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Full Length Research Paper

Income sources and their relation to wildlife poaching in Ugalla ecosystem, Western Tanzania

Paulo Wilfred[1,2]* and Andrew D. C. MacColl[2]

[1]Department of Life Sciences, Faculty of Science, Technology and Environmental Studies, Open University of Tanzania, P. O. Box 23409, Dar es Salaam, Tanzania.

[2]School of Biology, University of Nottingham, University Park, Nottingham, NG7 2RD, UK.

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In the Ugalla ecosystem, wildlife conservation is constantly and pervasively challenged by the local communities looking for ways to improve their livelihoods. The need to curb poaching of wildlife continues to spark debate amongst conservation stakeholders in the area. Assessing the livelihood contributions of different sources of income in light of wildlife poaching is vital to conservation effort. The heads of households in villages bordering Ugalla Game Reserve (an integral component of Ugalla ecosystem) were interviewed to obtain data on poaching and income sources. Income from crops (especially tobacco, maize and groundnut) and livestock (cattle), had a remarkable positive effect on not only improving household income, but also decreasing poaching frequency. Other economically important crops were rice, sesame and sunflower, although these did not significantly influence wildlife poaching. Household income from other sources, namely, wildlife, forests, small businesses, formal employment and remittances, were not significantly associated with wildlife poaching. Although generally, the study villages with relatively low mean income had high poaching frequency, the ones close to Ugalla Game Reserve tended to have higher poaching frequency than the ones far from it. However, improving agricultural production would help to lessen pressure on wildlife resources in Ugalla.

Key words: Western Tanzania, Ugalla, wildlife poaching, income sources, income determinants.

INTRODUCTION

The majority of rural communities in the developing world depend on the renewable natural resources such as forest (Butler, 2006) and wildlife (TNRF, 2008) for their livelihoods. These resources supply a basic safety net for the poor rural people. For example, forest as an alternative source of income offers a range of timber and non-timber products, such as fuel wood, honey, beeswax, building poles, fodder resources, fruits and medicinal plants (Sunderlin et al., 2005; Giliba et al., 2010). Economically, disadvantaged rural communities also depend on wildlife-based products such as bushmeat, fur, skin, claws, horns and teeth as sources of income and/or protein (LWAG, 2002; Pattiselanno, 2004; Bennett et al., 2006; Carpaneto et al., 2007). Since the rapidly growing human population is already accelerating the pace of exploitation of natural resources (Songorwa, 2004; Wilfred, 2010), there is a strong need for effective conservation measures. Roe and Elliott (2005) broadly defined conservation as “the management of renewable natural resources over the long-term”.

The main approach to conservation until the end of the 20th century has been the establishment of protected areas (Johannesen, 2007). A protected area is “a clearly defined geographical space recognized, dedicated and managed through legal or other effective means to achieve the long-term conservation of nature with associated ecosystem services and cultural values” (UNEP-WCMC, 2008). Protected areas are both advantageous, by providing alternative sources of income to local people mainly through tourism, and disadvantageous, by denying local people access to natural resources (Roe and Elliott, 2005). The latter is a problem because it leads to poor support for the principle of conservation

*Corresponding author. E-mail: plxpw1@nottingham.ac.uk, pwilfried@yahoo.com.

(Shemwetta and Kideghesho, 2000; Arjunan et al., 2006; Allendorf, 2007). Conservation has therefore found itself at a crossroad between meeting the demands of local people for sustainable livelihoods and ensuring the preservation of natural resources (Roe and Elliot, 2005).

From a wildlife conservation perspective, uncomfortable interactions between protected areas and local communities are perpetuated through illegal hunting activities (Wilfred, 2010). Such hunting activities are correctly referred to as wildlife poaching, since they are carried out regardless of whether the wildlife laws permit them. Wildlife poaching is often unsustainable and is mainly done to harvest bushmeat, although it may also involve small-scale trade of by- products such as skins, horns, teeth, claws, etc. (Taylor and Dunstone, 1996). A variety of different income-based factors behind bushmeat exploitation have been put forward, apparently by location-specific and thus it operates at a local scale. For example, Coad (2007) found that relatively rich households dominated the commercial use of wildlife in Dibouka and Kouagna villages in Gabon, precisely because they had the resources necessary to invest in the bushmeat exploitation.

Loibooki et al. (2002) found that keeping fewer livestock, in particular goats and sheep, coupled with a "lack of alternative income sources", were the main drivers of an increased dependency on wildlife in the Serengeti ecosystem. Shrestha and Alavalapati (2006) established that lower agricultural incomes were one of the main reasons for an increase in dependency on wildlife in the Koshi Tappu Wildlife Reserve in Nepal.

In the case of Tanzania, notwithstanding its internationally recognised and highly valued protected areas, wildlife poaching is increasingly becoming a controversial issue (Carpaneto and Fusari, 2000; Baldus, 2002; Rustagi, 2005; Holmern et al., 2004; Caro, 2008). One of the predominant reasons for poaching is a need to improve living standards (Caro and Scholte, 2007; Kideghesho, 2008). The government of Tanzania is strongly determined to improve the livelihoods of its people by integrating different local sources of income sustainably, for example, agriculture, wildlife, forests and small-scale businesses (URT, 1998; 2005). Assessing the relative importance of such sources of income in the light of wildlife poaching would reveal priority options for both improving livelihoods and minimising human pressure on wildlife protected areas.

This paper therefore explores the relative contribution of different sources of income to the livelihoods of rural communities, and how this relates to wildlife poaching around Ugalla Game Reserve, Western Tanzania. Ugalla Game Reserve was first occupied in the 1950s by Wagalla people, who were hunters, fishermen and honey gatherers. These people were allowed to carry out their livelihood activities in the reserve until 1965, when the area was officially gazetted as a game reserve. Owing to increased pressure on wildlife resources, all unauthorized use of resources were prohibited within the game reserve, and local people were compelled to move out, occupying the adjacent areas (Lutabingwa, 2006). Demand for wildlife resources in the area then continued to pose conservation challenges, despite the availability of alternative sources of livelihoods. Regrettably, the relationship between different livelihood opportunities (or sources of income) and wildlife poaching has received far less attention. The results presented here suggest opportunities for reducing poaching through improving the living standards of the people in Ugalla.

METHODOLOGY

Study area

The study was conducted in the Sikonge and Urambo Districts, Western Tanzania. These districts contain a substantial part of the Ugalla ecosystem, in which Ugalla Game Reserve is the key component (Figure 1). The area falls between 4 to 7^0 South and 31 to 34^0 East, with an altitude ranging from 1100 to 1300 m above sea level. The land areas of Sikonge and Urambo Districts are 21000 and 21299km^2, respectively (URT, 1998). According to the 2002 population census, Sikonge and Urambo District had a population size of 133,388 and 370,796, respectively (NBS, 2002). In general, the human population of Tabora region is among the fastest growing region in Tanzania with a growth rate of 3.6% (NBS, 2002).

The climate is defined by a distinct wet season from December to June and a dry season from July to November. The rainfall varies between 700 and 1000 mm per year, and the mean maximum and minimum temperatures lie between 28 and 30°C and 15 and 21°C, respectively (Mbwambo, 2003; Hazelhurst and Milner, 2007). The vegetation contains a dry Zambezian miombo woodland dominated by the following species*: Brachystegia spiciformis*, *B. microphylla*, *B. bussei, Isoberlinia globiflora*, *Acacia kirkii*, *Cassia abbreviata*, *Burkea africana*, *Cymbopogon giganteus, Julbernadia globiflora*, *Grewia bicolor*, *Ozoroa reticulata*, *Sesbania sesban*, *Ximenia americana* and *Pterocarpus angolensis*. Wooded grassland with a reduced tree cover is the most widespread vegetation type in the area. The herbaceous layer is dominated by Hyperrhenia species, with a shrub layer of saplings of the canopy trees (Carpaneto and Fusari, 2000; Lutabingwa, 2006). As in many other rural areas in Tanzania, the livelihoods of the local people around Ugalla Game Reserve rely fundamentally on a mixture of activities such as keeping livestock, agriculture, fishing, hunting, beekeeping and the harvesting of forest products (Lutabingwa, 2006). Rain-fed agriculture plays a central role in the people's livelihoods, but soil fertility is relatively low (URT, 1998; Hazelhurst and Milner, 2007). Popular crops grown in the area include maize, cassava, sweet potatoes, rice, groundnuts, tobacco and sunflower (Kikoti, 2009).

Sampling

Following the theory for sampling techniques by De Vaus (2002), a sample of 19 study villages was drawn randomly from a total of 122 villages (15% sampling intensity) in both Sikonge and Urambo Districts. The study villages were, Isongwa, Kangeme, Lumbe, Nsenda, Ukumbi-Siganga, Usinga, Zugimlole, Mole, Izengabatogilwe, Igalula, Ipole, Mitowo, Mitwigu, Wema, Usanganya, Kasisi, Izimbili, Nsogolo and Itebulanda. Data were collected from these villages through structured questionnaires, which were completed in the interviews with heads of 573 randomly selected households (out of about 11000 households in all the study villages, yielding the sampling intensity of 5.2%), in the period

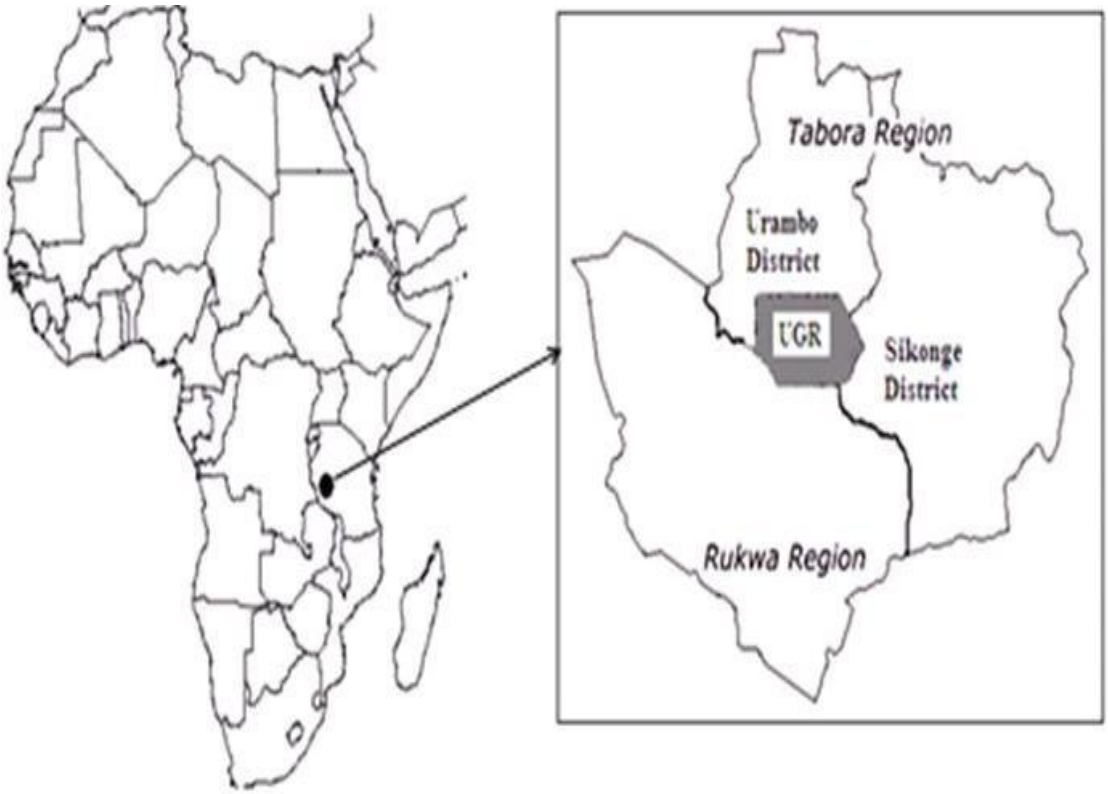

Figure 1. Map showing the study area. Ugalla Game Reserve [UGR] is also shown.

Table 1. Mean income (U.S. $) ± standard error (s.e.) from different sources in the study villages around Ugalla Game Reserve, Western Tanzania. Number of observations for different sources (n) and the total number of observations (N) are shown.

Income source	n	Income[¶] ± s.e.	Income[§] ± s.e. (N = 573)
Crop sales	460	1057.63 ± 67.64	849.05 ± 57.10
Livestock	173	249.45 ± 35.44	75.31 ± 11.70
Forests[1]	220	8.87 ± 0.87	21.19 ± 2.69
Small business[2]	49	147.31 ± 14.93	12.60 ± 2.14
Formal employment[3]	28	134.24 ± 24.45	6.56 ± 1.69
Wildlife[4]	90	134.89 ± 11.17	3.41 ± 0.38
Remittances[5]	40	33.62 ± 3.88	2.35 ± 0.45

Official exchange rate in 2009: 1 US dollar = 1300 Tanzanian Shilling (TZS). [¶]Income divided by "n". [§]Income divided by "N". [1]Forest-based products, for example, timber, charcoal, building poles, ropes, firewood, honey, beeswax, medicinal plants. [2]Self employment activities such as carpentry, local village midwifery and traditional healing practices; day labourers on farms; selling fruits, vegetables, fishes, soft drinks and local alcoholic drinks; kiosks; maize mills. [3]Formal employment such as primary school teaching; village healthcare practitioners; village agricultural extension officers; village executive officers; working with non-governmental organisations. [4]Wildlife-based products, for example, bushmeat, teeth, claws, skins, skulls, feathers, horns, jaws and other bones and organs. [5]Money sent home by children and/or other relatives working in towns or other regions.

from March to October, 2009. Random sampling was adopted in order to ensure that the estimated parameters (for example, income and poaching in this case) represent the population as adequately as possible (Levy and Lemenshow, 1999; De Vaus, 2002).

The survey gleaned information related to income generation through 7 sources (Table 1), in addition to wildlife poaching. Firstly, respondents were asked about production and sales of their crops and livestock in the preceding harvest season. They were then asked to estimate their income from small business, formal employment, forest- and wildlife-based products, and remittances in the previous 6 months. Conversely, the second portion of the survey encompassed questions of direct relevance to wildlife poaching. Respondents were asked to state whether or not poaching incidents had occurred in their villages in the previous 6

months. Responses concerning poaching were used as an indication of poaching frequency or intensity. Elsewhere, wildlife researchers have also gleaned information about wildlife exploitation from the views of local people (Holmern et al., 2004; Ndibalema and Songorwa, 2007; Caro, 2008; Rist et al., 2008; Smith, 2008). Indeed, assessment of wildlife poaching is enormously challenging not only because of the illegal nature of poaching, but also because capturing reliable information depends chiefly on the ability of respondents to remember any of the details (Knapp et al., 2010). However, due to good rapport established with the villagers, most were willing to report poaching activities in their villages anonymously. In addition, following Dewalt and Dewalt (2002), participant observation was carried out to verify various answers provided by respondents. In the data analysis and interpretation of the results, we were also mindful of any potential bias associated with the survey. For each of the study villages, distance from the centre of the village (as agreed with the village chairman) to the closest point on the Ugalla Game Reserve boundary was estimated using a hand-held GPS unit.

Data analysis

All statistical analyses were carried out using the statistical package GenStat version 10 (Payne et al., 2007). Non-parametric Kruskal-Wallis one-way analysis of variance was used in the comparison of different sources of income in order to determine their relative importance. The rest of the analysis was done using generalized linear models (GLMs). The interest here centred on the comparisons of household income among crops, livestock species and the study villages. The relationship between different sources of income and the frequency of wildlife poaching was also investigated. The best predictors or determinants of household income were identified from the list of potential variables: age, household size, family labour (household members aged>18 years), productive assets, tribe and level of education. This was done systematically by dropping predictors in order of their F-values (that is, lowest first) until all remaining predictors contributed significantly to the model. Thus the minimum sufficient model is presented in subsequent tables shown in this study.

RESULTS

Respondents' characteristics and income sources

The majority of the households that were surveyed had male heads (69.3%), while the average household size (± s.e.) was 9.1 ± 0.24 people. The age distribution revealed that 28.8% of the respondents were young- adults between 18 and 35 years of age, 46.8% were aged between 36 and 55 years and 24.4% were more than 56 years of age. However, the mean age was 45.3 ± 0.63 years. Of the respondents, almost 40% had no formal education, 60% had acquired primary education ranging from 1 to 7 years of schooling and 0.03% had achieved secondary education. There were no respondents with college and/or university education. On average, the years of formal education were 3.5 ± 0.13. The largest proportion of the respondents (37.5%) belonged to the Sukuma tribe, whereas 29.7 and 15.2% belonged to the Nyamwezi and Muha tribes, respectively. Other tribes combined (17.6%) were: Bemba, Bende, Bungu, Chaga, Fipa, Gogo, Haya, Hehe, Kimbu, Kanonko, Lungwa, Lwila, Wagalla, Gogo, Hyao, Wajita, Ngoni, Nyakyusa, Nyaturu, Nyiramba, Pimbwe and Tutsi.

All the respondents (99%) practiced small-scale farming, 80% of whom sold some of their produce. About 90% of the respondents kept livestock, 33% of whom sold some of them. Other sources of income, for example, forests, wildlife, small business, remittances, and formal employment, provided additional income to 38.4, 15.7, 8.6, 7 and 4.9% of the respondents, respectively. The mean self assessed household annual income was U.S. $ 819.67 ± 59, composed of income derived from various sources. Income sources differed significantly in their contribution to the total Kruskal-Wallis test: ^{2} = 1473, d.f. = 6, p<0.001 (Table 1), the most important one being crop sales, followed by livestock, whereas remittance income was the least one.

Crop and livestock sales

Owing to the central role played by crops and livestock in the household economy, it is worthwhile to quantify the contribution of each element to the household income. Table 2 presents the estimates of income for crops grown in the study area. Maize was the most commonly grown food and cash crop (98% of households), followed by groundnut (90%), whereas other crops such as cowpea, green gram and millet, were not common in the study area. Tobacco was grown exclusively for sale by 37% of the respondents. A Generalized Linear Model (GLM) analysis (with normal errors) showed that seven crops were important in determining household income (Table 4). The most profitable crop was tobacco, followed by groundnut, whereas others, for example, sorghum, beans and cassava had relatively low contribution to the household income.

In the case of livestock, the common species were chicken, goat and cattle. Only cattle had significant positive impact on the household income (Tables 3 and 4). Other livestock, for example, goat, sheep and duck, had low contribution to the household income.

Income determinants

Study villages varied significantly in the mean household income (GLM with normal errors, $F_{17,571}$ = 6.26, p<0.001) (Figure 2), whereas mean household income increased with the increase in distance from Ugalla Game Reserve ($F_{1,572}$ = 4.57, p<0.033). Of the individual villages, the ones located, at least, 10 km away had noticeably high mean incomes. There were, however, a few exceptions. For example, Kangeme village had a relatively high mean income despite being very close to Ugalla Game Reserve. Similarly, Igalula village had a very low mean income even though it was far from Ugalla Game

Table 2. Crops produced and sold annually in the study villages around Ugalla Game Reserve, Western Tanzania.

Crop	Respondents (%)	Mean amount produced (kg) ± s.e.	Mean amount sold (kg) ± s.e.	Mean income (U.S. $) ± s.e.
Tobacco	37	418.2± 35.5	418.2± 35.5	658.3± 54.0
Groundnut	90	1097.9 ± 65.0	568.7± 50.4	70.5 ± 7.3
Maize	98	1313.5 ± 77.2	285.3± 33.2	51.6 ± 6.4
Rice	28	467.3± 71.3	194.1± 36.6	43.9 ± 8.3
Sesame	10	19.3± 7.3	16.3± 3.4	17.8 ± 3.7
Sunflower	18	92.0 ± 20.8	38.3 ± 13.5	12.9 ± 1.3
Potato	32	152.9± 15.4	27.8± 6.3	7.6 ± 0.6
Cassava	40	238.4± 27.2	14.4± 4.6	1.1 ± 0.4
Beans	16	19.6± 5.3	1.3 ± 0.6	0.9 ± 0.4
Sorghum	10	40.2± 7.3	3.6 ± 1.9	0.7 ± 0.5
Other*	3	23.1± 7.9	5.5 ± 3.3	0.09± 0.04

Official exchange rate in 2009: 1 US dollar = 1300 Tanzanian Shilling (TZS). *include cowpea, green gram and millet.

Table 3. Ownership of livestock in the study villages around Ugalla Game Reserve, Western Tanzania.

Livestock	Respondents (%)	Mean owned	Mean sold	Mean income (U.S. $)
Cattle	32	10.7 ± 1.4	0.4 ± 0.1	64.2± 11.2
Goat	42	5.1 ± 0.5	0.3 ± 0.1	5.9± 1.3
Chicken	81	15.6 ± 0.7	1.2 ± 0.2	3.9± 0.6
Sheep	13	0.9 ± 0.1	0.01 ± 0.004	0.2± 0.1
Duck	72	0.5 ± 0.1	0.02 ± 0.01	0.07± 0.04

Official exchange rate in 2009: 1 US dollar = 1300 Tanzanian Shilling (TZS).

Reserve.

A number of factors were found to be associated with household income (Table 5): household assets (the value of the productive assets in the house) had a significant positive effect on the household income; households that were larger in total size tended to have lower income, although those with more members aged 18 and above had higher household income; educated individuals had higher income than the non-educated. However, age and tribe of the respondents had no significant influence on the income.

Income and wildlife poaching

Wildlife poaching frequency differed significantly across the study villages (GLM with binomial errors, d.f. = 17, deviance $\chi^2 = 51.4$, $p<0.001$) (Figure 3). Generally, mean poaching frequency decreased with increasing distance from the Ugalla Game Reserve boundary (d.f. = 1, deviance $\chi^2 = 41.3$, slope = -0.058 ± 0.009, $p = 0.001$), especially for study villages with relatively high mean household income (GLM with binomial errors, $p = 0.001$) (Figure 4). Of all the income sources, livestock and crop sales were the best predictors of wildlife poaching (Table 6), meaning that the increase in income from these sources led to significant decrease in poaching.

An attempt was made to identify the effects of individual crops, livestock species and income deter-minants on wildlife poaching. Of all the crops, as income from tobacco, groundnut and maize increased, the frequency of wildlife poaching decreased (Table 7). Likewise, cattle, goat and chicken were the livestock species, which significantly predicted poaching frequency. However, only income from cattle and goat led to the decrease in poaching frequency. Conversely, poaching frequency was high in the villages where most of the respondents relied on chicken as their main source of income (Table 7). Of the income determinants, the study villages with higher mean value of productive assets had significantly lower mean poaching frequency. In addition, increase in manpower led to significant decrease in poaching frequency, whereas household size had a positive impact on poaching frequency (Table 8).

DISCUSSION

In general, increases in income led to decreases in wildlife poaching, which suggests that most of the hunting

Table 4. Results of a GLM examining the association between the overall household income and income from different crops and livestock.

	F- value	(Estimate ± s.e.) x 10^{-3}	Probability
Constant		11520 ± 358	<0.001
Tobacco	3211.66	12.85 ± 0.23	<0.001
Groundnut	100.79	18.72 ± 1.86	<0.001
Cattle	78.80	16.4 ± 1.12	0.001
Maize	60.33	13.64 ± 1.65	0.011
Rice	42.37	20.38 ± 3.03	0.021
Sesame	28.95	12.64 ± 2.35	0.028
Sunflower	19.30	28.68 ± 7	0.033
Potato	11.09	41.4 ± 20.5	0.049
Chicken	4.74		
Goat	4.69		
Sheep	0.75		
Duck	0.45		
Cassava	0.32		
Beans	0.25		
Sorghum	0.24		
Other (crops)	0.12		

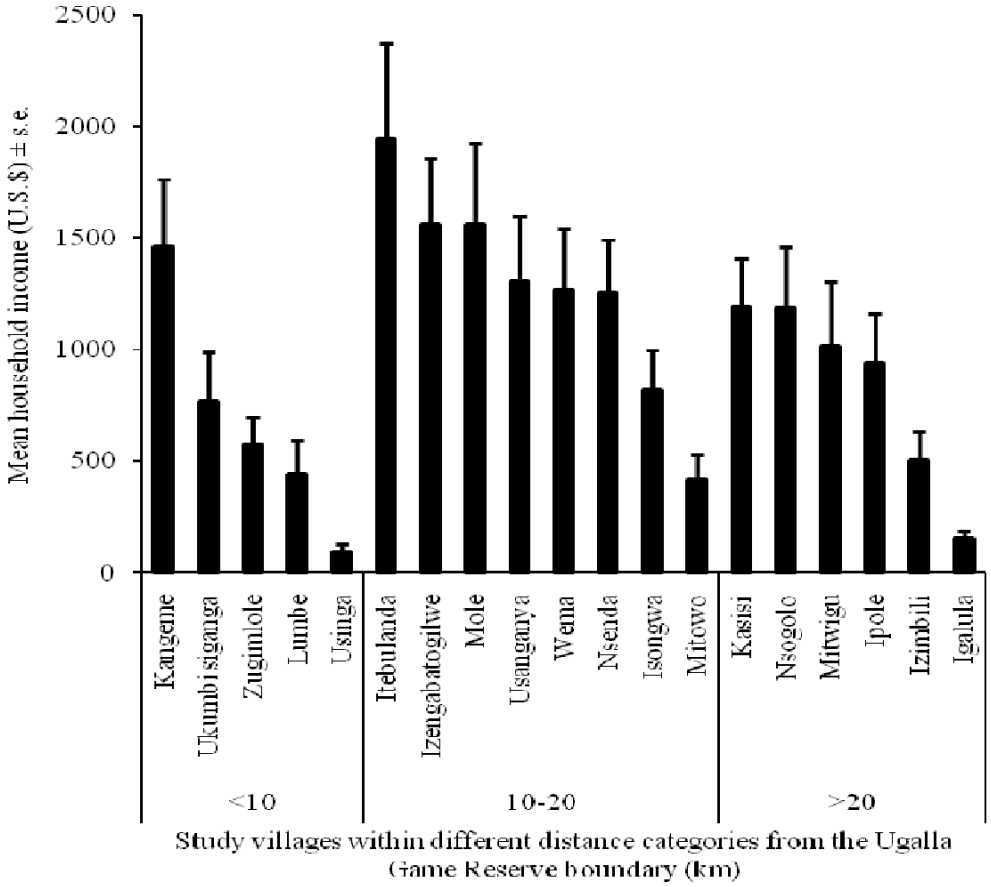

Figure 2. Comparison of mean household income across the study villages.

Table 5. Determinants of the household income (N = 573).

	d.f. (change, residual)	F- value	Estimate ± s.e.	Probability
Constant			7.85 ± 3.18	0.014
Household assets	1,565	134.88	1.209 ± 0.10	<0.001
Household size	1,565	9.80	-0.822 ± 0.26	0.002
Education	1,565	6.24	0.594 ± 0.24	0.013
Family labour	1,565	4.15	0.911 ± 0.45	0.042
Age	1,565	2.09	-0.072 ± 0.05	0.149
Tribe	3,567	1.55		0.200
Tribe (Sukuma)			-2.67 ± 2.20	
Tribe (Nyamwezi)			-2.36 ± 2.21	
Tribe (Other*)			1.23 ± 2.45	
Tribe reference level: Muha				

* include: Bemba, Bende, Bungu, Chaga, Fipa, Gogo, Haya, Hehe, Kimbu, Kanonko, Lungwa, Lwila, Wagalla, Gogo, Hyao, Wajita, Ngoni, Nyakyusa,Nyaturu, Nyiramba, Pimbwe and Tutsi.

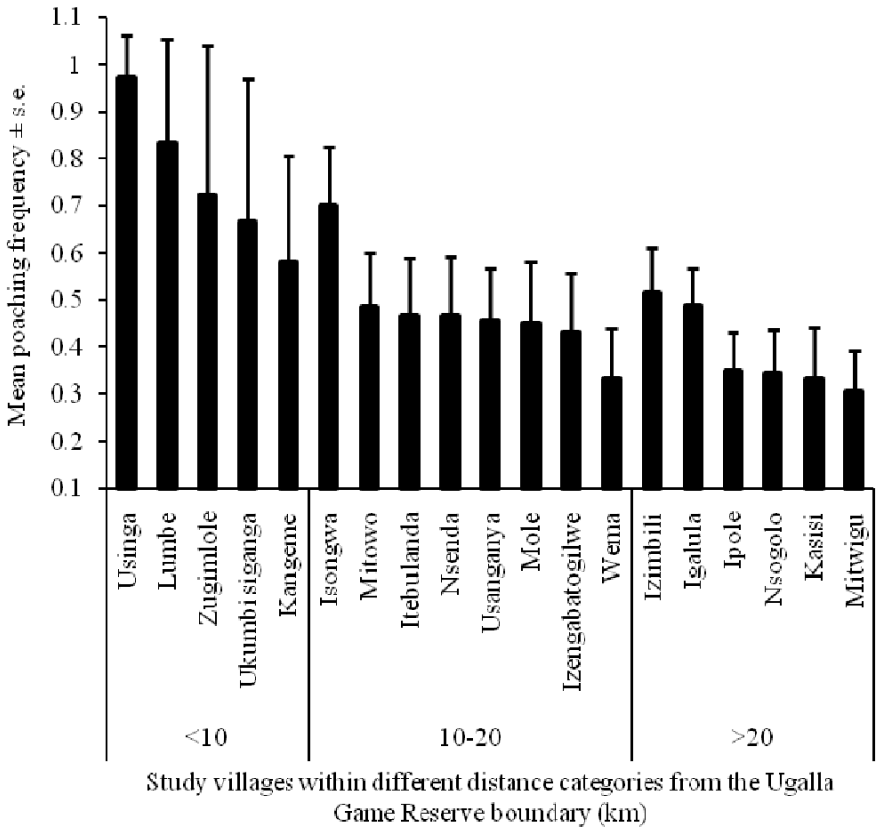

Figure 3. Comparison of mean poaching frequency across the study villages.

activities were carried out by low-income villagers. This is in accordance with several wildlife conservation studies elsewhere (Loibooki et al., 2002; Robinson and Bennett, 2004; Bennett et al., 2006). Nonetheless, the effects of different sources of income on the total household income determined the extent to which villagers were involved in poaching. For example, families who earned considerable income from agriculture were less likely to engage in illegal hunting activities. Shrestha and Alavalapati (2006) reported similar observations in Nepal and found that farmers who earned high incomes from agriculture were not very dependent on wildlife resources.

Household income ensued from crop and livestock

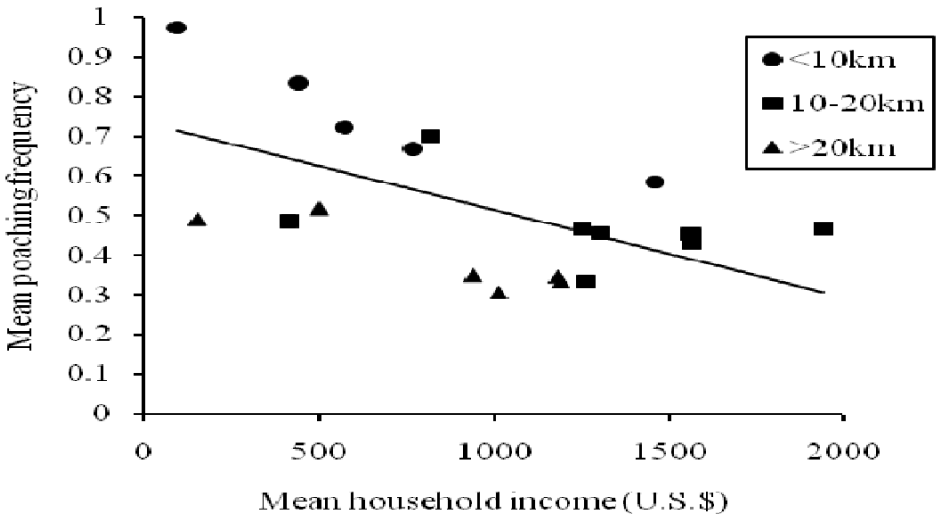

Figure 4. Relationship between mean household income and poaching frequency.

Table 6. General linear model, with a binomial error structure, showing the wildlife poaching influence of crop sales and livestock in the study villages around Ugalla Game Reserve, Western Tanzania.

Parameter	d.f.	Deviance	(Estimate ± s.e.) x 10^{-3}	Probability
Constant			1219 ± 194	<0.001
Crop sales	1	17.09	-0.73 ± 0.179	<0.001
Livestock	1	12.34	-3.82 ± 1.1	<0.001

Table 7. General linear model, with a binomial error structure, showing the influence of crops and livestock on wildlife poaching. N = 19 villages, d,f. (change, residual) = 1 and 13.

	Deviance	(Estimate ± s.e.) x 10^{-3}	Probability
Constant		1022 ± 222	<0.001
Cattle	19.17	-9.5 ± 2.19	<0.001
Chicken	16.99	194.3 ± 48.1	<0.001
Tobacco	13.59	-0.27 ± 0.07	0.007
Maize	12.11	-11.29 ± 3.26	0.013
Groundnut	7.85	-0.02 ± 0.01	0.024
Goat	4.42	-39.4 ± 14.6	0.057

sales. Of crops, tobacco was the most profitable and the only non-food crop grown for commercial purposes. Income from tobacco far exceeded other crops, undoubtedly due to its relatively high market price. Respondents admitted that the price per kg of tobacco had increased significantly in the 2008 to 2009 farming season compared to the situation in the 1990s. This however, represents a conservation problem, since it may attract many farmers into extensive cultivation of tobacco at the expense of the miombo ecosystem (Yanda, 2010). Other important food and cash crops that were not predictors of wildlife poaching were rice, sunflower and sesame. Generally, crop farming in the study area was confronted by a number of challenges. Some of them as mentioned by one of the farmers in Usanganya village were the expensive agricultural inputs such as fertilizer, power tillers, pesticide, water pumps, ploughs, etc.; poor access to credit facilities coupled with tightened eligibility criteria; poor soil fertility; and fewer agricultural extension officers (Ellias R. Kaugilla, pers. com.). Indeed, ensuring adequate and affordable inputs is a pre- requisite for increased profit from crop farming, because of the huge loss of soil fertility (Hazelhurst and Milner, 2007).

Table 8. General linear model, with a binomial error structure, showing the influence of income determinants on wildlife poaching around Ugalla Game Reserve. N = 19 villages, d,f. (change, residual) = 1 and 16.

	Deviance	Estimate ± s.e.	Probability
Constant		-2.37 ± 0.25	<0.001
Household assets	18.29	-0.16 ± 0.023	<0.001
Household size	9.31	0.18 ± 0.057	0.002
Family labour	5.00	-0.29 ± 0.092	0.002

The study found that livestock was the second most important source of income, as Bucheyeki et al. (2010) also found. Of the livestock species, only cattle had a significant effect on both household income and poaching frequency. However, some of the villagers were reluctant to sell their livestock, and in most cases, only sick or very weak animals saw their way to the seasonal local markets called “mnada”. According to URT (1998), for some communities in Tabora, keeping large numbers of livestock signals wealth and prestige. This has been a worrying scenario in terms of both the amount of land cleared to provide grazing space, and disputes between pastoralists and farmers over land resources, especially due to mobile and largely uncontrolled keeping of livestock (URT, 1998; Abdallah and Monela, 2007; Matata et al., 2010).

Apart from agriculture (crop farming and livestock keeping), villagers were also dependent on other income sources. Despite the fact that non-agricultural sources of income could not significantly predict wildlife poaching, respondents who made use of some of such sources (for example, small businesses, formal employment and wildlife), had somewhat substantial earnings from them. Forest-based products were consumed by a relatively large number of respondents, which is why the average income from “forests” seemed to be lower. However, during participant observation, it was established that charcoal, honey and timber were the most marketable and profitable forest-based products. Bucheyeki et al. (2010) reported substantial income earned from forest products by local communities in Western Tanzania. Utilization of forest products, especially through commercial logging and charcoal making has had a noticeable impact on miombo woodlands in the area (Mkanta and Chimtembo, 2002), which is more likely to have undesirable effects on wildlife habitats.

Wildlife seemed to have a relatively low contribution to household income. According to most of the respondents, income from wildlife was mainly generated through selling bushmeat, and much of the bushmeat was consumed for non-commercial purposes. Carpaneto and Fusari (2000) saw that bushmeat hunting was less important as a source of income for local people in Western Tanzania. In addition, owing to the fact that in Tanzania selling bushmeat is illegal, and in most cases, the people involved, sell it on black markets for fear of being arrested for poaching (Baldus, 2002; Knapp et al., 2010), the possibility that income from wildlife might be underestimated cannot be ruled out. Other wildlife by-products such as skin, claws, teeth, etc., were either sold or used for ritual and traditional purposes.

Income from other off-farm sources (formal employment, small business and remittances) accounted for 2.2% of the total income in the study area. Formal employment was uncommon, and one might expect that this would have been caused by the low literacy level, but this was not the case. Apart from few government employees such as primary school teachers and village executive officers, most of the unemployed respondents had at least a primary school education. Indeed, in the rural areas, economic openings are few (URT, 2005), and therefore, formal employment opportunities are limited.

Small businesses were carried out by a handful of people in the study area. Owing to their importance in the economy of rural areas, the government of Tanzania is strongly committed to undertake policy changes necessary to improve rural livelihoods through small-scale business enterprises (URT, 2004; 2005).

Variation in the mean household income explains the observed variation in wildlife poaching frequency among the study villages. However, wildlife poaching was more important to villages that are close to Ugalla Game Reserve than those far from it. Elsewhere, in Panama, Smith (2008) found a close relationship between increases in wildlife exploitation and decreases in distance of human settlements from wildlife areas. Household productive assets such as ploughs, water pumps, hand hoes, wheel barrows, traditional carts, tobacco barns and traditional grain storage baskets, were of paramount importance in increasing household income, thereby reducing villagers’ dependency on wildlife resources. Byarugaba (2003) pointed out productive assets as one of the missing ingredients in poverty-stricken rural communities whose lives are predominantly dependent on the natural ecosystem. The importance of family labour in crop farming and livestock keeping cannot be overemphasized. On the other hand, the increase in the household size heightened family demands, thus exacerbating the household economic situation, especially for larger-sized households with insufficient family labour available for agricultural activities, simply because most household members had migrated to

urban areas in search for a better life. Some respondents claimed that they had to hire additional labour for agricultural production, thereby further worsening their economic situation. The results also showed a significant positive impact of formal education on household income. Formal education is a tool for making sound decisions that would improve income from both livestock keeping and crop farming (Inoni et al., 2007; Serin et al., 2009). Nonetheless, education facilitates adoption and successful implementation of new technologies that would improve agricultural productivity (Weir, 1999; Serin et al., 2009).

Conclusion

Assessing different sources of income in Ugalla ecosystem from a wildlife poaching standpoint offers a good understanding of the tradeoffs existing between local livelihoods and wildlife conservation. This study has revealed some factors that influence both people's livelihoods and wildlife poaching. The study has revealed that crops and livestock are not only important sources of income, but also reliable options for curbing wildlife poaching.

Other sources of income, namely, forests, wild-life, small business, formal employment and remittances, although subsidiary, signify the presence of additional livelihood options for local people in the study area. None of these were relevant in reducing poaching. While income is an important ingredient in lessening local people's dependence on wildlife resources, the results suggest that villagers carryout poaching activities not only because of their economic hardship, but also because of their close proximity to wildlife areas.

Attempts to improve people's livelihoods in Ugalla should pay a great deal of attention to local communities neighbouring Ugalla Game Reserve. This would contribute to commendable conservation work carried out by the Ugalla Game Reserve Management Team. A considerable amount of emphasis should be put on the cultivation of important food and cash crops. In addition, the influence of other factors (apart from household income) on wildlife poaching is worthy of consideration in future studies.

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