the selected predictors, the software yielded chi-square statistics. The model fits statistics and the summary of the stepwise selection are presented as given by the software. We used chi-square to test the relationship between the different dependent variables, sub-variables and the variable Ethnic group as the different ethnic groups could not be rank ordered. Relationships were considered to be significant at $p<0.05$. The sign * indicates that the correlation is significant at the 0.05 level while ** indicates the significance at the 0.01 level and *** at the 0.001 level.

## 3.3 Results

### 3.3.1 Respondents profile

In accordance with their importance in the area, Berba comprised 52.2% of the respondents while Bourba, Waama and Gourmantché represented 7.1, 28 and 12.7% of respondents, respectively. The respondents lived in villages along Tanguieta-Porga road axis (50.3%), along Tanguieta-Batia road (40.7%) and between these axes (9%). The average distance from the park to villages was 29.6 ± 9.1 km.

Women represented only 6.2% of the respondents, as few women are heads of households. The average age of respondents was 42.7 ± 15.6 years. The mean size of a household in addition to the head was 9.4 ± 4.6 individuals.

Some 98.1% of respondents had farming as their primary activity while 93.8% of local people practiced animal husbandry as a secondary activity. The mean number of livestock owned, all species added together, was 41 ± 42 animals per household. The mean size of the cattle herd per household was 1.7 ± 5.9 cattle. Only 3.8% of respondents had activities related to the park, such as tourists' drivers and guides. Cotton, the main cash crop in the area, was produced by 40.7% of the respondents.

When people harvest their crops, the yield is not usually enough to sustain the whole family until the next harvest. Only 2.8% of respondents harvested enough food crops to sustain their family until the next harvest. The mean period in which the harvest is consumed was 6.8 ± 0.8 months. After this period, people had to rely on selling their livestock to buy food.

Local people had a long tradition of interacting with wildlife, which is an integral part of their culture and traditions. Most of the respondents (68.6 %) had at least one carnivore species as totem. This means that they were not allowed to kill and/or to eat this species. Many (40.8%) were aware of some uses of carnivore products for medicinal and magical purposes.

Regarding conflicts with wildlife, 77.2% of local people had experienced livestock depredation at least once, and 91.2% had their crops destroyed by wildlife at least once. Only 3.1% had ever heard about attacks on humans by a carnivore. In general, 85.5% of respondents felt livestock attacks by carnivores are decreasing while 3.8% thought they are stable.

### 3.3.2 Knowledge about carnivores

The mean number of carnivores that have been seen at least once by a person around Pendjari Biosphere Reserve is 2.7 ± 1.6 species of the six species considered. On average, people recognized 2.6 ± 1.6 carnivore species from a picture (Fig. 2). In case of livestock depredation, when the attacking animal was not seen or heard, people used spoors to identify the carnivore responsible. Lion and spotted hyaena spoors were successfully identified by 40.3 and 36.9% of the respondents, respectively, from the six different spoors of carnivores presented to them.

The mean knowledge score was 7.1 ± 3.8 on a scale of 0 – 15, indicating that the general knowledge about carnivores in the region is moderate. There is no significant difference in knowldegd between ethnic groups. Berba and Gourmantche had a higher knowledge however there is no significant difference between ethnic groups. Among all variables tested to explain the knowledge of carnivores, only the association to a totem has been found to be a significant predictor of respondents' knowledge (Table 3).

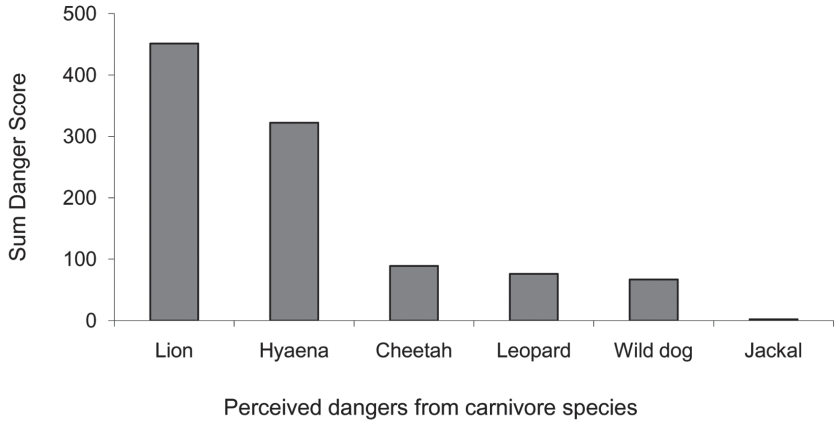


**Figure 2** Proportion of people that have seen at least once and recognized pictures of the different species of carnivores living in the Pendjari Biosphere Reserve (n=322)

### 3.3.3 Perception of carnivores

According to local populations, the lion presents the most danger to them and their livestock, followed by spotted hyaena (Fig. 3).

All respondents agreed that the main problem with carnivores is livestock depredation. Some 26.5% of respondents found that carnivores were also advantageous. The advantages listed included tourism (mentioned by 94.8% of the respondents

who found carnivores beneficial), sport hunting (3.9%) and traditional uses of by-products for medicinal and magical purposes (3.9%).

Perception of carnivores is defined by the possibility of identifying advantages to the presence of carnivores. In general, people perceived carnivores relatively negatively, with the mean value for carnivore perception of 0.7± 0.4 with values varying from 0 (positive) to 1 (negative). Gourmantché were less negative, whereas Bourba had the most negative perception of carnivores but the difference between ethnic groups was not significant.

According to the stepwise regression (Table 3), knowledge of a carnivore attack on humans is the one significant predictor of the perception of carnivores.

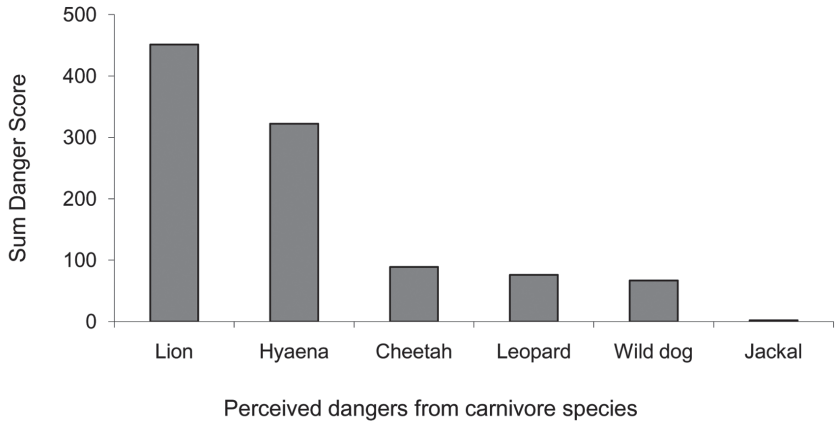


**Figure 3** Ranking of the six carnivore species included in the present study according to the perceived danger they represent to local populations.

### 3.3.4 Perception of conservation

According to local populations, the Biosphere Reserve belongs to all Beninese (56.7% of respondents) or to the government (42.3% of respondents). Very few believed the reserve belongs to tourists (1% of respondents) or to local populations (1% of respondents). Respondents supported the work done by the actual park administration (99.7%) and their local association (100%). As shown by the Fig. 4, while almost all respondents agreed that the park is useful, they felt it was more useful to them as a community than as individuals.

The perception of conservation around Pendjari Biosphere Reserve was positive (mean score 7.6 ± 0.8 with scores varying from 5 as most positive to 12 as most negative). There was a significant difference in different ethnic groups perceived conservation (df = 12; $\chi^2$ = 24.060; p = 0.020). Waama supported conservation

more and Bourba were the most negative towards conservation. Receiving an income from the park through an activity was the best predictor of positive conservation perception (Table 3).

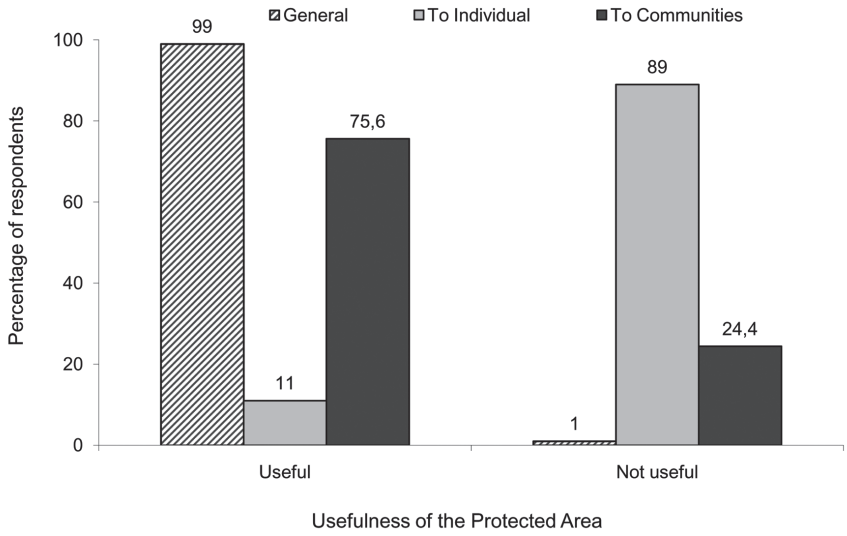


**Figure 4** Perception of the use of the Pendjari Reserve by local communities

### 3.3.5 Perception of depredation

Fig. 5 illustrates the respondents' opinions about the effectiveness of mitigating depredation. Many respondents thought it would not be possible to avoid depredation as long as carnivores lived in close proximity. This opinion varied between ethnic groups ($df = 6$; $\chi^2 = 17.140$; $p = 0.009$). Most respondents (75.6%) thought that damage compensation could be a good method to mitigate the effects of livestock depredation as opposed to 5.4% who thought it would not be possible to compensate for losses. Ethnic groups such as the Gourmantché were more willing to be compensated for livestock losses ($df = 6$; $\chi^2 = 39.710$; $p < 0.0001$) than others. Few people (13.1%) felt that carnivore attacks on their livestock caused more damage to them than crop raiding, in contrast to 8.8% who thought the two caused similar damage.

In general, the perception of depredation in the vicinity of Pendjari was positive, which means that it was tolerated (mean score 1.87 ± 1.13, most positive 0 – most negative 6). There is no significant difference between ethnic groups although Gourmantché seemed to be more tolerant than Bourba and Berba. No factor was found to significantly predict how depredation was perceived.

**Table 3** Results of stepwise selection for knowledge and perceptions

| Dependent variables | Model Fit Statistics | | Residual $\chi^2$ test | Analysis of Effects Eligible for Removal | Summary of stepwise regression | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Intercept only | Intercept & Covariates | | | Step | Effect entered | *df* | Score $\chi^2$ | Pr>$\chi^2$ |
| Knowledge | AIC =853.625<br>-2 Log L= 845.625 | AIC =850.995<br>-2 Log L= 840.995 | $\chi^2$=10.331; df=17; P=0.889 | Totem, DF=1; Wald $\chi^2$ = 4.714; p=0.029 | 1 | Totem | 1 | 4.478 | 0.0340 |
| Perception of carnivores | AIC =318.828<br>-2 Log L= 316.828 | AIC =315.997<br>-2 Log L= 311.997 | $\chi^2$=18.266; df=17; P=0.372 | Human attack, df=1; Wald $\chi^2$ = 4.682; p=0.030 | 1 | Human attack | 1 | 5.665 | 0.0173 |
| Perception of conservation | AIC =662.800<br>-2 Log L= 656.800 | AIC =641.080<br>-2 Log L= 633.080 | $\chi^2$=12.726; df=17; P=0.754 | Park activity, df=1; Wald $\chi^2$= 25.326; p<0.0001 | 1 | Park activity | 1 | 13.879 | 0.0002 |
| Perception of depredation | | | $\chi^2$=21.964; df=18; P=0.234 | – | – | – | – | – | – |
| Methods used | AIC =581.564<br>-2 Log L= 577.564 | AIC =575.216<br>-2 Log L= 577.564 | $\chi^2$=9.415; df=17; P=0.926 | Harvest Months, df=1; Wald $\chi^2$= 8.187; p=0.0042 | | Harvest Months | 1 | 8.174 | 0.0042 |
| Lethal control | AIC =412.395<br>-2 Log L= 408.395 | AIC =389.527<br>-2 Log L= 379.527 | $\chi^2$=15.347; df=14; P=0.355 | Ethnic group, df=1; Wald $\chi^2$= 13.604; p=0.0002<br>Age df=1; Wald $\chi^2$= 9.829; p=0.0017<br>Distance df=1; Wald $\chi^2$= 6.357; p=0.0117 | | Ethnic group<br>Age<br>Distance | 1<br>1<br>1 | 13.775<br>8.242<br>6.317 | 0.0002<br>0.0041<br>0.0120 |
| Will | AIC =258.312<br>-2 Log L= 254.312 | AIC =239.759<br>-2 Log L= 231.759 | $\chi^2$=10.905 ; df=15; P=0.759 | Age df=1; Wald $\chi^2$= 12.791; p=0.0003<br>Totem df=1; Wald $\chi^2$= 6.680; p=0.0097 | | Age<br>Totem | 1<br>1 | 15.682<br>7.373 | <0.0001<br>0.007 |

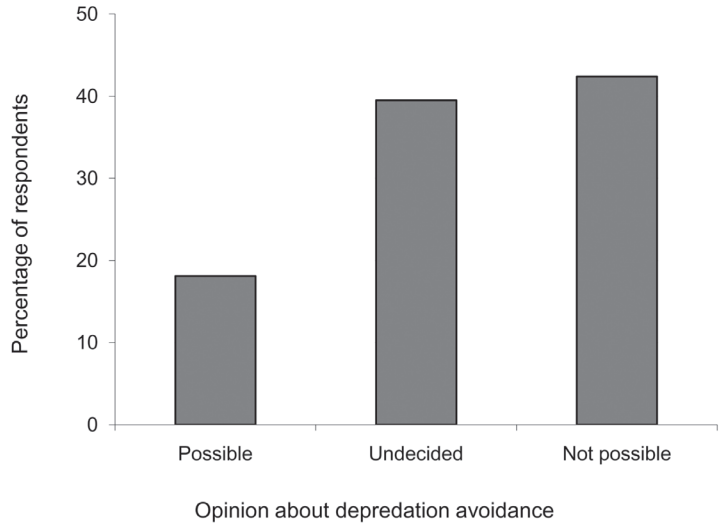


**Figure 5** Respondents' opinion about the possibility of avoiding livestock depredation

### 3.3.6 Lethal control and tolerance towards carnivores and depredation

Most respondents (84.9 %) were willing to see populations of carnivores increase in the park. The main reason was that carnivores (especially lions) are among the species wealthy tourists want to see when they visit the reserve. If there are more carnivores, then there will be more tourists and therefore more benefits to the local populations. The second reason was related to future generations. Children nowadays do not know much about carnivore species. If wildlife was better conserved, then their children would have more opportunity to learn about them in the future. Bourba did not mind seeing numbers of carnivores increasing while Gourmantché and Berba were more reserved about an increase in populations of carnivores in the area. The willingness to see carnivore populations increase could be predicted by the age of the respondent and his or her recognition of a totem (Table 3).

To reduce livestock depredation, some people guard their livestock or put them into enclosures during the night. Most people had dogs. However, dogs were mostly used against theft and were said to be inefficient against carnivores. The number of protective methods used varied according to the ethnic group, but not significantly. It could be predicted by the food security level in the household corresponding to the number of months during which the harvest of the previous year is consumed before it becomes necessary to buy food.

Fortunately only 13.1% of respondents supported retaliatory killing of carnivores against 73.2% who thought it was not a good mitigation measure. Opinions differed significantly among ethnic groups, with Waama being the most against lion retaliatory killing and Berba supporting it ($df = 6$; $\chi^2 = 14.933$; $p = 0.021$). Attitudes related to lethal control could be predicted by the ethnic group, the age and the distance of respondents to the park (Table 3).

### 3.3.7 Interrelationships between knowledge and perceptions

The more people knew about the carnivore species, the more positively they perceived them ($r_s = -0.137$; $p = 0.019$). Peoples' perceptions of conservation and carnivore species were positively correlated ($r_s = 0.148$, $p = 0.011$). Perception of carnivore species is also positively correlated to the perception of depredation ($r_s = 0.130$; $p = 0.026$). People willing to find advantages to the presence of carnivores are more willing to see their number increase ($r_s = 0.187$; $p = 0.001$), less likely to kill them ($r_s = 0.191$; $p = 0.001$) and more likely to use methods to protect their cattle ($r_s = -0.158$; $p = 0.007$). Those who tolerate depredation are less likely to use retaliatory killing ($r_s = 0.199$; $p = 0.0006$) and to use diverse methods to protect their livestock ($r_s = -0.304$; $p < 0.0001$).

## 3.4 Discussion

Wild carnivores are often known to engender negative attitudes among people coexisting with them (Mech, 1995; Oli *et al*., 1994). These negative attitudes usually reflect a history of depredation and awareness of the species and their interactions with humans (Oli *et al*., 1994; Kellert *et al*., 1996). Around Pendjari Biosphere Reserve, where populations have a long tradition of coexisting with wildlife, their perceptions of conflicts are mixed.

### 3.4.1 Knowledge and traditional values about carnivores

Local populations around the Pendjari Biosphere Reserve had an average knowledge about carnivores in general, with a better knowledge of lions and hyaenas. The difference in knowledge about various species is probably because some species are more numerous and charismatic (e.g., puma and jaguar around Iguaçu National Park area in Brazil; Conforti & de Azevedo, 2003). In Pendjari Biosphere Reserve, as in Kruger National Park (Lagendijk & Gusset, 2008), the better knowledge of species such as lion and hyaena is due to the fact that these species are the ones which were more commonly observed around villages and were more responsible for attacks on livestock than other carnivore species. People who had more interaction with the protected area due to their activities and to the proximity of their village to the park had more knowledge. This supports Ericsson &

Heberlein (2003) who found in Sweden that hunters, who have much experience with wildlife, had a better knowledge than other people in their study area.

Association with a totem is an important component of certain cultures and is still a reality in West African societies as elsewhere in the world (Tobayiwa & Jackson, 1985). Lagendijk & Gusset (2008) confirmed the impact of culture on attitudes towards carnivores and conservation, as we noticed in the Pendjari. The fact that negative behaviour such as retaliation killing of carnivores was uncommon even though people have negative perceptions could be partly attributed to the existence of carnivore totems and the importance of culture in the area. Similarly, Colding & Folke (2001) found that species-specific taboos could contribute to the protection of threatened species. However, traditional beliefs could also have a negative impact, for example if the local culture encourages the killing of predators, as has been observed with Rais people in Nepal (Mehta & Kellert, 1998). The positive impact we observed in Pendjari will probably not be permanent, however, as cultural beliefs seem to regulate life in the area less and less, due to urbanization and modernization.

### 3.4.2 Perceptions of conflicts

The main factors found to affect perceptions and tolerance of people residing in the vicinity of Pendjari Biosphere Reserve are the nature of their activities, the awareness of human attacks and the age of the respondents. The distance to the park, the ethnic group and the ownership of a totem also influenced perceptions and tolerance.

Usually, the more benefits people receive from wildlife and conservation activities, the more positive they are towards carnivores and conservation (Fiallo & Jacobson, 1995; Lindsey *et al*., 2005; Morzillo *et al*., 2007; Romanach *et al*., 2007; Schumann *et al*., 2008). However no impact can be expected if people are not made aware of the benefits they are obtaining from conservation (Allendorf *et al*., 2007). Around Pendjari Biosphere Reserve, similarly to Vodouhê *et al.*'s (2010) findings, those who benefitted from the park through their activities displayed the most positive perception of conservation. In some cases, people can be positive even if they do not receive any benefits from conservation (Arjunan *et al*., 2006). On the other hand, benefits alone do not necessarily lead to positive perceptions and attitudes (Gillingham & Lee, 1999). Species which cause great damage are not seen positively even if they also produce benefits for the human community (for example, lion and hyaena in Namibia: Schumann *et al*., 2008). In Pendjari, despite conflicts and the lack of mitigation and compensation incentives from the government, people are more tolerant toward conservation and predators compared to some other parts of the world where perceptions and attitudes did not

improve with compensation schemes and awareness (Gusset *et al*., 2009; Majić & Bath, 2010).

Predation events have been found to affect perceptions (Ericsson & Heberlein, 2003; Naughton-Treves *et al*., 2003; Zimmermann *et al*., 2005; Baral & Henien, 2007; Dar *et al*., 2009) or not at all (Conforti & de Azevedo, 2003). People who experienced attacks on livestock were found to be less positive towards carnivores (Røskaft *et al*., 2007), were more willing to kill them in retaliation and were against the increase of carnivore populations (Palmeira & Barrella, 2007; Kissui, 2008; Hazzah *et al*., 2009). Luckily, around Pendjari, depredation experiences did not have any significant impact on perceptions. Most people who did not tolerate depredation did not think carnivores should be killed. Instead, it is the knowledge of attacks on humans which influences people's perception of carnivores. However, except for one case, respondents did not themselves experience attacks on humans around Pendjari. The assertion of Gillingham & Lee (1999) that direct experience with wildlife largely determines attitudes does not extend to Pendjari. Indirect experience of attacks on humans seemed to be more important in influencing perceptions than direct experience of livestock depredation. This raises the question of real and perceived threat or risk that was considered by Marker *et al*. (2003) and Dickman (2010). Rare events can have more impact on risk perception and this risk perception is commonly spread through popular culture (Dickman, 2010) as is the case in Pendjari. A single case of a non-lethal attack on a human within one decade and the rumour of attacks in other regions was sufficient for everyone to think carnivores and particularly lions are very dangerous to humans.

Experience with carnivores could be direct (through attacks on human or livestock) or indirect (through knowledge about the species). Around Pendjari, the positive impact of knowledge on attitude towards carnivores agrees with several previous studies (Fiallo & Jacobson, 1995; Kellert, 1996; Zimmermann *et al*., 2001; Conforti & de Azevedo, 2003; Shivik *et al*., 2003; Lindsey *et al*., 2005; Schumann *et al*., 2008).

The highest intolerance level noticed in Berba people can be partially attributed to their relationships with natural resources in the past. Like Berba, Gourmantché were expelled from the protected area a few decades ago. But the Gourmantché have been found to rely more on the park for usage ceremonies (Vodouhê *et al*., 2010) and have stronger cultural attachment to wildlife and predators. These two groups also live more closely to the park than the Waama and Bourba. They are thus more likely to suffer from insufficient land and wildlife damages. Furthermore, the different ethnic groups' perceptions are influenced by their previous experience with wildlife and conservation and the benefits they offer, as was found in other areas (Mehta & Kellert, 1998; Romanach *et al*., 2007).

In contrast to comparable studies elsewhere (Williams *et al*., 2002; Ericsson & Heberlein, 2003; Zimmermann *et al*., 2005; Arjunan *et al*., 2006; Røskaft *et al*., 2007; Majić & Bath, 2010), we found that elder respondents were more tolerant. They have experienced the benefits that local populations are receiving since 2000 with the improvement in the park management and can better assess the advantages of carnivores and wildlife in general. They were also usually more attached to their cultural practices than younger people, which may have influenced their perceptions.

### 3.4.3 Implications for management and conclusion

Although livestock depredation is slightly less common than crop raiding around Pendjari Biosphere Reserve, it deserves considerable attention. Conflicts that generate peoples' negative perceptions favour harmful behaviour such as poaching and retaliatory killing of carnivores. More important, these conflicts usually target endangered and flagship species such as lions.

Retaliatory killing of carnivores is yet not common in Pendjari probably due to the overall positive and fatalist attitude of populations and the importance of their culture. Still, community perceptions should be improved in order to avoid such cases in the future and to secure the conservation of all wildlife species in the area.

Compensation has been suggested by several studies as a means to improve tolerance toward conservation in general and carnivores in particular (Andersone & Ozolins, 2004; Hazzah *et al*., 2009). In Pendjari Biosphere Reserve, as in some other regions (Badola, 1998), the lack of compensation is perceived by people as an indifference on the part of the government to their losses. But in order to compensate, it is usually necessary to have evidence of depredation. This is difficult in our study area, as dogs clean up depredation evidence when it occurs in villages. If there is any meat remaining, people prefer to cook it instead of letting it decompose while waiting for the wildlife officials to arrive. Awareness campaigns did not change this behaviour. It would be necessary to have permanent staff in all villages to obtain visual evidence, and this is difficult to achieve. Contrary to the popular belief, compensation is not always effective (Cuicci & Boitani, 1998; Naughton-Treves *et al*., 2003; Gusset *et al*., 2009; Agarwala *et al*., 2010). Corruption could also be a problem (Sukumar, 1994). There is currently a compensation scheme for elephant damage around Pendjari but many find it insufficient, inefficient and complicated. A compensation scheme for carnivore damage is likely to follow the same path. Moreover, it could also be difficult to secure funding for such a scheme. Activities such as anti-poaching patrols and wildlife monitoring are not continuous, due to the lack of funding towards the end of the projects. If local populations have become accustomed to being compensated, there may

be a gap at the end of the projects, which could give rise to negative attitudes in the populations that will be ultimately be detrimental to carnivores' conservation.

Moreover, as was pointed out by Madden (2008), compensation only addresses the economic aspects of a conflict that also has social, political and ecological implications. Social factors are usually neglected (Dickman, 2010) and need to be investigated in depth if sustainable solutions are to be found.

Other methods that seem more effective are incentive-driven conservation with a better sharing of benefits from the reserve and promotion of ecotourism (Sillero-Zubiri & Laurenson, 2001; Miller, 2002; Hutton & Leader-Williams, 2003; Bagchi & Mishra, 2006; Gusset *et al*., 2008). Benefits to individuals, more than benefits to communities, will contribute to improving peoples' perceptions. Furthermore, there is a need to develop projects that address specific issues, including improvement of animal husbandry and farming techniques. Local people should not only receive benefits but should also participate to a greater extent in management actions (Gusset *et al*., 2008). Local communities should be incorporated in long-term social and ecological monitoring, development of economic alternatives, and environmental education (Fiallo & Jacobson, 1995). However, community participation is not necessarily a guarantee for the success of programs (Infield & Namara, 2001). Therefore, good preliminary research to evaluate the real needs of communities is required. Projects to be developed should not be only economically-oriented, but also be adapted to the needs of the various ethnic groups and local cultural aspects. For example, groups such as the Berba and Gourmantché had some practices related to wildlife they were obliged to abandon when they left the reserve. A few concessions have been made, however, as populations are allowed to fish and worship their gods in the Bori pond located within the hunting area. These efforts to recognize cultural practices should be extended, but not to the detriment of wildlife.

Educating people about these issues is difficult (Pierce *et al*., 2001; Shanahan *et al*., 2001; Ericsson & Heberlein, 2003). However, education and development of awareness are good strategies to improve popular perceptions (Sudarmadi *et al*., 2001; Røskaft *et al*., 2003; Zimmermann *et al*., 2005; Thornton & Quinn, 2009). Education in Pendjari would improve knowledge about carnivores and hopefully peoples' perceptions and attitudes towards conflicts. This education should focus on individuals who do not have an activity related to the park/conservation. It should also focus on ethnic groups such as Berba, who are less positive.

An integrated approach, combining education, promotion of improved husbandry methods and development of economic incentives will be more effective for conflict mitigation in the region. Cultural aspects and differences between ethnic groups should be integrated. As education and compensation programs do not

always lead to positive results (Ericsson & Heberlein, 2003; Majic & Bath, 2010), a continuous monitoring, as suggested by Inskip & Zimmermann (2009) and Dickman (2010), will allow the assessment of the impacts of these programs and introduce changes when necessary.

## Acknowledgments

This research received financial support from NUFFIC, Panthera/Kaplan Foundation through Kaplan Graduate Award and African Wildlife Foundation through Charlotte Fellowship. We thank Drs R.K. Glele and K. Musters for their assistance in Statistics and Tracy Evans who help us to improve the text. We are also grateful to Benin Wildlife Office and Pendjari Project for facilitating field work and to the local people who, despite being tired of researchers, facilitated this research. Thanks also to anonymous reviewers for their valuable comments.

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# Appendix 3.1
# Semi-structured interview for conflicts perception surveys

1 Date:
2 Village:
3 Coordinates of the house/Location:

**Socio-economic characteristics of the respondent**

4 Name:
5 Gender :
6 Ethnic group
7 Age / Age class :
8 Family composition:
9 Main activity:
10 Second activity (when applicable):
11 Do you produce cotton? **a** Yes **b** No
12 Is your harvest usually enough to feed your family?
13 During how many months do you generraly consume your harvest before you start buying food?

**Carnivore knowledge and perception**

14 Which carnivore' species do you recognize on the pictures?

Lion Hyaena Leopard Cheetah Wild dog Jackal

15 According to you, which of these species live in this area or in the protected area?

Lion Hyaena Leopard Cheetah Wild dog Jackal

16 Which species have you ever seen?

Lion Hyaena Leopard Cheetah Wild dog Jackal

17 About the species you have seen, when and where have you sight them for the last time (for each species)?

18 According to you, for each species, what is the population evolution trend for these species? Precise for each species if the population is increasing, decreasing or stable this last decade or if you don't know?

19 Do you want these species population to increase?

a Yes b No

Why?

20 According to you, among the six species, which are the most dangerous? Give a score: 3 to the most dangerous, 2 to the second most dangerous and 1 to the third most dangerous

1 2 3

For each species, precise why it is dangerous.

21 Do you think carnivores'species have some advantages?

a Yes b No

22 If yes, which benefits could these species have?

23 What are the disadvantages of carnivore species?

24 Do carnivores species have a special meaning/importance in your culture?

25 Do you know some medicinal or magical uses of carnivore's parts?

26 Do you have totem? a Yes b No

27 Which wildlife species do you have as totem?

**The protected area**

28 According to you, to whom belongs the park?

a the government
b Hunting zones owners
c Local populations
d all Beninese
e Tourists
f Other (precise)

29 Is the protected area useful to you as individual?

a Yes b No

Why?

30 Is the protected area useful to your community?

a Yes b No

Why?

31 What do you think the management currently done of the protected area? Do you think the Wildlife Office is doing a good job?

a Yes b No c Don't know

32 What is your opinion of the AVIGREF? Are they doing a good job?

a Yes b No c Don't know

**Livestock depredation**

33 Do you breed livestock?

34 Which species? How many heads to you have for each livestock species?

35 Have you ever have livestock depredation problem?

36 If yes, please give details (year, month/period, livestock species, carnivore responsible, location, other conditions)?

37 How did you recognize the carnivore responsible?

a Spoor b Call c Other (precise)

38 Check if the respondent could identify lion and hyaena spoors on pictures

39 Do you think you can avoid depredation?

If yes, how?
If not, why?

40 Do you have a dog?

If yes, why?

41 Do you think it is possible to avoid livestock depredation?

42 How?

43 Which method do you use to limit your livestock depredation?

a Dog b Enclosures c Guard d Other

44 Do you think damage compensation could be me a good mitigation method? Why?

45 Do you think carnivotre killing could be a good method to reduce depredation?

46 According to you, what is the trend of livestock attacks these last years?

a Increasing b Decreasing c Stable d I don't know

47 Have you ever heard of human attack by carnivores?
If yes, please give details (place, date, circumstances)

48 Have you ever experienced crop raiding by wildlife? Details

49 Between livestock depredation and crop raidng, which one is the most detrimental according to you?
Why?

50 Despite all these problems, do you think the park is important?

51 Other remarks

**Thanks for your participation**

# Appendix 3.2
# Photographs used to identify survey species