

Research Application Summary

**Assessment of local communities' perceptions toward common hippopotamus conservation around the Pendjari Biosphere Reserve, Benin (West Africa)**

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**Abstracts**

Understanding local communities' perception about conservation can provide useful information that could be incorporated into decision-making processes and lead to resolution of conflicts between local people and protected area officials by improving attitudes and altering behavior of the local people. This study seeks to evaluate the local communities' perceptions towards hippopotamus conservation outside the Pendjari Biosphere Reserve (PBR) in northern Benin. Data were collected from 2018 to 2019 throughout twenty-three (23) villages around the Pendjari Biosphere Reserve during the wet season through semi-structured interviews and informal talks with 192 respondents from different socio-professional backgrounds. Local community perception towards the hippopotamus was measured with hippopotamus role as spiritual, tourism, ecological (positive perception), and nothing (negative perception). With regard to result, only 26% of questionnaire respondents recognized benefits of hippopotamus against 57% who did not recognize any benefit from hippopotamus conservation and 17% were unsure. Local communities' perceptions of the benefits of hippopotamus conservation, decrease progressively as moving farther from the PBR ( $\beta = -0.99$ ;  $p < 0.001$ ). In villages near Pendjari Biosphere Reserve, people have a positive perception towards hippopotamus. The most commonly cited benefit was that the common hippopotamus plays important spiritual and ecological roles, and also attracted tourists to the area. Further from the Pendjari Biosphere Reserve, many respondents have negative perception about hippopotamus. The most common reasons cited for why the hippopotamus was not beneficial included their relative uselessness, the potential danger for human, and the damage they caused to crops. Education of local communities located further from the Pendjari Biosphere Reserve remains a real challenge for the species survival. The manager of the Pendjari Biosphere Reserve together with the forester administration of the Atacora Department should create and sustain community awareness programs that promote human-hippopotamus relationship.

Keywords: Conservation, *Hippopotamus amphibius*, megaherbivores, Pendjari Biospher

**Résumé**

Comprendre la perception des communautés locales sur la conservation peut fournir des informations utiles dans le processus de prise de décision et aider à la résolution des conflits entre les populations locales et les aires protégées en améliorant les attitudes et comportement des populations locales. Cette étude vise à évaluer les perceptions des communautés locales vis-à-vis de la conservation des hippopotames hors de la Réserve de Biosphère de Pendjari (RBP) au nord

du Bénin. Les données ont été collectées de 2018 à 2019 dans vingt-trois (23) villages autour de la Réserve de Biosphère de Pendjari pendant la saison des pluies à travers des entretiens semi-structurés auprès de 192 enquêtés issus de différents groupes socioprofessionnels. Les perceptions de la communauté locale sur la conservation des hippopotames ont été évaluées sur la base des services des hippopotames tel que "spirituel", "touristique", "écologique" (perception positive) et "aucun" (perception négative). Les résultats de cette étude montrent que seulement 26% des enquêtés ont une perception positive sur l'importance de la conservation des hippopotames contre 57% ayant des perceptions négatives et 17% de neutre. Il est à noter que cette perception diminue progressivement au fur et à mesure qu'on s'éloigne de la Réserve de Biosphère de Pendjari ( $\beta = -0.99$ ;  $p < 0.001$ ). Les perceptions positives ont été beaucoup plus enregistrées dans les villages proches de la Réserve. Selon la population de ces villages, l'hippopotame joue un important rôle spirituel et écologique et attire également les touristes dans la région. Loin de la réserve, la majorité des enquêtés ont une perception négative sur la conservation des hippopotames due au fait que ces derniers causent des dommages aux humains et aux cultures. La sensibilisation des communautés situées plus loin de la réserve sur l'importance de la conservation des hippopotames reste un véritable défi pour la survie de l'espèce. Les autorités en charge de la gestion de la Réserve de Biosphère de Pendjari en collaboration avec les autorités forestières devraient initier un programme de sensibilisation au niveau local afin d'améliorer la relation hommes-hippopotame hors de la Réserve de Biosphère de Pendjari.

Mots clés : Conservation, *Hippopotamus amphibius*, mégaherbivores, Biosphère de Pendjari

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## Introduction

In African savannas, intensification of land conversion to cultivation and/or human settlement is a key factor driving people into more direct contact with wildlife (Sala *et al.*, 2000; Thuiller *et al.*, 2006). The pattern of increasing conflicts between people and wildlife is evident in Benin (Sogbohossou *et al.*, 2017; Efiu *et al.*, 2018). Land use changes especially within the pastoral systems of northern Benin, driven by rapid expansion of cotton cultivation, land subdivision and farming, are largely responsible for the escalating human wildlife conflicts. As a result, expanding settlements and cultivation are exerting increasing impacts on the distribution and abundance of wildlife at both the population and community levels (Verlinden, 1997; Serneels and Lambin, 2001). Consequently, wildlife grazing areas are increasingly dwindling in size, migration corridors are being lost or modified and wildlife access to water sources is being increasingly blocked, resulting in increasing human-wildlife conflicts and wildlife population declines (Serneels and Lambin, 2001; Thuiller *et al.*, 2006). Megaherbivores (weighing over 1000 kg, Owen-Smith, 1988), such as hippopotamus (*Hippopotamus amphibius* Linnaeus 1758), elephant (*Loxodonta africana* Blumenbach 1797), and large carnivores rank among the most problematic and lie at the heart of human wildlife conflicts because they are dangerous to humans. Hippopotamus differ from other megaherbivores in having a dual requirement of daily living space in water and an open grazing range often visited at night (Eltringham, 1999). This requirement affects the manner in which hippopotamus use resources and survive in areas dominated by high human population densities and continuous land use changes. While most studies on human-wildlife conflicts have concluded that conflicts are intense on the periphery of protected areas (Naughton-Treves, 1998; Saj *et al.*, 2001), this may not necessarily be true for hippopotamus since they inhabit wetlands that often extend outside protected areas into agricultural landscapes (Adoukè *et al.*, 2021).

Despite the fact that megaherbivores often cause major devastation to crops and are a physical threat to humans, most research has focused only on the elephant and neglected hippopotamus, yet the latter are involved in numerous conflicts with people in many parts of Africa (Eltringham,

1999; Mkanda and Kumchedwa, 1997). Crop raiding is the most important form of human-wildlife conflict (Naughton-Treves, 1998). Cereal crops are more prone to destruction (Kendall, 2011; Dibloni *et al.*, 2012) as they are easily accessed by hippopotamuses and represent a nutritious alternative food source with low degree of toxicity degree (Osborn and Hill, 2005; Cerling *et al.*, 2008; Kanga *et al.*, 2012). These crop raiding by hippopotamus is the cause of important economic losses throughout Africa and can jeopardize the efficacy of protected areas by undermining local support for conservation (Haule *et al.*, 2002; Gadd, 2005), leading to land conversion within protected areas for agriculture (Weladji and Tchamba, 2003). Adoukè *et al.* (2020) estimated the economic impact of the hippopotamus crop raiding from 2018 to 2019 at 2,575,760 XOF (4794.87 US\$) around the Pendjari Rivers. This can lead to an increase in negative perceptions of local people toward wildlife and could represent a major barrier to hippopotamus conservation efforts. Thus, understanding the local communities' perception about conservation can provide useful information that could be incorporated into decision-making processes and lead to resolution of conflicts between local people and protected area officials by improving attitudes and altering behavior of the local people. Considering the likelihood of additional stress on hippopotamus populations from water shortages, conservation of the species will depend on active management of human-hippopotamus conflict (Mkanda and Kumchedwa, 1997; Eltringham, 1999).

This study sought to understand human-hippopotamus coexistence and evaluate the local communities' perceptions towards hippopotamus conservation, outside the Pendjari Biosphere Reserve (PBR) in northern Benin. Specifically, it aimed to identify the spatial patterns and the economic impact of hippopotamuses crop raiding; assess the drivers of crop riding; and assess local communities' perceptions of the benefits of common hippopotamus conservation.

## Material and Methods

**Data collection.** The distribution patterns and perceptions of local communities regarding human-hippopotamus conflicts were evaluated through the questionnaire method. This method was used to interview one hundred and ninety-two (192) respondents belonging to different socio-professional and ethnic groups in twenty-three (23) villages that were selected based on their distance from the Pendjari River (10 kilometers maximum) and the limit of the Pendjari Biosphere Reserve (Table 1). The questionnaire was conducted using the non-probabilistic snowball sampling methods (Biernacki and Waldford, 1981) and had both open- and closed-ended questions to obtain useful information, and consisted of a series of semi-structured questions related to human-hippopotamus coexistence. Data were collected by the lead researcher through personal interviews in local languages, assisted by one trained assistant familiar with the local environments. The draft survey questions were pre-tested on a pilot sample of 30 households and adjusted accordingly. The survey was briefly described to the respondent as a study of crop-raiding issues in the area, and participants were asked if they would like to participate. Each interview lasted for an average of 20 minutes and was conducted in the afternoon between 4 pm and 6 pm when most farmers had returned home. Interviews were carried out over seven (7) months from September to December 2018 and from August to December 2019. We recorded demographic characteristics, including age, gender, level of education, and ethnic group. Local community perception towards the hippopotamus was measured with multiple-choice answers as a) spiritual, b) tourism, c) ecological, d) nothing (Conway *et al.*, 2014). Respondents were aged between 18 and 65 years with an average age of 43 years and consisted of farmers (79 %), hunters (2%), rangers (2%), and the non-target group 'others' (15%).

**Table 1. Characteristics of respondents**

Townships	District	Villages	Numbers of respondents	Average age (year)	Ethnic groups
Natitingou Ditamari	Peporiyacou	Peporiyacou, Koudengou, Bongou	66	40	Wama
Toukountouna	Toukountouna	Toukountouna, Tompatou, Korobounde, Tectiboyaou, Mousintingou	41	40	Natimba Wama
	Kouarfa	Bouyagnindi	11	36	Wama
	Tempegre	Kokota, Nabaga, Tampégré	11	39	Wama Ditamari
Tanguiéta	Tanougou	Niangou	4	27	
Kérou	Kaobargo	Koabagou	5	40	Bariba, Gourmantché
	Firou	Firou, Galini, Gori, Gorobani	20	44	Bariba, Gourmantché
Kouandé	Guilmaro	Fô-Mama, Ouroufinan, Seri, Kpakotankoga, Tandafa	32	46	Wama Ditamari
Total	8	23	192	40	5

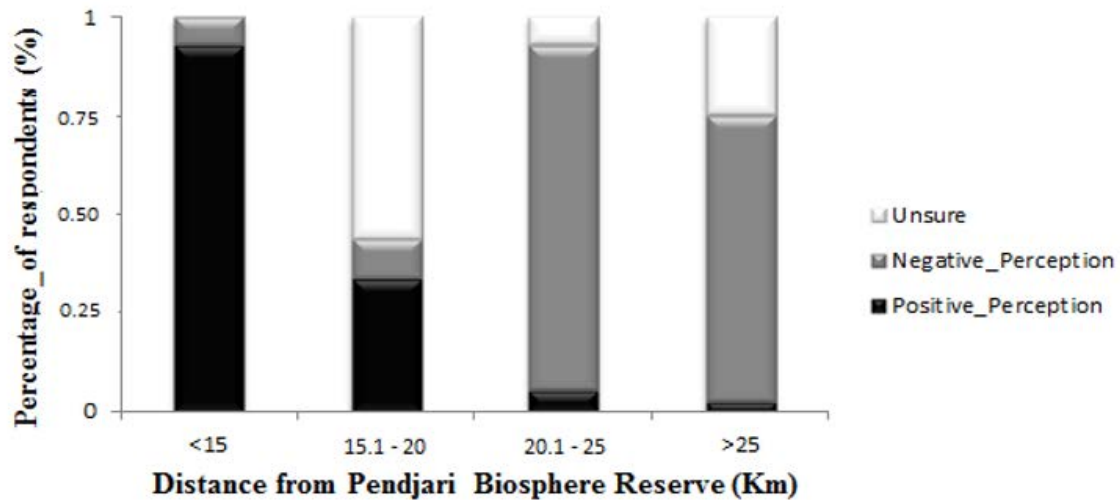
**Data analysis.** Binomial regression was used to evaluate local communities' perceptions toward hippopotamus conservation. For each model, the co-linearity among the predictor variables was investigated by examining the Pearson correlation coefficients between the measured variables (Fowler and Cohen, 1992). The backward stepwise procedure was done for model simplification to select the model with the lowest AIC (Akaike Information Criterion) and  $\Delta$ AIC values. The  $\chi^2$  test was used to assess the fit of each model to the data and the pseudo-coefficient of determination  $R^2$  (Nagelkerke, 1991) was calculated with the 'fmsb' package (Nakazawa, 2014) to evaluate the model's explanatory power. The goodness-of-fit of the overall model was examined by comparing the log-likelihood of the full model to that of the reduced model (model zero). We used R package 'sandwich' (Zeileis, 2006) and "msm" (Christopher, 2017) to obtain the robust standard errors and calculated the p-values accordingly (Cameron and Trivedi, 2009). Together with the p-values, we have also calculated the 95% confidence interval using the parameter estimates and their robust standard errors.

## Results

Overall, only 26% of questionnaire respondents recognized benefits to local communities and 17% were unsure. In villages near Pendjari Biosphere Reserve, the most commonly cited benefit was that the common hippopotamus plays important spiritual and ecological roles, and also attracted tourists to the area. Further from the Pendjari Biosphere Reserve, many respondents (57%) did not recognize any benefit from hippopotamus conservation. The most common reasons cited for why the hippopotamus was not beneficial included their relative uselessness, the potential danger they posed, and the damage they caused to crops.

The binomial regression model revealed multiple variables predicting the likelihood of respondents' recognition of benefits associated with common hippopotamus and the relative influence of multiple predictors on respondents' recognition of benefits related to common hippopotamus. Parameter estimates ( $\beta$ ) and odds ratios showed that the distance of the respondent from the Pendjari Biosphere Reserve was the only and strongest predictor of awareness of common hippopotamus-related benefits. Respondents in villages closer to the Pendjari Biosphere

Reserve were more likely to recognize benefits associated with hippopotamus conservation than those who lived far from the Reserve ( $\beta = -0.99$ ,  $df=1$ ,  $p<0.001$ ). For example, the ratio between residents living less than 15 kilometers from the Pendjari Biosphere Reserve and those living more than 25 kilometers regarding benefits associated with hippopotamus conservation was 31 (Figure 1). Thus, residents living in proximity of the Reserve are 31 times more likely to have a positive perception about hippopotamus conservation than those living further from the Reserve.



**Figure 1. Percentage of questionnaire respondents (n=193) in 23 villages with positive or negative perceptions of the common hippopotamus, according to distance from the Pendjari Biosphere Reserve. Questionnaires were administered during September–December 2018 and 2019.**

## Discussion

Few study respondents, except those living closer to the Pendjari Biosphere Reserve, recognize the benefits associated with hippopotamus (i.e through tourism, as well as their ecological and spiritual roles). Indeed, local people in the immediate surroundings of the Reserve are implicated in protected area management through a Local Association named AVIGREF. Through local organizations, populations living adjacent to the Reserve have directly profited from the protected area through employment and tourism revenue, as well as being involved in decision-making processes. They also benefit from research projects that involve awareness-raising and training, and secure meat and other products during the hunting season. These multiple advantages contribute significantly to decreasing negative perceptions toward wildlife conservation. The various mitigations methods promoted by Local Communities Associations and Non-Governmental Organizations, together with enhanced awareness of local populations, have contributed to a decrease in livestock depredation costs in around Pendjari between 2010 and 2018 (Efio *et al.* 2018) in Pendjari. Likewise, Conway *et al.* (2014) have shown that conservation education programs by the Environmental Foundation for Africa during 2006–2010 generated support for conservation of pygmy hippos around Tiwai Island (Sierra Leone).

In countries such as India (Sekhar, 2003) and Kenya (Gadd, 2005), ecotourism has been shown to have a positive effect on the attitudes of local people towards conservation. However, most of the respondents during this study had a negative perception about the benefits of hippopotamus and are less likely to express the desire to conserve hippopotamus. This negative perception is strongly correlated with hippopotamus inutility, the potential danger they pose and the damage they cause to crops. Nevertheless, we have identified the distance of respondents from the Pendjari Biosphere Reserve as the predictor of support for hippopotamus conservation. The positive perception and

attitude of communities toward hippopotamuses decreases progressively as they move further away from the boundaries of the Pendjari Biosphere Reserve to the agricultural landscape away from the Reserve. Benefits from protected areas are more evident in the landscapes surrounding the reserve. Indeed, local people living far from the Reserve endure damages from the wildlife being conserved whilst being marginalized and not benefiting from any projects or awareness programs (as is the case with the surrounding populations of the PBR). This can lead to an increase in negative perceptions of local people toward wildlife and could represent a major barrier to hippopotamus conservation efforts. Thus, the benefit from the protected area must be extended to all villages affected by wildlife-conflict to ensure the better conservation of species living outside the protected area. Local communities living some distance from the Pendjari Biosphere Reserve should also be included in the program activities of Local Associations in charge of the Reserve, participate in conservation actions, and benefit from any jobs and revenue generated through tourism. This could provide supplementary income and contribute to improved human-hippopotamus coexistence around the Pendjari River. Randolph *et al.* (2007) shows that supplemental income could influence local victim tolerance of wildlife such as hippopotamus in the Tiwai area. Local communities outside the Pendjari Biosphere Reserve are cash-poor and are negatively impacted by the presence of hippopotamuses given that their crops represent their main income source.

It is urgent that a tangible resolution of human-hippopotamus conflicts is found, to ensure sustainable conservation of the species outside the protected area. The best mitigation measures must be promoted and/or reinforced in the village included in the conflict particularly in the hotspot zones of the conflict identified in this study. Saley (2005) in the south-east of Burkina-Faso, identified three main mitigation strategies commonly used against hippopotamus: dead hedges based on thorns, night guarding, and wire fences or ropes. According to Akama *et al.* (1995) as the level of education increases, the level of negative attitude towards conservation activities decreases. Local communities living in the vicinity of the Pendjari Biosphere Reserve seem to be more aware about hippopotamus conservation as the protected area represents a source of jobs and revenue through tourism (Sogbohossou, 2011; Sogbohossou *et al.*, 2011). Nevertheless, education of local communities located further from the Pendjari Biosphere Reserve remains a real challenge for the species survival. Finally, intensive communication among local communities is suggested to exchange experiences and ideas that may support a peaceful human-wildlife relationship (Kpéra *et al.*, 2014). Finally, the administration of the Pendjari Biosphere Reserve together with the administration of the Atacora Department should create and sustain community awareness programs that promote human-hippopotamus relationship (Chomba *et al.*, 2013).

## **Conclusion**

Human-hippopotamus conflicts, like in several African protected areas, are effective around the Pendjari Biosphere Reserve, northern Benin. Local communities, paid dearly for hippopotamus presence because of damage to the crops yet crops represent their main income source. Consequently, most of local people had negative perception about hippopotamus. Intensive communication among local communities is suggested to exchange experiences and ideas that may support a peaceful human-hippopotamus relationship. Finally, the administration of the Pendjari Biosphere Reserve together with the administration of the Atacora Department should create and sustain community awareness programs on the best mitigation measures to cope with hippopotamus depredation.

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