FOOD SECURITY RESEARCH PROJECT

Wildlife Conservation in Zambia: Impacts on Rural Household Welfare

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EXECUTIVE SUMMARY

Tourism is one of the most rapidly growing economic sectors in the world, especially in developing countries; growth rates in international tourist arrivals and receipts in these countries are roughly double the world average. In Zambia, the tourism sector has grown steadily in recent years; international tourist arrivals from 1990 to 2005 grew at an average annual rate of 9.7%, and tourism receipts grew at 10.2%, compared to average growth rates for developing countries of 6.6% and 9.9%, respectively. Tourism in Zambia is largely based on the country's stock of natural resources, particularly the system of national parks (NPs) and game management areas (GMAs). GMAs serve as buffer zones between the NPs and rural agricultural land. They were intended to promote sustainable hunting as an alternative to activities not compatible with wildlife protection. The Zambia Wildlife Authority partners with community organizations to share wildlife management responsibilities and revenue from hunting licenses.

This approach is an example of Community Based Natural Resource Management (CBNRM), with the dual goal of enhancing the welfare of local communities and creating incentives for the protection and conservation of natural resources. The co-management of wildlife resources presents opportunities and threats for communities living in GMAs. Through the CBNRM program, communities receive a share of the revenues generated from hunting licenses and concession fees paid by hunting outfitters. These funds are distributed to Village Action Groups (VAGs), which use the revenue to employ village scouts (who aid in wildlife protection) and for implementation of community development projects (such as the construction of health clinics, schools, water wells, and boreholes). Tourism development also creates opportunities for wage employment and entrepreneurship, in addition to the benefits from increased access to infrastructure and services. However, capturing these benefits depends on various factors, such as the potential for tourism growth, the appropriate planning of land uses and human settlements, the transparency with which the main actors (ZAWA, area chiefs, community representatives) manage the program, the authority for decision making granted to communities, and the community's commitment to protect wildlife.

The effectiveness of the program is also threatened by unintended negative effects, such as greater crop destruction with increasing wildlife populations and the pressure that in-migration puts on land and other natural resources. Crop losses from wildlife conflicts are cited by village leaders and residents as the greatest impediment to socioeconomic development in GMAs. Despite the apparent increase in crop losses and injuries related to wildlife conflicts, there is currently no means to compensate households for such losses.

In a study of the effects of GMAs on rural welfare, we use data from a survey of households adjacent to four national park systems: Bangweulu (including Isangano, Lavushi and Kasanka NPs), Kafue (including Kafue, Blue Lagoon and Lochinvar NPs), Lower Zambezi (Lower Zambezi NP) and Luangwa (South Luangwa NP). We find that GMAs generate meaningful economic benefits but that these benefits accrue primarily to wealthier households and to those GMAs with greater levels and variety of wildlife. These results should encourage the continuation of CBNRM programs. However, the uneven distribution of the benefits of living in a GMA demonstrates that, to have meaningful impact on rural poverty alleviation, tourism development needs to be pro-poor by design. Community participation in tourism development is one of the major avenues for promoting pro-poor tourism. These findings suggest a role for policies that enhance the upstream linkages between tourism and small

enterprises in rural areas, particularly in agriculture, in order to boost rural incomes and increase demand for locally-manufactured goods.

Despite the overall positive effect of GMAs on household income, our results confirm the views expressed by community leaders and residents regarding crop loss from wildlife: households living in areas with higher wildlife populations suffer more intensely from crop destruction. Current policies provide no compensation to households experiencing such damage. Yet continued success of the GMAs in protecting the population and diversity of wildlife may exacerbate this problem, potentially threatening the sustainability of tourism development and eroding community support for environmental conservation. Wildlife conservation and tourism development may thus be sustainable only if human-wildlife conflicts are minimized or compensated.

This research also highlights policy implications for the role of village scouts, since we find that more scouts in a community are associated with more crop loss. This suggests that scouts have been successful in protecting wildlife but have been unable to prevent (or to focus on preventing) wildlife from destroying agricultural fields. A review of the scouts' mandate could help more appropriately balance their role across these competing objectives. Policies that simultaneously protect wildlife and minimize or compensate for conflict may more effectively advance the overall goals of wildlife conservation.

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ACRONYMS

APE	Average Partial Effects
CAPE	Conditional Average Partial Effect
CBNRM	Community Based Natural Resource Management
CRB	Community Resource Board
CSO	Central Statistical Office
GMA	Game Management Area
IGMAW	Impact of Game Management Areas on Household Welfare
LCMS	Living Conditions Monitoring Survey
LDC	Least Developed Countries
NGO	Non-Governmental Organization
NP	National Park
NRCF	Natural Resources Consultative Forum
OLS	Ordinary Least Squares
PPS	Probability Proportional to Size
SEA	Standard Enumeration Area
UAPE	Unconditional Average Partial Effect
UNWTO	United Nations World Tourism Organization
USAID	United States Agency for International Development
VAG	Village Action Group
WB	World Bank
ZAWA	Zambia Wildlife Authority

1. INTRODUCTION

Rural poverty in Zambia remains a persistent problem. The majority of rural households rely on subsistence agriculture as their main livelihood, which is typically insufficient to ensure food security. Although most households seek livelihood diversification opportunities as part of their strategy for risk management and income generation, such opportunities are often out of reach for the poorer households, due to capital or labor constraints as well as a general scarcity of off-farm employment. Providing access to off-farm employment in rural areas is one of the Zambian Government's key objectives for 2006-2010. Acknowledging the need to strengthen linkages within the economy and to focus on sectors that generate broad-based wealth and job creation, the Government of Zambia plans to promote sectors thought to be pro-poor and labor intensive. Tourism has been identified as a key sector for pro-poor growth (Government of Zambia 2006) in large measure due to its potential to generate off-farm income opportunities in rural areas (typically surrounding national parks) where commercial agriculture is a less attractive option.

Tourism is one of the most rapidly growing economic sectors in the world, especially in developing countries; growth rates in international tourist arrivals and receipts in these countries are roughly double the world average (UNWTO 2006). In Zambia, the tourism sector has been growing steadily in recent years; average annual growth in tourism arrivals between 1990 and 2005 has outpaced the growth rate for developing countries in the period. International tourist arrivals in Zambia grew at an average rate of 9.7%, and tourism receipts grew at an average rate of 10.2%. The developing country average growth rate for arrivals and receipts was 6.6% and 9.9%, respectively (UNWTO 2006).

Tourism in Zambia is largely based on the country's stock of natural resources, particularly the system of NPs and GMAs. GMAs serve as buffer zones between the NPs and rural agricultural land. ZAWA partners with community organizations to share wildlife management responsibilities and revenue from hunting licenses. Households in GMAs benefit from these arrangements through access to infrastructure development, employment and business opportunities, and revenue sharing; however, they may also suffer negative effects, including crop destruction from increasing wildlife populations and pressure from in-migration on land and other natural resources. In interviews with community leaders and residents of villages in GMAs, the human-elephant conflict was cited as the greatest development challenge among GMA households.

In consideration of the policy objectives of promoting wildlife conservation and alleviating rural poverty, it is important to evaluate the effects of GMAs on rural welfare. In this study, household survey data were used to measure the effect of GMAs on rural household income. Stratified two-stage cluster sampling was used to identify households in 139 standard enumeration areas (SEAs) adjacent to four national park systems. A total of 2,800 households were selected, with about half located in GMAs, and about half located in non-GMAs (as a control group). The survey was administered by the Central Statistical Office (CSO), and there were only about 32 (1.1%) non-responses. We use ordinary least squares (OLS) regression to identify the significant determinants of rural household income and to measure the effect of GMAs on income. A double-hurdle model was used to estimate the probability and value of crop damages resulting from wildlife trampling. We find that households in GMAs enjoy higher levels of income overall, but the gains accrue to wealthier households. Households located in prime GMAs (with higher levels of biological diversity) accrue greater benefits, but are also more likely to suffer damage from crop losses related to wildlife. The

findings suggest that tourism and wildlife conservation are positively associated with household welfare, but have implications for natural resource management policies and the objectives of pro-poor tourism development, which may be sustainable only if human-wildlife conflicts are minimized or compensated.

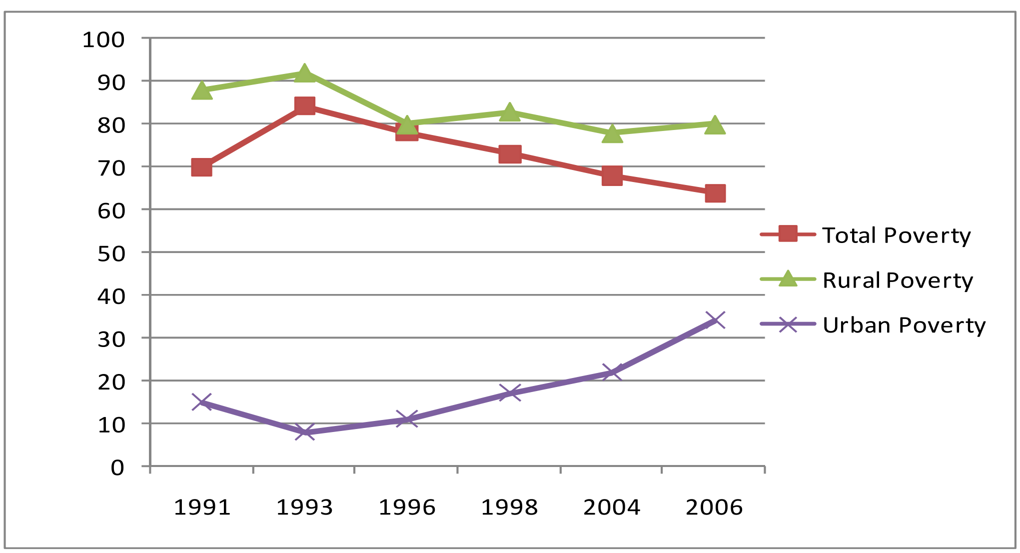
2. BACKGROUND

During the first decade of independence (1964-1974), Zambia was one of the wealthiest countries in Sub-Saharan Africa. Prosperity was mainly a result of the successful mining industry which benefitted from high international prices. However, weaker copper prices and the oil crisis of the mid-1970s led to declines in national income, a greater dependence on foreign borrowing, and deterioration in the balance of payments. Economic growth returned in the late 1990s, fueled by favorable global economic conditions, the impact of the economic reforms, expansion of the mining industry, and growth of the construction sector through private investments (Government of Zambia 2006).

However, despite the acceleration of economic growth, Zambia still suffers from persistent income poverty. Economic growth has not translated into a significant reduction of rural poverty, which still ranks among the highest in Sub-Saharan Africa. According to the 2006 Living Conditions Monitoring Survey (LCMS), 80% of the population in rural Zambia is poor and 67% is extremely poor (Central Statistical Office 2006). Still, total rural poverty rates have shown a slight decline over the last decade, diminishing from 92% to 80% from between 1993 and 2006 (see Figure 1) (Central Statistical Office 2006). In rural areas, the decline in poverty levels can be partly explained by the increased supply of food crops such as cassava, sweet potatoes, and groundnuts, as well as export commodities like cotton and tobacco, which have helped to boost rural incomes (Tschirley and Kabwe 2007; Fynn and Haggblade 2006).

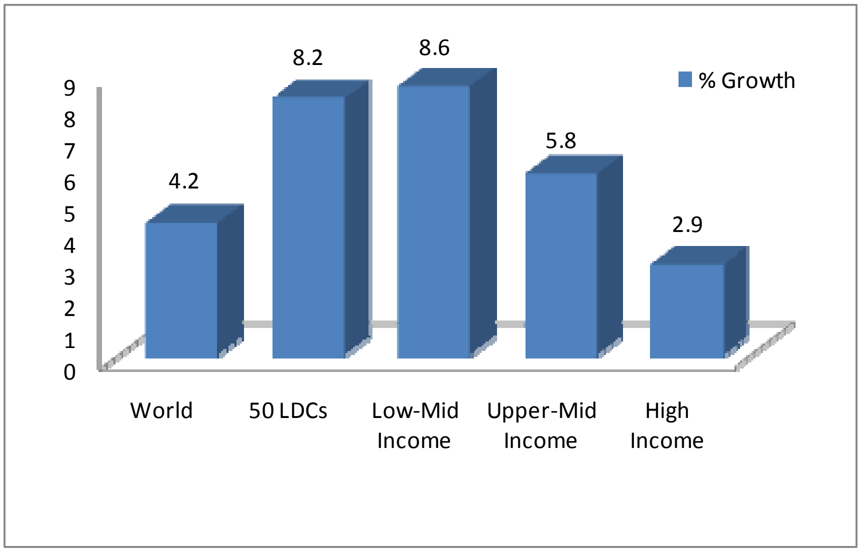
Since poverty is more acute in rural Zambia, agriculture is one of the main areas of attention for national development, through the promotion of large-scale commercial farms, technological development, and strengthening of upstream linkages. In addition to agriculture, the Government envisions the expansion of a diversified export base and a stronger tourism sector as engines of pro-poor growth (Government of Zambia 2006).

Figure 1. Poverty Incidence in Zambia (Percent), 1991-2006



Source: Elaborated from CSO data (2008). CSO uses the food energy intake approach to define the poverty line. The caloric requirement per adult equivalent per day is set at 2,721 calories.

Figure 2. Average Annual Tourism Growth, by Income Classification of Countries (1990-2005)



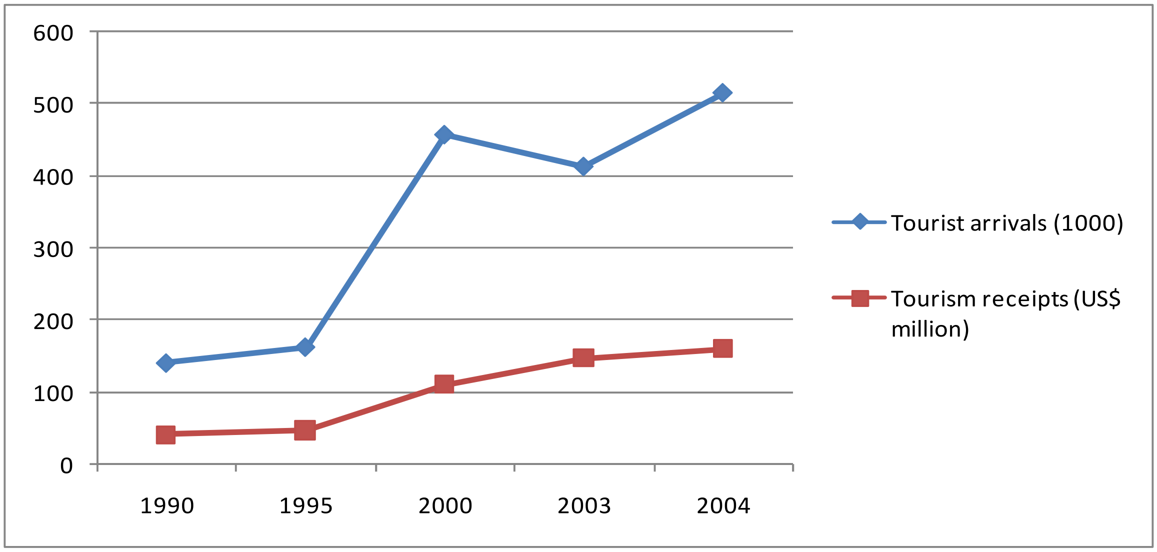
Source: U.N. World Tourism Organization

Tourism is increasingly important for economic growth worldwide, particularly in developing countries. Global tourism revenues grew at a rate of 11.2% per year between 1950 and 2005 (UNWTO 2006). International tourism arrivals grew at an average annual rate of 6.5%, increasing from 25 million to 806 million visitors. The sector has become one of the major businesses in international commerce, and represents one of the main sources of economic growth and foreign exchange earnings for many developing countries. The increasing importance of the sector in development is reflected by the growth rate of tourism in low-mid income countries and least developed countries (LDCs), which is roughly double the worldwide growth rate and nearly triple the growth rate in higher income countries (see Figure 2).

In Zambia, the tourism sector has been steadily growing over the past years both in terms of arrivals and tourism receipts (see Figure 3), ranking 15th out of 73 countries in the list of emerging tourism destinations during the period 1995-2004. Average annual tourism growth in the period has outpaced the growth rate for LDCs in the period; international tourist arrivals grew at an average rate of 9.7%, and tourism receipts grew at an average rate of 9.8%.

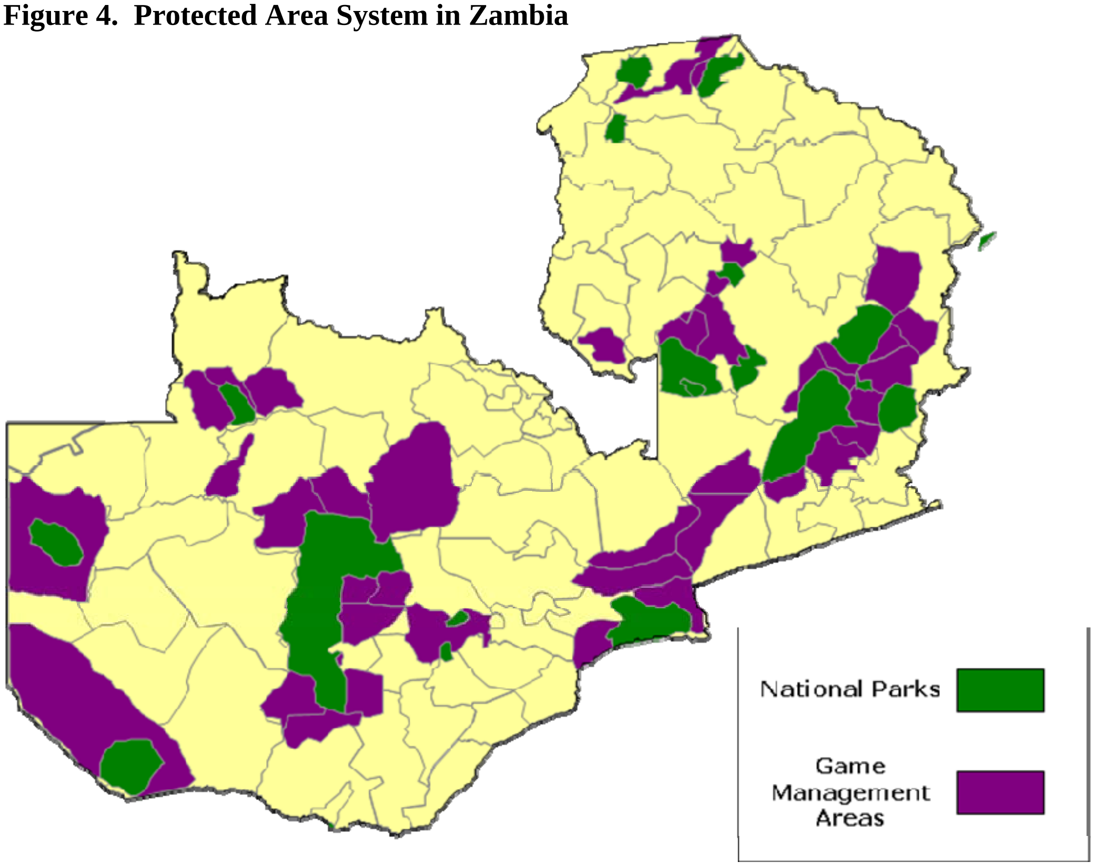
Tourism in Zambia relies largely on the country's endowment of natural resources. The protected area system consists of 19 NPs and 35 GMAs, representing 30% of the total territory. Figure 4 presents a map depicting the system of protected areas in the country. NPs are intended for the protection and enhancement of wildlife, ecosystems, and biodiversity. There are no human settlements and only photographic safaris and wildlife viewing (i.e., non-consumptive wildlife use) are permitted. GMAs are designated as buffer zones between the NPs and rural agricultural land, and human settlements are contained within their boundaries. They were intended to promote sustainable safari hunting as an alternative to other economic activities not compatible with wildlife protection.

Figure 3. International Tourist Arrivals and Receipts in Zambia, 1990-2004 (US$millions)



Source: U.N. World Tourism Organization

Figure 4. Protected Area System in Zambia



Source: Zambia Wildlife Authority

GMAs are classified as prime, secondary, specialized, or under-stocked. Prime areas are those in which trophy species are abundant and can sustain safari hunting. Secondary GMAs are those in which species are less abundant but that can still sustain limited hunting. Specialized GMAs are frequently found in wetland areas and are characterized by the presence of only a few species (usually antelope). In under-stocked GMAs, wildlife populations are sparse and hunting quotas are limited.

Community participation in tourism development is one of the major avenues for promoting pro-poor tourism. During the last two decades, the Government of Zambia has been implementing co-management agreements for the management of wildlife use (consumptive and non- consumptive) with communities in GMAs. ZAWA promotes the organization of Community Resource Boards (CRB) to become partners in both wildlife protection and the sharing of license revenues from hunting and photographic safaris. This approach, known as Community Based Natural Resource Management (CBNRM), has the dual goal of enhancing the welfare of local communities and creating incentives for the protection and conservation of natural resources (Leach, Mearns, and Scoones 1999).

The co-management of wildlife resources presents opportunities and threats for communities living in GMAs. Through the CBNRM program, communities receive a share of the revenues generated from hunting licenses and concession fees paid by hunting outfitters. These funds are distributed to VAGs, which use the revenue to employ village scouts (who aid in wildlife protection) and for implementation of community development projects (such as the construction of health clinics, schools, water wells, and boreholes). Tourism development also creates opportunities for wage employment and entrepreneurship, in addition to the benefits from increased access to infrastructure and services. However, the realization of these opportunities depends on various factors, such as the potential of the tourism industry to create employment and revenues through hunting licenses, the appropriate planning of land uses and human settlements, the transparency with which the main actors (ZAWA, area chiefs, community representatives) manage the program, the actual degree of devolution of decision making to communities, and the community's commitment to protect wildlife. The effectiveness of the program is also threatened by unintended negative effects, such as greater crop destruction with increasing wildlife populations and the pressure from in-migration puts on land and other natural resources. The problem of crop losses from wildlife conflicts was cited by village leaders and residents as the greatest impediment to socioeconomic development in GMAs. Despite the supposed increase in crop losses and injuries related to wildlife conflicts, there is currently no means for compensating households that suffer such losses.

3. THEORETICAL FRAMEWORK

We estimate the impact of living in a GMA on household welfare and test the null hypothesis that GMAs have no effect on income. To estimate the GMA effect, all other factors that affect household income are held constant. Typically, the determinants of household income include human capital, physical assets, locational characteristics, and other social and institutional assets (De Janvry and Sadoulet 2001). The relationship can be generally represented as:

$$Y = f\,(\text{HC, PC, SA, LC}) \qquad (1)$$

where Y is the level of household income, HC is a vector of human capital and socio-demographic variables, PC is a vector of physical capital variables, SA is a vector of social and institutional asset variables, and LC is a vector of locational variables. To test the effect of living in a GMA on household income, we create a locational dummy variable representing households that live in a GMA.

We also model the effect of crop losses resulting from wildlife damage. Human-wildlife conflict represents one of the biggest challenges for communities living in GMAs or near national parks. Farmers are routinely affected by crop destruction, mainly by elephants which have proven to be extremely difficult to control. Despite efforts from non-governmental organizations (NGOs) and ZAWA to help communities with electric fences and other strategies (e.g., chili fences, beating of drums) to keep elephants away from crops, the problem remains serious in areas where significant elephant populations are found. The efforts of ZAWA, safari outfitters, and village scouts to control poaching in GMAs – in an effort to increase tourism related incomes – may exacerbate the problem for households whose main economic activity is farming. We model the probability and value of crop losses from wildlife damage, testing the null hypothesis that households living in prime GMAs are more likely to experience crop damage and report higher values of crop losses than households living in secondary or specialized GMAs or in rural areas outside GMAs.

We use a two-stage model to first estimate the probability of crop losses from wildlife damage and then to measure the determinants of the value of crop losses for households that incur them; as in the income regression, we use locational dummy variables to test the effect of GMAs on the probability and level of damage. The two stages are modeled as follows:

$$\text{Tier 1: } Prob(CD) = f\,(\text{HC, PC, SA, LC}) \qquad (2)$$
$$\text{Tier 2 } \; Z = f\,(\text{HC, PC, SA, LC}) \qquad (3)$$

where CD is the crop damage variable (which takes the value 1 if the household experienced crop losses) and Z represents the value of crop losses.

4. DATA AND MODEL SPECIFICATION

We use data from the Impact of Game Management Areas on Household Welfare survey (IGMAW), which was jointly commissioned by the Natural Resources Consultative Forum (NRCF), the World Bank (WB) and ZAWA as part of an effort to inform policy on the effectiveness of the GMA arrangements administered by the government, private sector, and the respective communities. The specific objective of the survey was to determine the impact of GMAs on the economic welfare of households residing in them. The survey covered areas adjacent to four national park systems: Bangweulu (including Isangano, Lavushi, and Kasanka NPs), Kafue (including Kafue, Blue Lagoon, and Lochinvar NPs), Lower Zambezi (Lower Zambezi NP) and Luangwa (including North and South Luangwa NP). Each of the park systems was considered a reporting domain in the sampling process.

Sampling was done in two stages. In the first stage, the list of SEAs within GMAs was obtained by overlapping overlaying GMA digital maps from ZAWA with maps of SEAs from the CSO. All SEAs outside GMAs but bordering national parks were also included as control areas. A sample of 139 SEAs was drawn from the two lists using probability proportional to size (PPS), and drawing upon the 2000 census of population and housing.

In the second stage, all households in each Standard Enumeration Area (SEA) were listed, and sample households were selected for interviewing using a probability sampling scheme. The total number of households interviewed was 2,769 out of a target of 2,800, amounting to a 99% response rate. Approximately half of the respondents reside in GMAs (58%) and the other half in non-GMA or control areas (42%). Data were collected at the household and community levels using household and community questionnaires, respectively. For the community questionnaire, key informants were interviewed including the village leaders, chairpersons of CRBs, chairpersons of VAGs, school headmasters, and others.

In this study, household welfare is measured by total income. All welfare indicators have advantages and disadvantages. Barrett et al. (2001) advocate for the use of multiple welfare indicators to cross check on inference. Household income in rural areas comes from many sources. An income indicator is created to capture the total value of household income, including farm income (total value of sold and retained harvest, value of livestock sold, consumed and owned, value of forest products, value of sales from honey, income from hiring of equipment, and income from game meat) and off-farm income (from wage employment and self employment). The household income variable is continuous with a small number of zero observations reported (presumably corresponding to missing or incorrectly recorded data). Missing observations represented only 1.9% of the total sample, so they were dropped for the purposes of the analysis. Eliminating the zero values makes the income variable positive for all observations and allows for the use of OLS estimation.

The potential for sample selection bias (related to migration to or from GMAs) gives rise to the concern of endogeneity, which creates bias and inconsistency in the OLS parameters. Households migrating into GMAs may be attracted by employment opportunities or existing amenities derived from the investment in community projects. Those households emigrating from GMAs (perhaps those most oriented towards agriculture) might do so as a consequence of human-wildlife conflicts. Overall, 11.6% of households surveyed migrated in the past five years; 12.8% of households migrated to GMAs, and 9.9% moved into other rural areas (not designated as GMAs). To examine the effect of migration in endogeneity, we tested for structural differences in the two sub-samples using the Chow test (Chow 1960). The null hypothesis is that the parameters for households that migrated are equal to those for households that did not migrate. The F statistic for testing the restriction that the coefficients in the two subsets are the same is 1.99. The critical value is 2.46 at 1% significance, so the null hypothesis cannot be rejected. We conclude that households that migrated are statistically identical to those that did not migrate.

We use OLS regression to estimate the effect of GMAs on household income. The basic OLS estimation for the determinants of income takes the form:

$$\ln Y_i = \alpha + \beta_1 HC + \beta_2 PC + \beta_3 SA + \beta_4 LC + \mu_i \qquad (4)$$

where i represents an individual household in the sample, $\ln Y_i$ is the natural logarithm of income for each household. The selection of variables included in the model is guided by a review of literature on the determinants of rural household income (Barrett et al. 2001; De Janvry and Sadoulet 2001; Yúnez-Naude and Taylor 2001; Reardon 1997), factors specific to Zambia that influence how these variables are specified, and data availability. See Table 1 for variable names, definitions, and statistical properties.

Human capital and socio-demographic variables include household characteristics such as the age and sex of the household head, the level of education of the highest educated household member, and the household size. Physical capital variables include total area cropped in hectares (used as a proxy for total land holdings, which was not collected in the survey), productive assets (value of tractors, ploughs, wheel barrows, fishing nets, and traction animals), and consumer durables (including radios, refrigerators, cell phones, bicycles, and sewing machines). The vector of social and institutional assets includes community characteristics related to population, remoteness, and access to markets. Distance in kilometers to the nearest all-weather road is expected to negatively influence income.

Table 1. Variable Means for Full Sample and Subsets

Variable description	Full Sample	GMAs	Non-GMAs	Sig.
Number of sample households	2,717	1,574	1,143	
Human capital				
Total household income (Kwacha)	4,235,762	3,591,253	5,123,301	*
Household size	5.28	5.08	5.57	***
Age of household head (in years)	42.46	41.00	44.48	***
Sex of household head (=1 if male)	0.74	0.73	0.76	**
Maximum education (in years)	6.78	6.42	7.27	***
Number of children (< 15 years)	2.55	2.46	2.67	***
Number of female adults	1.10	1.08	1.12	
Number of male adults	1.03	1.00	1.07	**
Physical capital				
Cropped area (hectares)	0.92	0.93	0.92	
Value of consumer assets (Kwacha)	401,588	285,362	561,641	**
Value of productive assets (Kwacha)	618,036	256,729	1,115,584	***
Social and institutional assets				
Distance to nearest main road (km)	5.09	6.08	3.80	***
Population density (per sq km)	35.20	41.41	26.97	***
Infrastructure	3.62	3.64	3.59	
Locational characteristics				
Tourist lodge in SEA (=1)	0.07	0.10	0.02	***
GMA-1 classification (=1 if primary)	0.17	0.30	*n.a.*	
GMA-2 classification (=1 if secondary or specialized)	0.20	0.35	*n.a.*	

* 10% significance   ** 5% significance   *** 1% significance   *n.a.*= not applicable

Infrastructure is an index equal to a simple count of the number of schools, clinics, wells, and dip tanks in the community, and it is expected to have a positive sign. A population density variable is included to capture any remaining unobserved aspects of infrastructure.

The vector of locational variables describes community characteristics in terms of location and availability of amenities which are hypothesized to have an effect on opportunities for employment. A dummy variable for the existence of a tourist lodge in the community is expected to have a positive sign because of opportunities for earning off-farm income.

Households in GMAs differ significantly from households in the control group across several variables. GMA households have lower average household incomes, lower levels of education, and fewer assets than households in other rural areas. GMA households are also more likely to be in remote and sparsely-populated areas, relative to households in the control group.

We hypothesize that the stock and variety of wildlife has positive effects on household income and on the expected level of crop destruction. We therefore disaggregate the GMA variable into GMA-1 for prime areas and GMA-2 for secondary and specialized areas. The former takes the value of 1 if the household lives in a prime GMA (well stocked with a high variety of species; otherwise, the value is zero) and the latter takes the value of 1 if the household lives in a secondary or specialized area (lower stocks and variety than in prime areas; otherwise, the value is zero). The summarized empirical model is represented as follows:

$$\ln Y_i = \alpha + \beta X_i + \gamma G_i + \varepsilon_i \qquad (5)$$

where X_i is the combined vector of household and community characteristics (HC, PC, SA, LC variables) and G is a vector of GMA dummy variables. The null hypothesis that a GMA has no effect on household income is[1]:

$$H_0: \gamma = 0 \qquad H_A: \gamma \neq 0 \qquad (6)$$

Turning now to the crop loss analysis, only 14% of respondents reported such loss. This model therefore falls under the category of corner solution models (Gujarati 2003; Wooldridge 2008), in which the dependent variable takes a zero value for a non-trivial part of the population and the values greater than zero are continuous. Tobit models are frequently used in corner-solution models; however, a Tobit model calculates the determinants of the probability of an outcome and the magnitude of the effect on the dependent variable simultaneously. The model estimates only one set of coefficients, which are assumed to be equal for both equations (the probability and the level of output). The Cragg Tobit alternative (Cragg 1971) presents a variation of the Tobit model that allows for separate estimation of the probability of sustaining crop damage and the value of that damage. Double-hurdle models such as this consist of a Probit and truncated regressions. The empirical model is represented as follows:

$$P(CD_i=1|\, X_i) = \beta X_i + \gamma G_i + \mu_i \qquad \text{(Tier 1)} \qquad (7)$$
$$Ln\, Z = \alpha + \delta X_i + \varphi G_i + \varepsilon_i \qquad \text{(Tier 2)} \qquad (8)$$

1 Stata's *hettest* suggested strong heteroskedasticity with respect to the set of right hand side variables. All inference in this model is therefore made on the basis of standard errors robust to this problem (produced through the *hc3* option under the regression command).

where *CD* is the crop damage variable which takes the value 1 if the household reported crop loss, and all other variables are as defined in (5). Note that X_i is assumed to be the same for both tiers. As with the income effects model, the test of the null hypothesis that a GMA has no effect on the probability and value of crop losses is:

$$H_0: \gamma = 0 \qquad H_A: \gamma \neq 0 \tag{9}$$

5. RESULTS

The results of the OLS regression are presented in Table 2. All coefficients have the a priori expected signs and for the most part are significant at 1%, 5%, or 10%. The age of the household head is negatively and significantly associated with household income. Male-headed households show a positive but insignificant association. The level of education (maximum education of any household member) is, as expected, significantly associated with higher levels of income. An additional year of education of the highest educated household member increases total household income by 4.3%. The number of adults (men and women) is significant and positive, which is an expected result since income is aggregated at household level. Distance to the nearest all-weather road has a negative effect on income; an additional 10 kilometers from a main road would decrease total household income by 5%. This result is consistent with the hypothesis that remoteness has a negative effect on household welfare by limiting opportunities for off-farm employment, raising the cost of transport, limiting access to markets, and increasing transaction costs (e.g., access to information, search costs).

Other factors positively and significantly affecting household income are the presence of a tourist lodge in the area, other aspects of infrastructure, and population density. Infrastructure and population density have been found to be positively associated with wage earnings (Reardon 1997; Haggblade, Hazell, and Brown 1989). Infrastructure levels may be associated with a reduction in transport costs, increased access to markets, greater provision of services (banks, extension services), and facilities (clinics, schools, wells) and greater access to

Table 2. Ordinary Least Squares Regression of the Effect of GMAs on Household Income

Variable	Coefficient (standard error)	Significance
Intercept	13.101 (0.122)	***
Human capital		
Age of household head (in years)	- 0.003 (0.002)	*
Sex of household head (=1 if male)	0.069 (0.060)	
Maximum education (in years)	0.043 (0.009)	***
Number of children (< 15 years)	0.019 (0.015)	
Number of female adults (15-60 years)	0.113 (0.036)	***
Number of male adults (15-60 years)	0.070 (0.033)	**
Social and institutional assets		
Distance to nearest main road (km)	- 0.005 (0.002)	***
Population density (per sq km)	0.001 (0.000)	***
Infrastructure	0.032 (0.011)	***
Physical capital		
Cropped area (hectares)	0.039 (0.022)	*
Log of consumer assets (Kw)	0.020 (0.002)	***
Log of productive assets (Kw)	0.010 (0.001)	***
Locational Variables		
Tourist lodge in SEA (=1)	0.186 (0.107)	*
GMA-1 classification (=1 if primary GMA)	0.170 (0.069)	**
GMA-2 classification (=1 if secondary or specialized GMA)	0.022 (0.071)	

Dependent variable is logarithm of total household income
R-squared = 0.213 n = 2,264
* 10% significance ** 5% significance *** 1% significance

employment opportunities. Population density is generally positively associated with income too; for any given level of infrastructure, population density generates greater opportunities for exchange.

Finally, results show that households living in a prime GMA (GMA-1) have 17% higher total incomes than comparable households residing in non-GMAs. For households living in secondary or specialized GMAs (GMA-2), the result is positive though not significant and relatively low in absolute terms. By classifying GMAs by stocking levels and diversity, we show that the GMA effect is dependent on the level and variety of wildlife population. This is an expected outcome since the potential benefits from living in a GMA are hypothesized to be directly linked to the tourism industry and the revenues obtained from wildlife hunting, which are dependent on wildlife resources. These results are consistent with the findings of Bandyopadhyay and Tembo (2009), which used a treatment effects regression to conclude that households living in a GMA were positively associated with per capita consumption expenditures.

To explore how the GMA effect varies by type of household, we separated households into quintiles according to the value of consumer assets, created a series of dummy variables on this basis, and repeated the regression in Table 2, this time interacting the two GMA variables with the consumer asset dummies. Results indicate that the GMA effect is more likely to be attained by wealthier households (see Table 3).

The lowest two quintiles refer to the poorest 40% of the population, who according to the results are not significantly impacted by living in a GMA; the same result applies if the analysis is expanded to include the poorest 60% segment of the population. Only when the upper two quintiles are considered do the results become positive and significant, indicating that the gains derived from living in a GMA are likely to be attained by the non-poor segment of the population. It is also worth noting that the impact is insignificant for all segments living in secondary or specialized GMAs. That wealthier households capture the positive impact of the GMA effect is not surprising. They are in a better position (in terms of access to financial, human, and political capital) to take advantage of the opportunities offered in the non-farm sector as entrepreneurs and as wage employees (Haggblade, Hazell, and Reardon 2007). Note also that our dependent variable is current income, while current assets are a function of past income. This suggests that the same set of households has tended to benefit from the GMA through higher income over time, capitalizing those incomes into higher current asset holdings. This may be further related to participation in community resource management, which has been found to be greater among households with greater wealth and levels of education. Bandyopadhyay and Tembo (2009) found that active members of CRBs may be paid allowances from ZAWA and may have greater access to credit from CRB funds. Conversely, weak participation levels among poorer households may limit their ability to capture some of the benefits of the GMA effect (Bwalya 2003).

Table 3. Comparison of GMA Effect on Household Income by Welfare Level

Consumer asset quintiles	**GMA-1**	**GMA-2**
Lower 2 quintiles	0.033	-0.059
Lower 3 quintiles	0.031	0.040
Upper 2 quintiles	0.046**	-0.008

**5% Significance level

The results suggest that, *ceteris paribus*, there is a positive association between prime GMAs and household income. This association implies that the benefits derived from living in a GMA (mainly through tourism and CBNRM programs) outweigh the potential costs (mainly the possible opportunity cost of land use and the increased probability of crop damage). The fact that the effect is only significant in GMAs classified as prime, indicates that the state of wildlife population is a key factor for the potential of tourism and CBNRM programs to generate employment and hunting revenues. The results also reveal that benefits are more likely to be attained by those groups in the upper quintiles of the welfare scale, suggesting an uneven distribution of the GMA effect among community members, a common finding in the literature of welfare and non-farm rural income (Haggblade, Hazell, and Reardon 2007).

For the two-stage analysis of the probability and value of crop losses, we use the double-hurdle Cragg Tobit alternative model. The results of the two-step estimation are presented in Table 4. The model includes four variables not included in the OLS regression: the percentage of households that reported crop damage and the value of crop damage are included as dependent variables in this model. The number of scouts and the total value of harvest (inclusive of the value of crop loss) were added as additional explanatory variables in this model to test for their relative effects on the probability and value of crop losses.

Number of scouts may be endogenous to the crop damage regression, since higher stocks of wildlife (and thus higher crop damage) are likely to lead to the hiring of more scouts, using revenues from hunting through the CBNRM programs, especially in GMAs where wildlife is abundant and revenues are sufficient to support adequate staff. We tested for this possibility using Stata's ivtobit command and the Hausman test for endogenous regressors[2] (Hausman 1978). Instruments for number of scouts were a dummy variable indicating whether the VAG had received funds from ZAWA, and three park system dummies. All four instruments were

Table 4. Cragg Two-stage Analysis of the Probability and Value of Crop Losses from Wildlife Conflicts

					Marginal Effects					
Variable	**Tier 1**	**Sig.**	**Tier 2**	**Sig.**	**Probit**	**Sig.**	**CAPE**	**Sig.**	**UAPE**	**Sig.**
Intercept	-2.324	***	5.587		n/a		n/a		n/a	
Age of household head	-0.002		0.013		-0.000		0.002		-0.001	
Sex of household head	-0.041		0.249		-0.006		0.032		-0.046	
Household size (#)	-0.039	**	-0.020		-0.006	**	-0.003		-0.076	**
Distance to nearest road (km)	0.006	**	-0.014		0.001	**	-0.002		0.009	*
Cropped area (hectares)	0.068	**	-0.003	*	0.010	**	-0.051	*	0.077	
Consumption assets (Kw)	-0.002		-0.015		-0.000		-0.000		-0.005	
Production assets (Kw)	-0.004	*	-0.394		-0.001	*	-0.002		-0.010	**
Population density	0.000		-0.001		-0.000		-0.000		-0.000	
Infrastructure	-0.006		-0.014		-0.001		-0.002		-0.013	
Number of scouts (#)	0.025		0.047		0.004		0.006		0.053	*
Value of harvest	0.041	***	0.189	***	0.006	***	0.024	***	0.102	***
Primary GMA (=1)	0.780	***	0.080		0.161	***	0.010		1.486	***
Secondary/specialized GMA	0.643	***	0.172		0.122	***	0.022		1.238	***

***10% significance level, **5% significance level, *1% significance level.

[2] The new *craggit* command does not support IV procedures, nor does Stata's *truncreg* command (the second stage of the Cragg model). We chose to use *ivtobit* as the closest approximation to our two-stage model, since it applies to the same type of corner solution data.

statistically significant above 0.01, and the Hausman test generated a Wald p-value of 0.33, which leads to failure to reject the null hypothesis of exogeneity. Therefore, we conclude that the number of scouts is not an endogenous regressor in our two-stage model of crop damage associated with wildlife conflicts.

The first two tiers show the results of the Probit and truncated regressions, respectively (Table 4). For easier interpretation, the coefficients for the first tier are presented as the marginal effects in the third column and the second tier is displayed as average partial effects (APE) in the last two columns. The third column (Probit) represents the marginal effects of the independent variables on the probability of experiencing crop damage from wildlife conflicts. The fourth column represents the conditional average partial effect (CAPE) on the expected value of crop losses. This coefficient measures the effect of the independent variables on the value of losses only for the households who experienced crop damage. The fifth column is the unconditional average partial effect (UAPE); it is a function of both stages of the estimation, the probit and the truncated regression, and is interpreted as the expected effect of each variable across all households, regardless of their experience of crop loss; the UAPE is thus of particular policy interest as a summary indicator of the effects of GMAs on crop losses[3]. Significance testing for the CAPEs and UAPEs was done through bootstrapping in Stata with 500 iterations.

Household size has a negative impact on the probability and value of crop loss, suggesting that additional labor may help contain wildlife and protect the fields. Distance to all-weather roads is positively associated with the probability of crop damage, suggesting that, as expected, more remote areas are likely to have greater wildlife populations. Cropped area and total value of the harvest are control variables to account for the effect that larger areas under cultivation and higher value crops (or higher yields per unit area) will have in the probability and total value of crop loss. As expected, both are positively associated with the probability of crop damage, though interestingly, for those households that suffered crop damage, cultivated area is negatively associated with the total value of crop loss (CAPE).

The number of scouts hired in the community has a significant and positive effect on the probability and the value of crop damage. This finding suggests that effective anti-poaching patrol may help to increase (or sustain) wildlife populations.

Finally, the GMA effect on the probability of crop loss is, as expected, positive and significant, more so in prime GMAs than in secondary or specialized GMAs. The results clearly confirm the hypothesis that households are more likely to be affected by crop loss in better stocked GMAs. As mentioned before, the human-animal conflict represents one of the biggest threats to the success of CBNRM programs.

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[3] See Wooldridge 2008, pp. 574-611 for treatment of CAPE and UAPE. Model estimation and computation of CAPEs and UAPEs follow Burke (2009).

6. DISCUSSION AND POLICY IMPLICATIONS

The main goals of this study were to estimate the effects of living in a GMA on household income and the probability and value of crop losses from wildlife conflicts. These questions were evaluated using econometric techniques that seek to isolate the variables of interest. The first analysis used OLS regression to explore the relationship between GMAs and total household income. The second analysis used a Cragg double-hurdle model to identify the extent to which households living in GMAs are more prone to crop damage.

Results support the hypothesis that the level and variety of wildlife are positively associated with household income, as indicated by the sign and magnitude of the coefficients for the variables representing prime and secondary or specialized GMAs. The results from the first model suggest that prime GMAs increase average net household income by 17%, while secondary and specialized GMAs have no significant effect. Only households in the upper two asset quintiles are found to benefit from living in GMAs, which suggests an uneven distribution of the potential benefits to living in a prime GMA, a common finding in the literature on poverty reduction and rural non-farm income. We conclude that this may be related in part to wealth effects as well as likelihood of participation in CRBs and VAGs.

Despite the overall positive effect of GMAs on household income, the second analysis found that GMAs are positively associated with the probability and the value of crop loss from wildlife conflicts. The results support the hypothesis that households living in areas with higher wildlife populations suffer more intensely from crop destruction, and confirm the views expressed by community leaders and residents during interviews. Current policies make no allowance for compensation in the event of damage from human-wildlife conflicts. While wildlife conservation policies and the designation of GMAs appears to have had positive effects in terms of protecting the population and diversity of wildlife resources, and has so far had a positive net effect on household incomes, future increases in wildlife population may exacerbate conflicts and escalate economic damages, potentially threatening the sustainability of tourism development and eroding community support for environmental conservation. These issues suggest the need for consideration of policies that compensate or avert losses from human-wildlife conflicts.

Evidence that the GMA policies positively affect household income is a promising outcome that encourages the continuation of CBNRM programs. The results of this study indicate that wildlife conservation policies can be successfully aligned with the goal of rural development. The positive GMA effect on total household income is only found in prime GMAs, which suggests that the level and diversity of wildlife stocks are linked to the potential of these areas to generate benefits for the community. However, the uneven distribution of the benefits of living in a GMA demonstrates that in order to have any meaningful impact on rural poverty alleviation, tourism development would need to be pro-poor by design. Community participation in tourism development is one of the major avenues for promoting pro-poor tourism. These findings suggest a role for policies that enhance upstream linkages between tourism and small enterprises in rural areas, particularly in agriculture, in order to boost rural incomes and increase demand for locally-manufactured goods (Torres 2003; Kirsten and Rogerson 2002).

The issue of crop losses from wildlife conflicts threatens the success of the GMA policies and the CBNRM programs. Overall, the findings of this study show that households living in GMAs obtain higher incomes compared to those in non-GMA designated areas, despite these losses. However, with increasing wildlife populations, there may be a threshold beyond which crop losses could reverse the positive GMA effect, reducing the welfare of rural households. Wildlife conservation and tourism development may be sustainable only if human-wildlife conflicts are minimized or compensated. Successful GMA policies that increase wildlife populations to a point where they are incompatible with community livelihoods could eventually cause more harm than benefit. Further research could consider a model that tests different scenarios, for example, analyzing the outcome of the GMA effect in case a significantly larger number of farmers are affected by crop loss, or by increasing the average value of crop loss. It would be particularly interesting to test this in prime GMAs where the number of reported incidents and value of damages are greater.

The issue of crop damage also suggests policy implications for the role of village scouts and their capacity to protect wildlife while simultaneously defending farmers from crop damage. The findings of this study indicate that there is a positive relationship between the number of scouts hired in the community and the probability of crop loss in GMAs, which could indicate on one hand success in protecting wildlife, hence the proliferation of incidents, but also that scouts are not able to contain wildlife and prevent them from destroying agricultural fields. A review of the scouts' mandate could help clarify the role they are given in terms of resource management and community development. A mandate that is solely focused on wildlife protection may overlook the importance of the role of GMA communities in resource management. Policies that protect wildlife and minimize conflict may more effectively advance the overall goals of wildlife conservation.

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