The Sustainable Tree Crops Program (STCP)

STCP Working Paper Series
Issue 3

Wildlife Diversity in Cocoa/Agricultural Mosaics at the Congo Basin Forest Margin

(Version: December 2007)

By:
Karen Weinbaum*, Denis J. Sonwa[§], Stephen F. Weise[Ψ], Justin Brashares*,
& Wayne M. Getz*

*Department of Environmental Science, Policy & Management, University of California, Berkeley
[§]International Institute of Tropical Agriculture, Yaoundé, Cameroon
[Ψ]International Institute of Tropical Agriculture, Accra, Ghana

International Institute of Tropical Agriculture

The Sustainable Tree Crops Program (STCP) is a joint public-private research for development partnership that aims to promote the sustainable development of the small holder tree crop sector in West and Central Africa. Research is focused on the introduction of production, marketing, institutional and policy innovations to achieve growth in rural income among tree crops farmers in an environmentally and socially responsible manner. For details on the program, please consult the STCP website <http://www.treecrops.org/>.

The core STCP Platform, which is managed by the International Institute of Tropical Agriculture (IITA), has been supported financially by the United States Agency for International Development (USAID) and the World Cocoa Foundation (WCF) together with the global cocoa/chocolate industry. This study was supported by an Andrew and Mary Thompson Rocca pre-dissertation award through the Center for African Studies at the University of California, Berkeley. Additional financial and logistical support for the study was provided by Mars Inc.

About the STCP Working Paper Series:

STCP Working Papers contain preliminary material and research results that are circulated in order to stimulate discussion and critical comment. Most Working Papers will eventually be published in a full peer review format.

Comments on this or any other working paper are welcome and may be sent to the authors via the following e-mail address: STCP-WCA@cgiar.org

All working papers are available for download from the STCP website.

Sustainable Tree Crops Program
Regional Office for West and Central Africa
IITA-Ghana, Accra
Ghana.

Correct Citation:

Weinbaum, K, D. Sonwa, S. Weise, J. Brashares and W. M. Getz, 2007. Wildlife Diversity in Cocoa/Agricultural Mosaics at the Congo Basin Forest Margin. STCP Working Paper Series 3 (Version December 2007). International Institute of Tropical Agriculture.

Abstract

While forest conversion to agriculture is considered one of the most important threats to biodiversity in the tropics, the over harvesting of wildlife is considered to be an even more important threat in the Central African context. The human population gradient on the northern fringe of the Congo Basin represents the future trajectory of change in land use, bushmeat consumption, and biodiversity if human population growth rates continue. In this preliminary study we conducted wildlife transects (n=35 km), hunter-follow surveys (n=14), and socioeconomic interviews (n=42) in four villages across a gradient of human population density (from peri-urban to remote) in southern Cameroon in an agricultural mosaic consisting of cocoa agroforests, food crops, fallow fields, secondary forest and primary forest. Transect results reveal that mammalian diversity increases with village remoteness. Secondary forest had the largest proportion of animal signs of all land uses. Hunter-follows reveal that people invest more time to hunting in more remote areas, and interviews highlight that bushmeat is a more important source of income in more rural areas, and is more often consumed. Fish is consumed more often than bushmeat, however, and is reportedly becoming more scarce locally along with wildlife. The Food and Agriculture Organization has called the unsustainable hunting of bushmeat "one of the most important food security and biodiversity conservation challenges" in Central Africa and requires further research.

Key words: Wildlife diversity, bushmeat, cocoa/agricultural landscape, southern Cameroon, Congo Basin.

TABLE OF CONTENTS

List of Figures

List of Table

Introduction

Forest conversion to agriculture is considered one of the most important threats to biodiversity in the tropics. Such land use change modifies forest habitat and facilitates human access to the hunting of wildlife. In Central Africa, deforestation occurs at an estimated rate of 0.1-1.0 % per year (FAO 2005), and in Cameroon, over 85% of this deforestation is attributed to smallholder agriculture, which often ensues after logging roads have been built for the selective extraction of timber. The over harvesting of wildlife for food and income, however, is considered an even more immediate threat to biodiversity than current rates of habitat conversion (Wilkie & Carpenter 1999). The unsustainable harvesting of wildlife in the region therefore poses a major issue to both biodiversity conservation and rural people's food security. Wildlife provides up to 90% of rural forest people's animal protein intake (Fa et al. 2003), and currently >120 mammals in the region are considered threatened with extinction (IUCN Red List 2006).

Although forest conversion to agriculture is often cited as a major threat to tropical biodiversity, some farming systems may incorporate habitat elements that may make them more suitable to integrated conservation strategies. Forest conversion in Cameroon attributed to smallholder agriculture forms a diversified mosaic of agricultural systems which include food crops, cocoa agroforests, and fallow fields (IITA 2000). The potential contribution of mixed agricultural systems to mammalian conservation has largely been overlooked. Robinson & Bennett (2004) demonstrate that grasslands with rainfall above 500mm can typically support mammalian biomasses of 15,000-20,000 kg/km^2, whereas mammalian biomass in tropical forests can rarely exceed 3,000 kg/km^2. Ungulates make up the bulk of the savanna mammalian biomass, and in the forest ecosystem browse is largely high in the canopy and unavailable to ground-dwelling animals. Mixed agricultural landscapes may contribute to higher rates of mammalian production in otherwise low biomass tropical ecosystems by providing more available browse for ground-dwelling species. To date little work has been done to assess the potential contribution of the mixed agricultural mosaic to mammal conservation and food security in the forest frontier of the Congo Basin (vis-à-vis bushmeat availability).

This project seeks to elucidate the potential contribution of the agricultural mosaic to the conservation of wildlife. We combine biodiversity assessments using transect methods, socio-economic interviews with local residents, and hunter-follows to assess levels of biodiversity and hunting pressure in the mixed agricultural mosaic of the forest margin of Cameroon, Central Africa. We investigate the role of human population pressure on biodiversity and hunting pressure by sampling four villages in a gradient of human population density. Understanding the potential costs and contribution to wildlife at the forest/agricultural interface will be critical to informing both conservation and food security policies.

Methods

Study Site

This research was conducted in the forest frontier zone of southern Cameroon, in the International Institute of Tropical Agriculture's (IITA) Forest Margins Benchmark Area (FMBA), established in the early 1990's as part of the global research initiative known as the Alternatives to Slash-and-Burn program (ASB). The benchmark area encompasses 1.4 million hectares, and was chosen for its representative gradient of population pressure (est. 4-100 people/km^2 (IITA 2000)) and resource use intensity. This region also contains representatives

of the region's forest margin land use types, including logging concessions, small-holder slash-and-burn agriculture, fallow land, cocoa agroforests, and protected areas.

The Forest Margins Benchmark area is typically divided into three blocks which represent high, moderate, and low human population pressure. Three villages, one in each block, were chosen for this pilot study, with a fourth village included to represent an even more remote site. The northernmost village is Nkometou II in the Yaoundé block, which lies on the national road and is characterized by the high rural population density (72 persons/km^2), good market access, and the most deforestation. The middle block, Mbalmayo block, was represented by the village Awae, which is characterized by moderate population pressure (37 persons/ km^2), relatively poor market access, and moderate deforestation rates. The southernmost village site is Mengomo, which lies on a major national road but has very low population pressure (~4 persons/ km^2), moderate market access, and relatively low deforestation rates. Finally, the village of Akam was chosen which lies on the western border of the Mengamé wildlife reserve, and has both very low human population pressure and poor market access due to its remote access and poorly maintained roads.

Wildlife Census

We estimated wild mammal (>1kg) diversity and relative abundance using traditional line-transect methodology (Muchaal & Ngandjui 1999; Plumptre 2000; White 1994). We established two 5km transects radiating out from each village site (one 5km transect in Akam due to time constraints). Each transect was then walked one time with the help of at least two experienced hunters, and we noted all live animal sightings, dung, footprints, game trails, and nest sites, with perpendicular distance measured for live sightings, dung and nests.

Hunter Follows

In each village site, hunters who hunted on a regular basis (Nkometou, n=2; Awae II, n=5, Mengomo, n=5, Akam, n=1) were identified and accompanied on their next regularly scheduled hunting trip. On each hunter-follow the distance traveled, total time spent hunting per trip, numbers of traps, and any wild meat caught were recorded. These data allow for a common measure of hunting pressure on biological resources known as catch per unit effort (CPUE).

Interviews with Heads of Households

At each of the four village sites we conducted interviews with approximately 10-15 local heads of households per village. Interviews consisted of basic household information, sources of annual revenues, sources of protein, the importance of bushmeat in protein consumption and the economic importance of bushmeat in annual household revenues.

Results

Transects

Increasing remoteness (i.e. increased distance from Yaoundé and more forest area still intact primary forest) predicts higher levels of mammalian diversity. In Nkometou and Awae, the two villages closest to Yaoundé, signs of nine different mammalian species were identified, while in Mengomo, further from Yaoundé and with more forest cover, 16 species

were identified. Finally, the most remote village site, Akam, had 20 mammalian species encountered, even though at this site only one 5 km transect was undertaken whereas at the other sites 10 km of transects were conducted (Tables 1 & 2).

Nkometou and Awae had the same common species; these included the giant pouched rat (*Cricetomys emini*), cane rat (*Thryonomys swinderianus*), brush-tailed porcupine (*Atherurus africanus*), tree pangolin (*Phataginus tricuspis*), African civet (*Civettictis civetta*), and blue duiker (*Cephalophus monticola*). Several species of red duiker were evident, but because their footprints are difficult to tell apart we lumped these into a red duiker group category (*Cephalophus spp*). Additional species found in Mengomo included several species of monkey (*Cercopithecus nictitans, Cercopithecus cephus, Miopithecus ogouensis*), the larger Yellow-backed duiker (*Cephalophus silvicultor*), and the African palm civet (*Nandinia binotata*). Finally, in the most remote site, Akam, additional species encountered included the larger primates: mandrills, gorillas and chimpanzees (*Mandrillus sphinx, Gorilla gorilla gorilla, Pan troglodytes*), red river hog, (*Potamochoerus porcus*), and Elephant (*Loxodonta africana cyclotis*) (for full list see Table 2).

Table 1. Village sites and transect summaries.

	Population density (by subdivision, people km^2) *	**Village size**	**Area in primary forest***	**# km**	**# Spp encountered**
Nkometou	72	1600	3.71%	10	9
Awae	37	300	5.30%	10	9
Mengomo	4	700	22.00%	10	16
Akam	<4	100	58.90%	5	20

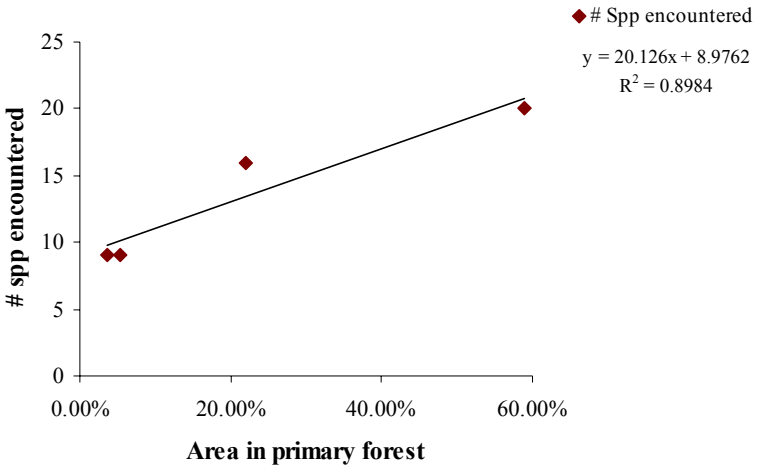

Figure 1. Number of species encountered on transects as a function of percent forest cover in village site block (note: figure based on preliminary results).

Table 2. Species encountered on biodiversity transects in four village sites.

Common Name	Scientific Name	Nkometou	Awae	Mengomo	Akam
Giant pouched rat	Cricetomys emini	*	*	*	*
Cane rat	Thryonomys swinderianus	*	*	*	*
Brush-tailed porcupine	Atherurus africanus	*	*	*	*
Tree pangolin	Phataginus tricuspis	*	*		*
Giant pangolin	Manis gigantea			*	*
Marsh mongoose	Atilax paludinosus	*	*	*	*
African civet	Civettictis civetta	*	*	*	
Blue Duiker	Cephalophus monticola	*	*	*	*
Red Duiker (spp?)	Cephalophus spp	*	*	*	*
Sitatunga	Tragelaphus spekei	*	*	*	*
Yellow-backed duiker	Cephalophus silvicultor			*	*
African palm civet	Nandinia binotata			*	
Putty-nosed monkey	Cercopithecus nictitans			*	*
Moustached monkey	Cercopithecus cephus			*	
Northern talapoin	Miopithecus ogouensis			*	
Gorilla	Gorilla gorilla gorilla			*	*
Chimpanzee	Pan troglodytes				*
Red river hog	Potamochoerus porcus			*	*
Elephant	Loxodonta africana cyclotis				*
Potto	Perodicticus potto				*
Mandrill	Mandrillus sphinx				*
Tree hyrax	Dendrohyrax arboreus				*
Nile monitor	Varanus niloticus				*
Ogilby's duiker/red duiker spp?	Cephalophus ogilbyi ??				*
Squirrel					

Land use

Transects were 5km long straight routes that directed in the landscape at fixed compass bearings. Therefore, an uneven proportion of land uses were sampled. Land use categories included field, fallow, cocoa agroforests, swamp, riparian area, secondary forest, primary forest, and urban area (villages). In order to account for disproportionate representation of different land uses sampled, we compared the proportion of animal signs relative to the proportion of land class represented. In general, wildlife use did not differ significantly between land uses, although secondary forest made a disproportionate contribution to use of land by wildlife (Figure 2).

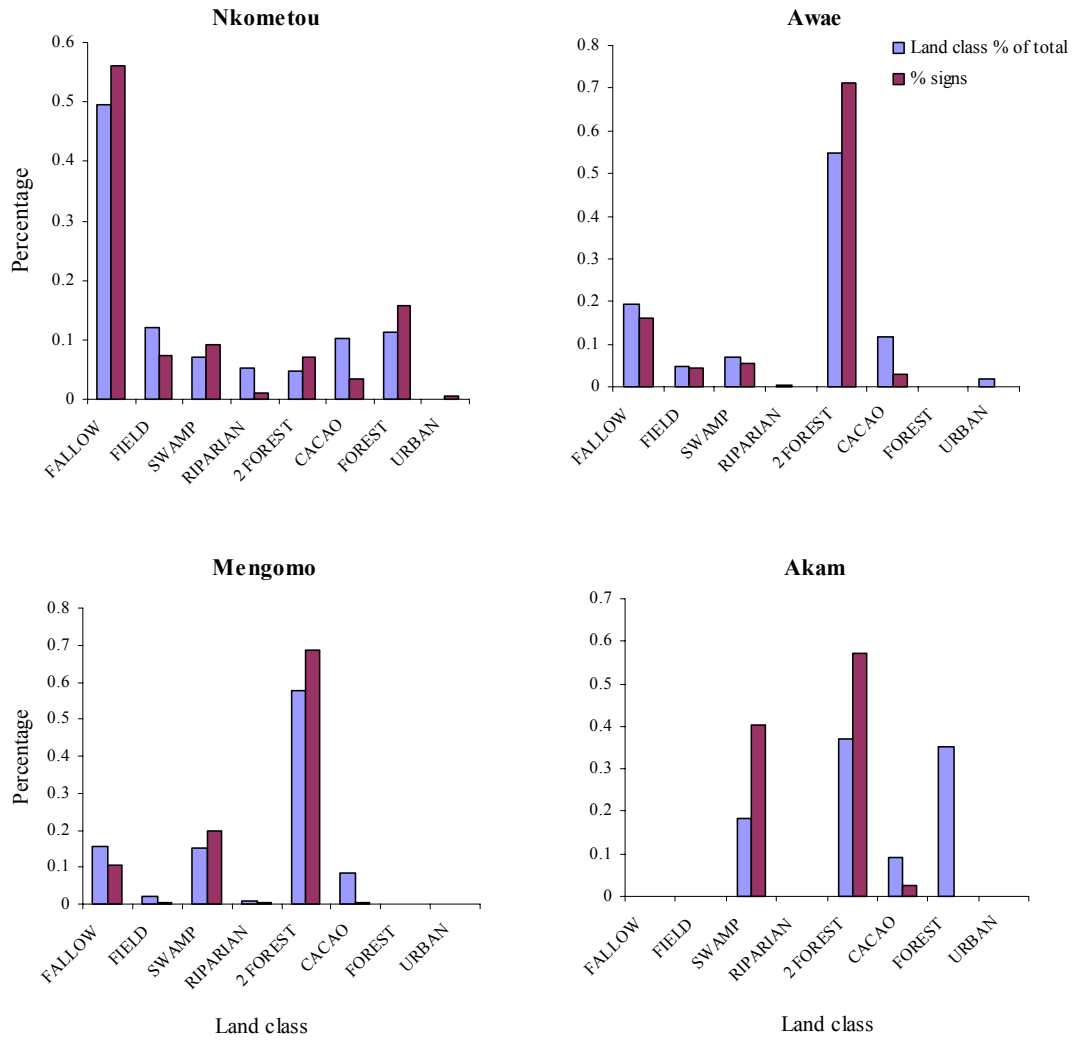

Figure 2. Proportion of animal signs detected per land use.

Socioeconomic Interviews

A total of 42 interviews with heads of households were conducted, but due to various time constraints they were distributed unevenly among the village sites (Nkometou (8), Awae (16), Mengomo (15), Akam (3)). Average age of the head of household interviewed was 48.07 years. Household size tended to be larger nearer Yaoundé, perhaps because it was easier for extended family to move back and forth between the capital and nearby agricultural land (pers. obs.). Farm size tended to increase with increasing rurality. Cocoa and manioc were the most important sources of income at all sites, with tomatoes, plantains, and government posts also important income sources. There was an increasing tendency for hunting to be an important part of a household's annual revenue in more remote locations, but total household income was fairly variable between sites (Table 3).

Table 3. Household demographics for four village sites.

	Nkometou (n=8)	**Awae** (n=16)	**Mengomo** (n=15)	**Akam** (n=3)*
Head of household ave. age (mean ± SE)	46.38 ± 4.34	49.38 ± 3.6	45.53 ± 3.2	51.0 ± 10.54
Household size (mean ± SE)	13.5 ± 2.31	10.5 ± 1.16	8.2 ± 0.81	9.67 ± 4.26
Farm size (mean ha ± SE)	10.15 ± 3.34	12.47 ± 3.17	16.87 ± 3.48	18.83 ± 15.66
Total annual revenue (CFA)	1,467,938 ± 509,247	651,777 ± 99,058	833,556 ± 87,193	592,341 ± 248,898
Most important sources of revenue (proportion of total revenue)	cacao (0.22)	manioc (0.29)	cacao (0.28)	cacao (0.65)
	manioc (0.21)	cacao (0.25)	plantain (0.21)	business/other (0.22)
	tomato (0.19)	government post (0.20)	manioc (0.13)	plantain (0.10)
	mais (0.12)	casual labor (0.07)	**hunting (0.11)**	local wine production (0.03)
	plantain (0.09)	plantain (0.06)	casual labor (0.10)	
	business/other (0.08)	macabo (0.03)	business (0.05)	
	macabo (0.03)	local wine production (0.03)	local wine production (0.05)	
	hunting (0.02)	**hunting (0.03)**	groundnut (0.02)	
	groundnuts (0.02)	mais (0.02)	sugar cane (0.02)	
	potato (0.02)	fishing (0.01)	fishing (0.01)	

* Sample size in Akam is too small for statistical comparison. Also, at the time of survey there were two Ministry of the Environment forest guards stationed in the village which may have limited hunting activity and people's willingness to discuss it.

Part of the purpose of the questionnaire was to assess the relative importance of domestic animals, fish, and bushmeat sources in household's subsistence needs as well income. Domestic animal holdings were relatively insignificant across all village sites. Respondents frequently attributed this to poor veterinary services and frequent diseases sweeping through the village, and also often cited theft of domestic animals as not an uncommon occurrence. Fish was by far the most important source of animal protein, consumed on average 156-253 days a year (Figure 3). Bushmeat was also consumed in each village site, but on 51-143 days a year (Figure 3). There appears to be more reliance on bushmeat in more remote sites, but Nkometou, the village closest to Yaoundé, had an exceptionally high bushmeat consumption rate (albeit with large variance). This anomaly had largely to do with a few individuals hunting heavily with dogs, and catching mainly giant pouched rats.

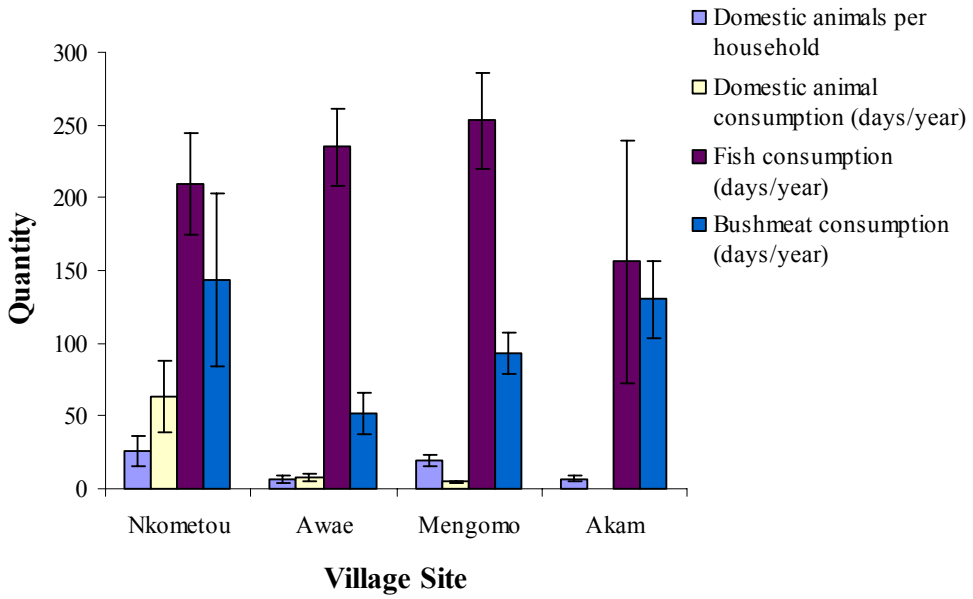

Figure 3. Comparison across village sites of domestic animal holdings per household, and domestic animal, fish and bushmeat consumption in number of days per year. Error bars are plus/minus standard error.

Hunter Follows

In each village site we identified hunters that hunted on a regular basis (Nkometou, n=2; Awae II, n=5; Mengomo, n=5; Akam, n=1), and agreed for us to accompany them on their next hunting trip. (Small sample sizes were due to time constraints, not to small numbers of hunters.) On each hunter-follow the following data were recorded: distance, total time spent hunting per trip, numbers of traps, and any wild meat caught. Hunting trip duration and distance traveled are highly correlated, indicating that they are both reasonable proxies for hunting effort (Figure 4).

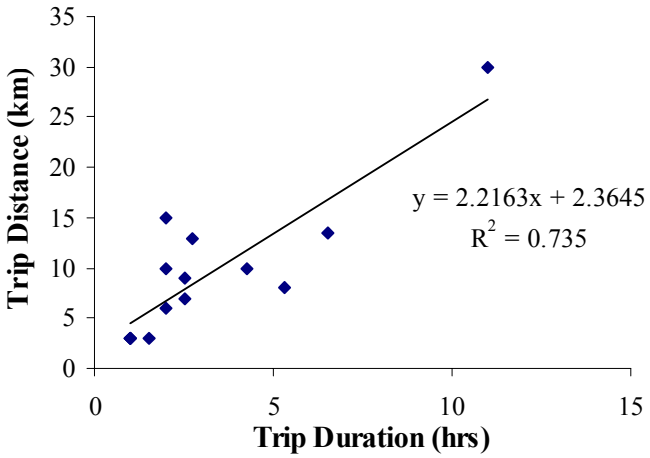

Figure 4. Correlation between trip distance (km) and trip duration (hrs) as proxies for hunting effort.

Table 4. Results of hunter-follows across village sites, including trip duration (hrs), trip distance (km), total number of traps set per hunter, and average # of animals caught in traps per hunter. Values include standard error.

	Nkometou (n=2)	**Awae** (n=6)	**Mengomo** (n=4)	**Akam** (n=1)
Trip Duration (hrs)	2.25 ± 0.25	1.58 ± 0.30	4.44 ± 2.19	6.5
Trip Distance (km)	5 ± 0	4.67 ± 1.09	17.0 ± 4.45	13.5
Total number of traps	59 ± 27	116.67 ± 40.92	166.5 ± 27.74	46
Average # game caught per visit	0.5 ± 0.5	0.5 ± 0.5	0.25 ± 0.25	3

Effort in hunting (i.e. trip duration, distance, and numbers of traps laid) generally tended to increase with increasing remoteness of the site, although the farthest site, Akam, is represented by only one data point and therefore should not be included in the comparison (Figure 5). Catch was very low across all sites (except Akam) so that a much bigger sample size is needed before conclusions can be drawn about tendencies (Figure 6). However, it appears that more effort is put into hunting in more remote sites, but assessing a tendency in catch per unit effort (CPUE) will require more data.

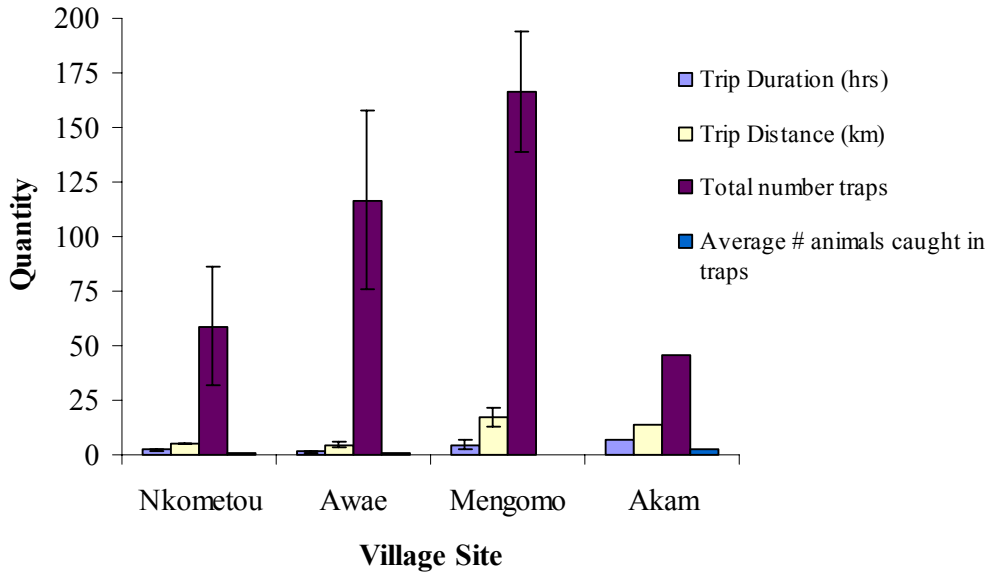

Figure 5. Results of hunter-follows across village sites, including trip duration (hrs), trip distance (km), total number of traps set per hunter, and average # of animals caught in traps per hunter. Error bars represent standard error.

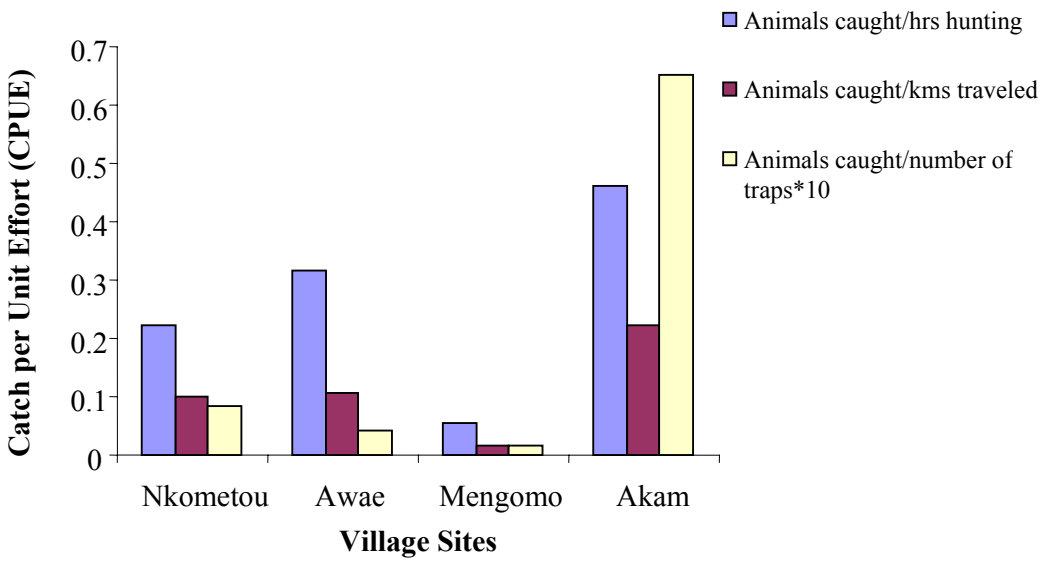

Figure 6. Catch per unit effort (CPUE) compared as catch per hunting trip duration, catch per hunting trip distance, and catch per number of traps per hunter (multiplied by 10 to allow visual comparison on same scale).

Discussion

This pilot study investigated the relationship between human population pressure, land use change and change in wildlife hunting patterns. This study also began to predict which species are most at risk with human expansion and how people in the Forest Margin Benchmark of southern Cameroon respond to declines in bushmeat availability. It was also intended to identify which types of land use associated with the mixed agricultural mosaic common to southern Cameroon may be of conservation benefit.

In the study area, the general pattern of biodiversity response to human population pressure is for increasing mammalian diversity with increasing remoteness (in terms of distance from Yaoundé and primary forest cover left). Therefore, even though all transects were carried out within 5.5 km of each village, the number of species encountered doubled from 9 to 20 between the village site very close to Yaoundé and the farthest site near the border with Gabon. In addition to declines in numbers of species, the species composition changed as well. Greater human population pressure is associated with a loss of the larger-bodied fauna, such as forest elephants, many of the primate species, including gorillas, chimpanzees and mandrills, and the largest of the forest duikers, the yellow-backed duiker. Rodents, small carnivores and many of the forest duiker species, however, seem to persist in areas with heavier human population pressure.

Interviews with heads of households revealed interesting trends in the changing importance of domestic animals, fish, and bushmeat in local protein consumption as well as annual revenue streams. Although results are preliminary, there appears to be an inverse relationship between domestic animal consumption and bushmeat consumption, so that as human population pressure causes bushmeat to become less available, people substitute bushmeat with domestic animal meat either raised at home or purchased. Fish was found to be the most important animal protein source in all sites, contrary to popular belief that bushmeat is the most important source. However, many people in these village sites reported declines in

both bushmeat and fish resources, posing a major food security concern and necessitating further investigation.

Cocoa and manioc were the most important sources of income at all sites, with tomatoes, plantains, and government posts (salaried employment) also important income sources. Although total household income was fairly variable between sites, cocoa and hunting are an increasingly important part of a household's annual revenue (in percent contribution of total) in more remote locations. This may be due to the "cash crop" nature of both cocoa and wildlife, for both of which there is an important market and demand. Implicit in this finding is that if cocoa income were to decline due to decreased prices or demand, income would need to be substituted from other sources, with the probable effect of increasing hunting pressure on wildlife.

Hunter follows are one method with which to quantify hunting returns to effort expended. These hunting returns for effort indices, also known as catch per unit effort, are relatively well established for quantifying fishery stocks and harvest, but have been used relatively little to date on terrestrial mammal-harvesting scenarios, particularly in the developing world context (Lancia et al. 1996; Schmidt et al. 2005). This pilot study was an attempt to gauge the feasibility of using the number of animals caught in traps per hunter effort (comparing distance traveled, duration of hunting trip, and numbers of traps as proxies for effort). We anticipated that more rural areas would have higher remaining densities of wildlife and therefore have higher returns to effort. There seems to be an increasing trend in CPUE with more remote sites (Fig. 6), but the dataset is too small at present to draw strong conclusions from and Mengomo posed an anomaly to the expected pattern because although the most effort was expended, the least amount of wildlife was caught. Mengomo was the only village site on a paved highway, which may mean that it has higher than expected hunting pressure perhaps because people from outside the region can access it relatively easily. Also, the road itself might deter wildlife or make them flee farther into the bush. Anecdotally though, one hunter that was followed in the most remote site (Akam) had more and larger game than any of the other hunter-follows conducted in any of the sites.

In general, wildlife use did not differ significantly between land uses, although secondary forest made a disproportionate contribution to use of land by wildlife. Interviewees in the two most remote sites also reported crop raiding by chimpanzees and gorillas (cocoa), and raiding by a small primate (*Miopithecus ogouensis*) of corn fields, implying that these species are benefiting at least to some extent by provisioning in people's fields.

Conclusions

This pilot study was conducted as a preliminary assessment of various methodologies to look at wildlife abundance and diversity in the mixed agricultural mosaic of southern Cameroon, the importance of wildlife in farmer's annual income and protein intake, and the effects of human population growth rate and land use change on wildlife resources. It is hoped that further study will reveal what supplementary forms and amounts of animal protein would be necessary under different levels of human population pressure to promote a more sustainable harvest of Cameroon's wildlife resources.

Acknowledgements

The authors wish to thank Mars and STCP/IITA for financial and logistical support in the field. K.Z.W. was supported by an Andrew and Mary Thompson Rocca pre-dissertation award through the Center for African Studies at the University of California, Berkeley. We thank the people of Nkometou, Awae, Mengomo, and Akam for their help and collaboration on all aspects of this project.

Selected References

Fa, J. E., D. Currie, and J. Meeuwig. 2003. Bushmeat and food security in the Congo Basin: linkages between wildlife and people's future. Environmental Conservation **30**:71-78.

Lancia, R. A., J. W. Bishir, M. C. Conner, and C. S. Rosenberry. 1996. Use of catch-effort to estimate population size. Wildlife Society Bulletin **24**:731-737.

Muchaal, P. K., and G. Ngandjui. 1999. Impact of village hunting on wildlife populations in the western Dia Reserve, Cameroon. Conservation Biology **13**:385-396.

Plumptre, A. J. 2000. Monitoring mammal populations with line transect techniques in African forests. Journal Of Applied Ecology **37**:356-368.

Robinson, J. G., and E. L. Bennett. 2004. Having your wildlife and eating it too: an analysis of hunting sustainability across tropical ecosystems. Animal Conservation **7**:397-408.

Schmidt, J. I., J. M. V. Hoef, J. A. K. Maier, and R. T. Bowyer. 2005. Catch per unit effort for moose: A new approach using Weibull regression. Journal Of Wildlife Management **69**:1112-1124.

White, L. J. T. 1994. Biomass Of Rain-Forest Mammals In The Lope Reserve, Gabon. Journal Of Animal Ecology **63**:499-512.

Wilkie, D. S., and J. F. Carpenter. 1999. Bushmeat hunting in the Congo Basin: an assessment of impacts and options for mitigation. Biodiversity And Conservation **8**:927-955.