

FARMERS SURVEY OF WILD MAMMALS SPECIES IMPLICATED IN CROP DAMAGE IN THE OKAPI WILDLIFE RESERVE (OWR-EPULU, DEMOCRATIC REPUBLIC OF THE CONGO): SEVERITY AND CONTROL STRATEGIES

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Investigations on mammal species implicated in crop damage and control techniques used to protect fields was carried out in the Okapi Wildlife Reserve (OWR). The aim of this study was to identify mammal species causing damages on crops, the growth stages affected, the frequency and severity of damage in the fields and control techniques used. Data were collected in six villages using a standard questionnaire form translated in the main local languages (Swahili and Lingala), between 02–29 June and 07–31 August 2010. A probabilistic survey and structured interview have been used to collect data. Farmers of 7 main tribes were interviewed (a total of 210 farmers) who are living in OWR. The study shows that Primates (*Cercocebus galeritus agilis*, *Papio anubis*) and elephant (*Loxodonta cyclotis*) cause considerable damage during maturation and fructification of maize, cassava and bananas in the fields. Farmers keep their fields under guard to drive away animals and prevent crop damage.

Key words: crop damage, Democratic Republic of the Congo, Okapi Wildlife Reserve, wild mammals

Introduction

The integration of conservation with other land uses is especially difficult where densely settled agricultural land abuts a protected area containing large or potentially dangerous animals, as is the case for several parks in Africa and Asia (Dudley et al., 1992). The Okapi Wildlife Reserve (OWR) is concerned by this fact this last decade, people develop different activities in the OWR (e.g. artisanal gold mining, diamond, coltan, etc.), uncontrolled immigration, poaching, hunting, deforestation for crops, etc. (Baraka, 2009). Climate changes have increased the situation by encouraging the growth of the size of the populations of certain species of crop pests in the region, including the green locusts, the lack of vegetation at certain periods of the year, the drying up of some rivers and the agricultural calendar perturbation causes loss in agricultural production. In fact, the lack of water and food, but also poaching, result of several wars occurred these last decades in the East Democratic Republic of the Congo (DRC), push animals to leave their usual habitat. This situation allows farmers to grow a big area which destroys wildlife habitats by decreasing wildlife food.

In OWR, farmers cultivate more than one crop in the same field. They are totally dependent on agriculture as trading hunting is forbidden, while pygmies do until the traditional hunting. Herbicide are not used. Several crops were identified: cassava (*Manihot esculenta* Crantz, 95% of people), maize (*Zea mays* L., 92%), rice (*Oryza sativa* L., 90%), bananas (*Musa* spp., 60%), peanut (*Arachis hypogaea* L., 40%), bean (*Phaseolus vulgaris*, 35%), potato (*Ipomoea batatas* (L.) Lam., 25%), (*Solanum melongena* L., 17%) marrow (*Cucurbita maxima* Lam., 13%), tarot (*Colocasia esculenta* (L.) Schott, 12%), and sugar cane (*Saccharum officinarum* L., 10%). Fruit trees were not cultivated by local people, except in agricultural territory. These crops cover a big area in OWR and replace the original habitat.

By reduction of the area of the original habitat, wildlife moves toward villages to look for food. The animal moving has considerable consequences on crop, livestock, house and even death of man. Damage without repair could cause serious mistrust in farmers on the conservation purpose, particularly in the DRC where laws related to compensation of wildlife crop damage are not applied (Lwanzo, 2008). The lack of

such law on wildlife crop damage increases mistrust within farmers and do not facilitate to solve the problem by the chiefs of the OWR, especially if species of mammals involved in damaging the crop and the period of great damage are not known. In fact, this information is poorly documented in the DRC except on animal crop damage in Ituri forest (Scott, 1987), on an assessment of crop damage by large mammals in the OWR with a special emphasis on elephants and on diet insecurity for the human population around the Virunga National Park (Lwanzo, 2008). Our objectives are to study:

- the wild mammals recognised by farmers implicated in crop damage; the vulnerability of the crop and crop stages;
- the techniques that farmers are using to control animal damage in their fields;
- What the farmers are thinking about the OWR.

Material and Methods

Study sites

The OWR (2°00'00" N; 28°30'00" E; 700–1000 m above sea level) is located in the Ituri

Forest, in Ituri Province in the northeast of the DRC. It is an area of 13726 km² (Kümpel et al., 2015). The OWR is limited in the North by the Nepoko stream, in the South by the River Ituri, in West by the Lenda stream and in the East by the road which connects Andudu to Mambasa Territory. It is extended on 3 Territories (Mambasa in Ituri Province, Wamba and Watsa in Haut-Uele Province). Over 80% of this area is located in Mambasa Territory. Based on this reason, we investigated in this Territory.

We investigated six localities in the OWR: Badengaido, Molokay, Salate, Babama, Bandisende and Nduye (Fig.). Badengaido (1°23' N; 28°04' E) is situated 52 km from Epulu. Molokay (1°25' N; 28°18' E) is situated 40 km from Epulu and 12 km from Badengaido. Salate (1°24' N; 28°23' E) is located 25 km from Epulu; it is the third locality in the OWR. Babama (1°39' N; 28°61' E) is located 16 km from Epulu. Bandisende (1°20' N; 28°46' E) is located 35 km from Epulu. Finally, Nduye (1°50' N; 29°01' E) is situated 140 km from Epulu in the Northwest.

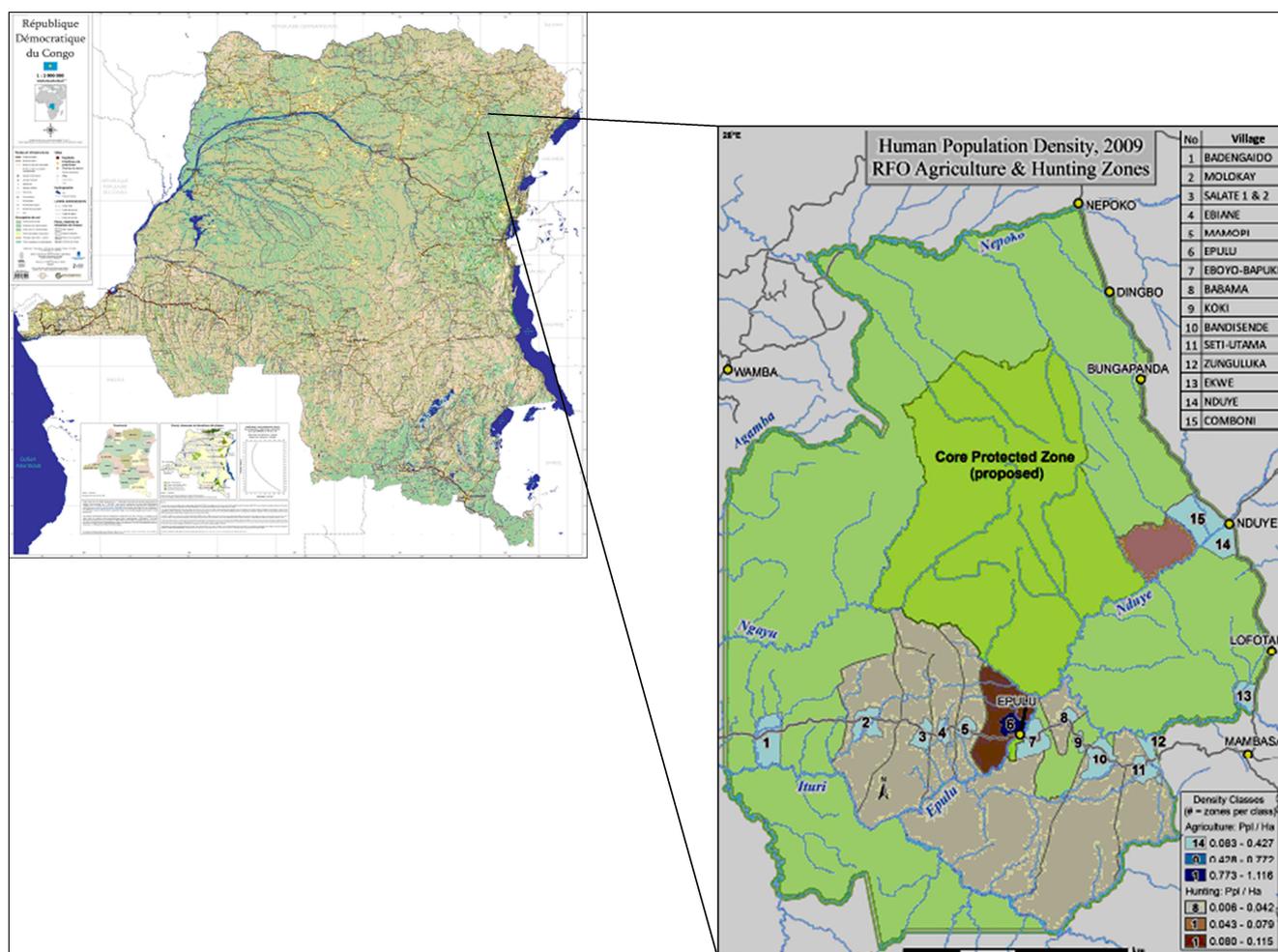


Fig. Map showing agricultural areas in Okapi Wildlife Reserve with the investigated localities (Democratic Republic of the Congo). Source: WCS/ICCN-RFO (2009).

The vegetation of the OWR is constituted of four main habitats (CBFP, 2006): the primary forest is dominated by *Gilbertiodendron dewevrei* (De Wild.) J. Leonard. The secondary forest is dominated by *Musanga cecropioides* R. Br. ex Tedlie and *Ricinodendron rdheudelotii* (Baill.) Heckel. The marshy forest is occupied by *Fleroya stipulosa* (DC.) Y.F. Deng and *Uapaca guineensis* Müll. Arg. The mixed forest is dominated by *Julbernardia seretii* (De Wild.) Troupin, *Cynometra alexandri* C.H. Wright and *Brachystegia laurentii* (De Wild.) Hoyle. The Northeast of the OWR is occupied by dry forest, gallery forest and savannah in the territory of Watsa. In the OWR, 8 main tribes exist: Lese, Ndaka, Mbo, Bila, Budu, Bangwana (Bangwana is a tribe used by the Arab people as slaves and became aboriginal of Mambasa), Nande and Pygmy (Pygmy is a member of an ethnic group whose height is unusually short; many anthropologists define pygmy as a member of any group where adult men are on average less than 150 cm tall. They are also called *Mbuti*). The first seven are Bantu tribes while pygmies are ancient inhabitants of the DRC. These populations were estimated on 17000 individuals in 2004 and more than 20797 in 2009 (Baraka, 2009; Kümpel et al., 2015).

An exceptional fauna diversity is known in the OWR: *Okapia johnstoni* Sclater, 1901, an endemic species with 20000 individuals and 14 in captivity until 2012 (Kümpel et al., 2015). However, all individuals in captivity were killed in the night of 23–24 July 2012 by an uncontrolled army group in the region.

The OWR is under influence of the equatorial climate Guinean type. It is classified in Af climate type according to the Köppen classification (Duvigneaud, 1974). The climate is hot (25°C), without an absolute dry season, with a yearly precipitation around 2500 mm, and a minimum of 60 mm during the driest month (Budjo & Batido, 2009).

Data collection

We carried out interviews based on a standard questionnaire translated into the two main local languages (Swahili and Lingala), but native name of wild mammals species were given in Lese language (Carpaneto & Germe, 1989). A pre-survey have been made two days before the survey in Epulu centre, to facilitate the understanding of the questionnaire form. During the survey, all farmers' answers were noted on French survey forms.

The questionnaire was designed to gather general information about farm characteristics, control techniques used, and mammal crop raiding. Our questions were focused on active farmers and the Chief of villages.

We used coloured photographs associated to native names of wild mammal species in the OWR to lead people to identify species involving in crop damages (Kingdon, 2015). Interviews were organised between 8:00 and 17:00 during 52 days (02–29 June and 07–31 August 2010). The questionnaire was composed of 52 questions. An interview was conducted during 30 min. Sunday was reserved to visit farmers' crop fields. A structured interview based on probability in selecting people was used for collecting data. This method has been used for people with low instruction level (Grawitz, 2001). In total, 210 farmers were interviewed in 6 villages. In each village, we interviewed 35 households (men and women) in each tribe. The collected data were analysed by Excel of Windows 2007.

Results

Crop pest

A high degree of severity and frequency of damage caused by *Cercocebus galeritus agilis* Peter, 1879 are recognised by 90% of the interviewed farmers (Table 1). About 90% of the farmers agreed that damage caused by *Loxodonta cyclotis* (Blumenbach, 1797) were very severe in all localities. However, their frequencies were recognised only by 50% of farmers, except in Salate where 90% of farmers confirmed that damage was very frequent. In Babama and Molokayi, 67% and 76% of the farmers respectively confirmed that crop damage caused by *Papio anubis* Linnaeus, 1758 was frequent, while only 45% and 56% recognised the severity of damage. About 80% of the farmers accepted that damage caused by *Thryonomys swinderianus* (Temminck, 1827) are severe in Nduye, while in others localities, only 25% of the farmers recognised the same. Finally, less than 10% of the farmers recognised severity and frequency of crop damage in the case of *Potamochoerus porcus* (Linnaeus, 1758), *Hylochoerus meinertzhageni* Thomas, 1904, and *Syncerus caffer nanus* (Sparrman, 1779) in all localities. Below we present people's point of view about damage caused by different mammals species on crops during their phenological stages.

Table 1. Severity and frequency of crop damage in different villages

Common name	Native name (Lese)	Mammal species	Percent of farmers showing severity of damage on crop						Percent of farmers showing frequency of damage on crop						Type of crop
			1	2	3	4	5	6	1	2	3	4	5	6	
Allen's Swamps Monkey	Angala	<i>Cercocebus galeritus agilis</i> Peter, 1879	88.5	98.3	89.6	87.5	90.2	78.9	90.5	87.2	78.3	89.4	91.3	67.7	Maize, Cassava, banana
Red-tailed monkey	Ngema	<i>Cercopithecus ascanius</i> (Audebert, 1799)	34	45	23.9	45.7	34.5	45.1	34.4	43.6	45.2	32.1	34.6	23.8	Maize, Cassava, banana
L'Hoest's monkey	Sabila	<i>Cercopithecus lhoesti</i> Sclater, 1899	23	12	24	32	10	24	13	24	16	27	34	10	Maize, Cassava, banana
Baboon	Me'ba	<i>Papio anubis</i> Linnaeus, 1758	45	56	50	56	13	35	67	76	50	57	39	59	Maize, Cassava, Banana, rice
Elephant	U'ku	<i>Loxodonta cyclotis</i> (Blumenbach, 1797)	85	78	87.9	80	80	90	50	46	90	45	44.2	50	Maize, Cassava, banana
Red River Hog	Ti'ko	<i>Potamochoerus porcus</i> (Linnaeus, 1758)	1	1.2	3	5	8	1.2	5	6	7	6	9.1	1.3	Cassava, banana
Giant Forest Hog	Ekuma	<i>Hylochoerus meinertzhageni</i> Thomas, 1904	8.9	12	3.4	1.4	12	2.4	4	7	4	2.1	1.9	0	Cassava, banana
Buffalo	Tu'pi	<i>Syncerus caffer nanus</i> (Sparman, 1779)	2.1	2.3	4	2.8	1.9	3.4	0	1.4	2.5	2.4	0	2	Maize, Cassava, banana
Cane rat	Simbriki	<i>Thryonomys swinderianus</i> (Temminck, 1827)	13	24	12	13	20	86	10	23	22	19	21	80	Maize, Cassava, rice
Giant pouched rats	Apolo	<i>Cricetomys emini</i> Waterhouse, 1840	0.3	1.4	3.5	1.3	2.7	1.4	3.2	1.0	0.5	1	2.4	1.3	Maize, Cassava

Table keys: 1 = Babama; 2 = Molokayi; 3 = Salata; 4 = Bandisende; 5 = Badengaindo; 6 = Nduye.

Severe damage on crop phenology (sowing, fructification and maturation)

In the OWR, 80–90% of the farmers confirmed that *Cercocebus galeritus agilis* destroye mainly maize during fructification and maturation (Table 2). At the same time 50–75% of the farmers recognised that *Cercopithecus ascanius* (Audebert, 1799) and *Thryonomys swinderianus* cause severe damage on maize during fructification and maturation. Finally, the severe damage caused by *Cricetomys emini* Waterhouse, 1840, *Papio anubis* and *Syncerus caffer nanus* are recognised by less than 30% of the farmers.

In Table 2 50–65% of the farmers pointed *C. galeritus agilis*, *Papio anubis*, *Loxodonta cyclotis*, and *Cricetomys emini* as responsible in severe damage on cassava during maturity, while less than 40% of the farmers accused *Potamochoerus porcus*, *Syncerus caffer nanus*, *T. swinderianus*, and *Hylochoerus meinertzhageni* to cause considerable damage on cassava during fructification and maturation.

In addition, 100% of the farmers pointed *L. cyclotis* for severe damage on banana during maturation and 90% during the fructification. About 70% of the farmers indicated that *C. galeritus agilis* and *P. anubis* cause severe damage on banana during maturation. At least 50% of the farmers recognised this damage during the fructification. Only 10% of the farmers pointed severe damage caused by *S. caffer nanus*, *T. swinderianus* and *C. emini*.

50–70% of the farmers recognised that *T. swinderianus* cause severe damage on rice during fructification and maturation. Less than 10% of the farmers pointed *Papio anubis* to cause severe damage on rice during maturation and fructification.

Control strategies

One of the objectives of this study was to show different techniques (Table 3) used by farmers to control the crop damage caused by wild animals in the OWR.

More than 80% of the farmers in all villages ask for help from the OWR guardians to drive away animals from their fields. About 80% of the farmers from Nduye are trapping animals while 40% of the farmers in others localities except Salata (with only 23.9%) use also the trapping technique. About 65% of people in Nduye use dogs to drive away animals. Finally, 12% of farmers are passive as they do not control their fields while 88% of the farmers keep their fields under guard by driving away animals.

Table 2. Percent of Mammal species pointed as responsible of severe damage on crop phenology (sowing, fructification and maturation)

Crops	Phen	MAMMAL SPECIES									
		C.g	C.a	C.lh	P.a	L.c	P.p	H.m	S.c	T.s	C.e
Maize	Fruct.	90	52	28	10	5	–	–	10	63	25
	Mat	100	73	28	13	–	–	–	12	55	33
Cassava	Fruct.	46	12	21	38	44	24	12	10	12	31
	Mat	69	45	45	60	52	36	22	20	21	68
Banana	Sow.	–	2.5	–	–	5	–	–	–	–	–
	Fruct	45	21	35	34	92	21	11	3	8	–
	Mat	74	35	50	73	98	30	20	10	–	5
Rice	Fruct.	–	–	–	20	–	–	–	–	95	–
	Mat	–	–	–	19	–	–	–	–	68	–

Legend: C.g – *Cercocebus galeritus*; C.a – *Cercopithecus ascanius*; C.lh – *Cercopithecus l'hoesti* Sclater, 1899; P.a – *Papio Anubis*; L.c – *Loxodonta cyclotis*; P.p – *Potamochoerus porcus*; H.m – *Hylochoerus meinertzhgeni*; S.c – *Syncerus caffer nanus*; T.s – *Thryonomys swinderianus*; C.e – *Cricetomys emini*; Fruct. – fructification; Mat – maturation; Sow – sowing

Table 3. Percentage of farmers interviewed on the mammals control techniques used on the fields

Techniques/Villages	Bab	Mol	Sal	Ban	Bad	Ndu
Driving away by reserve guardians	88.5	98.3	89.6	87.5	90.2	78.9
Hunting (using barriers, rifles, spears, arrows and bows)	34	45	23.9	45.7	34.5	80
Hunting using dogs	0	0	0	12	0	65
Traditional poison	0	0	0	0	0	12
Keeping	70	78	89	87	96	86
None	0	0	12	0	0	0

Legend: Bab – Babama; Mol – Molokayi; Sal – Salate; Ban – Bandisende; Bad – Badengaido; Ndu – Nduye.

What farmers are thinking about Okapi Wildlife Reserve

The last objective of this study was to know the vision of farmers on the OWR (Table 4). Different opinions were obtained from the farmers: 50% of the farmers in six localities investigated recognised that the OWR is very important in this remote area because its reduce jobless and contribute in developing the environment, while 50% did not agree. In fact, they argue that the OWR is not important for two reasons: the lack of bushmeat and the lack of compensation of wild crop damage. In Salate, 36% of the farmers recognise the importance of OWR while 58.9% do not agree. Finally, less than 10% of farmers have no meaning.

Discussion

Our results show that in total, 11 mammal species are implicated in crop damage in the OWR. The Allen's swamps monkey (*Cercocebus galeritus agilis*), and the elephant (*Loxodonta cyclotis*) cause severe damage on cassava, maize and banana during fructification and maturation. Our results confirm those of Kambale (1998) that indi-

cate the severity of the damage caused by elephant and Allen's swamps monkey on crop in the OWR. These species are followed by baboon (*Papio anubis*) and red-tailed monkey (*Cercopithecus ascanius*). A similar result was observed by Parker et al. (2007) and Kagoro-Rugunda (2004) in Zambia and Uganda. On the other side, Loki & Parker (2002) indicated that primates and elephants are major crop pest in Zimbabwe and the National Park of Mburo in Uganda. The severity of damage of these groups of animals may be explained by their high number of individuals during the transhumance, the quantity of food that one individual can eat, but also because in the OWR, farmers use slash-and-burn as the main technique. This technique favours the opening of large areas for the fields by creating pressure on the OWR and putting animals in direct contact with the crop fields (Baraka, 2009).

In the Locality of Salate, the severity and frequency of damage, especially caused by the elephant, might be explained by isolation of this locality and low human density (Baraka, 2009). In fact, the human presence pushes this animal to go far in the forest where a dense canopy cover is observed.

Table 4. Vision of farmers on the importance of Okapi Wildlife Reserve

Is it necessary to keep this Reserve?	Bab	Bom	Sal	Ban	Bad	Ndu
Yes, important (jobs for local people)	56.5	41.9	36.6	50.5	50.2	47.8
No, not important (no bush meat, severe damage on crops without compensation)	40.5	50	58.9	45.7	47.8	48.2
No meaning	3	8.1	4.5	3.8	2	4

Legend: Bab – Babama; Mol – Molokayi; Sal – Salate; Ban – Bandisende; Bad – Badengaido; Ndu – Nduye.

The Cane rat, *Thryonomys swinderianus* causes severe and frequent damage on maize and rice during maturation and fructification in Nduye. In this village, this might be explained by a higher level of deforestation leading this savannah species to get a new ecological niche as previously observed. Although mammal species cause damage on crop during each phenological stage, the most vulnerable periods concern maturation and fructification. In fact, animals struck matures crop, probably because they have rich nutriment (Raemaekers, 2001).

Wild pigs (*Potamochoerus porcus*, *Hylochoerus meinertzhageni*), buffalo (*Syncerus caffer nanus*) and Giant pouched rat (*Cricetomys emini*) cause less damage in all localities in the OWR. This could be explained because of their reduced density and also of the relatively small number of individuals.

Kagoro-Rugunda (2004) observed that *P. porcus*, *Papio cynocephalus* and *Tragelaphus scriptus* occupied the first position in crop damage in fields surrounding the National Park of Mburo in Uganda. Kambale (1998) pointed five species in OWR for crop damage: *C. galeritus agilis*, *Cercopithecus lhoesti* Sclater, 1899, *C. ascanius*, *L. africana cyclotis* and *P. porcus*. In Kenya, de Vos & Omar (1970) observed *Cercopithecus mitis* to be active during the dry season, while *L. africana* was active during the rainy season. In agreement with these authors, Primates and elephants cause considerable damage on crop. While, some difference between mammals species implicated in crops damage surroundings parks and reserves vary in function of the vegetation and habitat of each park or reserve.

In the OWR, driving away animals by guardians, keeping fields under guard are techniques commonly used by farmers. The work of Guinness and Taylor (2014) revealed a danger in this case as some farmers have been killed by elephants in Queen Elisabeth National Park Uganda. Regular driving away might be a better technique than keeping fields under guard against wild mammal crop damage. Trapping as 80% of farmers are doing or using dogs (15%) to control crop damage in Nduye might be more efficient than keeping and driving in the case of the cane rat which is known as major crop damage for cereales as observed

in Kisangani region (Amundala et al., 2008). In Salate, only few people, being scared, do not control their fields against elephants. In this case, they have a negative attitude against the presence of the OWR.

Generally, the lack of bushmeat and compensation of wild crop damage and missing of fertile land for agriculture are serious problems of the population who lives in the OWR. As only a few people have a good education level, the OWR does not have a job for them. This could be the reason that the Okapia in captivity were killed in the night of 23–24 July 2012 by an uncontrolled army group in the region.

Conclusions

Finally, 11 mammal species are known to be responsible for crop damage in the OWR. On this list, *Cercocebus galeritus agilis* and *Loxodonta africana*, followed by *Papio anubis*, cause severe and frequent damage on banana, maize, cassava which form the main cultivated crop. *Thryonomys swinderianus* cause severe crop damage on maize and rice during fructification and maturation in Nduye where the species is trapped for field control. Driving away animals and keeping fields under guard are techniques widely used to protect fields in all villages.

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ИССЛЕДОВАНИЕ ФЕРМЕРАМИ ДИКИХ МЛЕКОПИТАЮЩИХ, ПОВРЕЖДАЮЩИХ СЕЛЬСКОХОЗЯЙСТВЕННЫЕ КУЛЬТУРЫ В ЗАПОВЕДНИКЕ ОКАПИ (ДЕМОКРАТИЧЕСКАЯ РЕСПУБЛИКА КОНГО): СЕРЬЕЗНОСТЬ И СТРАТЕГИИ КОНТРОЛЯ

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Исследования видов млекопитающих, повреждающих сельскохозяйственные культуры и методы их контроля для защиты полей были проведены в заповеднике Окапи. Целью данного исследования было выявление видов млекопитающих, вызывающих повреждения сельскохозяйственных культур, затронутых влиянием стадий роста растений, частоты и серьезности ущерба на сельскохозяйственных полях и используемых методов контроля. Данные были собраны в шести деревнях с использованием стандартной формы опроса, переведенного на основных местных языках (суахили и лингала) между 02–29 июня и 07–31 августа 2010 г. Для сбора данных использовались вероятностный опрос и структурированное интервью. Были опрошены фермеры из семи основных племен (в общей сложности 210 фермеров), которые живут в заповеднике Окапи. Исследование показало, что приматы (*Cercopithecus galeritus agilis*, *Papio anubis*) и слон (*Loxodonta cyclotis*) вызывают значительный ущерб во время созревания и плодоношения кукурузы, маниока и банана на сельскохозяйственных землях. Фермеры держат свои поля под охраной, чтобы отгонять животных и предотвращать потерю урожая сельскохозяйственных культур.

Ключевые слова: Демократическая Республика Конго, дикие млекопитающие, заповедник Окапи, повреждение сельскохозяйственных культур