Improving conservation efforts in the Serengeti ecosystem, Tanzania: an examination of knowledge, benefits, costs, and attitudes

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Dedication

This dissertation is dedicated to my parents,
who taught me I can do anything;
and to my husband,
who enables me to do anything.

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Abbreviations and Acronyms

FZS – Frankfurt Zoological Society

MKUKUTA – National Strategy for Growth and Reduction of Poverty

NCA – Ngorongoro Conservation Area

SE – Standard Error

SEMP – Serengeti Ecosystem Management Project

SFTZ – Savannas Forever Tanzania

SLEMP – Serengeti - North Luangwa Ecosystem Management Project

TANAPA – Tanzanian National Parks

Tsh – Tanzanian Shilling

WD – Wildlife Division of Tanzania

WMA – Wildlife Management Areas

Introduction

Conservation of nature is important for both utilitarian and intrinsic values. Conservation helps maintain benefits from nature such as the provision of goods (e.g. food, timber) and services (e.g. nutrient cycling, pollination) and also maintains informational (e.g. genetic diversity, pursuit of knowledge) and psychological (e.g. scenic views, spiritual areas) benefits. Furthermore, conservation preserves biodiversity, an intangible benefit in and of itself. These benefits from nature, coupled with increasing threats to nature from human activities, have fueled conservation efforts across the globe. Achieving conservation requires mitigating problems such as natural resource consumption, human population growth, and land conversion and requires solutions that address these problems simultaneously. In finding solutions for conservation, there are often difficult tradeoffs between conservation and other social goals such as development, and between anthropocentric and biocentric goals.

Conservation practitioners have tried two main methods for navigating these tradeoffs, fences-and-fines strategies and community-based conservation. Initially, fences-and-fines strategies arose as the management method for parks. Such strategies eventually became one of the cornerstones of conservation. These strategies focused on separating humans and nature with the use of fences (actual and virtual) that created protected areas and criminalizing the use of natural resources in protected areas with fines, arrests, and jail time. However, during the 1960s and 1970s, conservationists became skeptical of the ability of fences-and-fines policies to successfully achieve conservation. Practitioners realized that while the benefits of conservation were global, the costs of conservation were primarily born by local communities (Wells 1992). Furthermore, the creation of parks often displaced local people and cut them off from resources vital to their livelihoods, contributing to continued illegal natural resource use, agricultural encroachment, and illegal grazing in protected areas; as well as raising concerns about equity, fairness, and effects on poverty (Wells & Brandon 1992; Ghimire & Pimbert 1997; Terborgh & Schaik 2002).

The failure of fences-and-fines strategies, combined with increasing international focus on the welfare of local people, led to a new strategy for conservation, coined community-based conservation (Western et al. 1994; Sinclair 1995; Zimmerer et al. 2004). Community-based conservation strives to overcome the human and nature segregation of fences-and-fines strategies. The focus in community-based conservation is bottom-up management that engages local communities in conservation through benefit sharing and local participation. The degree and type of benefit sharing and local participation vary widely with different types of community-based conservation strategies.[1] Benefits may be provided in the form of direct payments, managed resource use, hunting quotas, building of schools, wells, and other social infrastructure, employment, and other means. Local involvement may be as simple as educational programs or as complex as community designed and managed conservation areas. Often community-based conservation advocates promote returning property rights to the land and/or resources to the local communities (Western et al. 1994; Hackel 1999; Songorwa et al. 2000; Hulme & Murphree 2001). Initially, the promise of community-based conservation was so popular that by the 1990s virtually all conservation projects in Africa claimed to be community-based conservation (Emerton 2001).

After two decades of community-based conservation projects, the incorporation of a human dimension into conservation has not met universal acceptance or success. Many conservation projects have had at best minimal success and a resurgence of support for fences-and-fines policies has emerged (Caro et al. 1998; Hilborn et al. 2006). Reasons for the less than successful outcomes of community-based conservation abound, including lack of local participation, unsustainable use of natural resources, failure to link benefits to conservation objectives, and lack of ecological and socioeconomic monitoring (Barrett & Arcese 1995; Gibson & Marks 1995; Hackel 1999; Barrett et al. 2001; Johannesen & Skonhoft 2005). However, despite the problems with community-based conservation, the fact remains that local people incur most of the costs of conservation,

[1] These strategies include, but are not limited to, integrated conservation and development projects, buffer zones, protected area outreach, community-based natural resource management, sacred groves, and wildlife management areas.

which creates both an incentive and a humanitarian problem from imposing burdens on people living at or near subsistence levels. It is therefore imperative to find ways to improve community-based strategies so that local people are involved in, and benefit from, conservation; while at the same time achieving conservation goals.

The Serengeti ecosystem in Tanzania provides an ideal case study for examining conservation and finding solutions to improve these different conservation strategies. The Serengeti ecosystem encompasses two UNESCO world heritage sites, two biosphere reserves, and is a national treasure for Tanzania. The ecosystem is home to the world's largest migrating ungulate population, a high concentration of large predators, over 500 species of birds, and numerous other ecological treasures (Sinclair 1995; Sinclair et al. 2008). Tanzania has a long history of conservation. The core of the Serengeti ecosystem, the National Park, has been protected through fences-and-fines conservation since the colonial era. All natural resource use with the Serengeti National Park has been prohibited since the park's inception in 1959. At the same time, the government of Tanzania began one of the first forms of community-based conservation, the Ngorongoro Conservation Area, a multiple use area involving the local Maasai people (Sinclair 1995). In the late 1980s and early 1990s conservation in Tanzania continued incorporating local people, and the government went as far as institutionalizing community-based conservation with the creation of wildlife management areas outlined in the 1998 Wildlife Policy (Ministry of Natural Resources and Tourism 1998). Wildlife management areas give the user rights to wildlife back to local communities and require establishing benefit streams from wildlife use to local communities. Around the Serengeti ecosystem, numerous organizations, government offices, and private tourist companies claim to engage local people in conservation benefits and activities.

Despite the history of having large protected areas and an emphasis on community-based conservation, human actions still threaten the integrity of the ecosystem suggesting that neither fences-and-fines nor community-based conservation has been sufficient (Sinclair & Arcese 1995a; Homewood et al. 2001). Furthermore, external pressures are confounding conservation efforts. Human populations are growing at two and half to four percent around the ecosystem (Polasky et al. 2008). Expansion of

agriculture has already significantly hampered wildebeest migration in the Kenyan portion of the ecosystem (Homewood et al. 2001). Development pressures will continue to connect villages in the ecosystem to urban and international demand centers for charcoal, bushmeat, and other natural resource commodities. It is unclear if conservation in the ecosystem can persevere in the face of these pressures.

My dissertation addresses the overarching question of how protected area managers can meet the needs/desires of local people and maintain a unique and valuable ecosystem. The Serengeti ecosystem provides the perfect backdrop for addressing this question with very poor people living in the midst of a very rich ecosystem. Other studies have also addressed this question, using primarily theoretical approaches that point out the limitations of conservation activities (Barrett & Arcese 1998; Johannesen & Skonhoft 2004) or by using socioeconomic data from part of the ecosystem to shed light on bushmeat hunting (i.e. the illegal hunting of wildlife for food) or conservation attitudes (Newmark et al. 1993; Loibooki et al. 2002; Kideghesho et al. 2007; Knapp 2007). However, these studies all lack two things, data encompassing the entire ecosystem and the incorporation of data on knowledge of protected areas.

My dissertation uses data from areas throughout the ecosystem and includes the analysis of knowledge along with socioeconomics, costs, benefits, and attitudes. In determining how to improve conservation, I critically examine a key assumption of community-based conservation, i.e. that local people are benefitting from conservation. I also focus on how monitoring and evaluating more than just local people's attitudes can provide important insight and suggestions for conservation policies. Although my data is specific to the Serengeti ecosystem, my emphasis on using socioeconomic data for monitoring, evaluating, and improving conservation projects can be applied in other places. My work in the Serengeti ecosystem provides a good template for how conservation practitioners can monitor and evaluate the human dimensions of their work and how this data can improve conservation efforts.

In addressing the question of how to improve conservation, I begin my dissertation with a chapter describing the socioeconomics around Serengeti National Park. Chapter one is based on a report solicited by Frankfurt Zoological Society (FZS)

that provides a descriptive overview of the socioeconomic realities facing communities around the ecosystem and speaks to Tanzania's dual commitment to conservation and poverty reduction (Schmitt 2008). I amended the initial report to include data from all 20 of the villages that I studied and added analysis about differences between those villages participating in wildlife management areas and those not participating. Understanding the livelihoods and realities of people in the ecosystem is the first step to understanding how conservation projects are, or are not, affecting local communities.

In my second chapter I examine the effectiveness of both community-based and fences-and-fines conservation by evaluating the benefits provided to, and costs imposed on, local people by these conservation strategies. I use empirical data on knowledge of protected areas and the costs and benefits of both conservation and illegal natural resource use to examine how current conservation strategies have affected the decisions of local people. I begin my evaluation by assessing the knowledge of local people about Serengeti National Park and its surrounding protected areas. I then analyze the different costs and benefits local people receive from protected areas and wildlife. Without changing benefits or costs in a significant manner, both community-based and fences-and-fines conservation approaches are unlikely to change behavior of local people, and therefore, unlikely to be effective conservation strategies.

My third chapter identifies successes and problems in current conservation strategies by linking socioeconomic data with data on knowledge, benefits, costs and attitudes. I tie the socioeconomic data from chapter one to the knowledge, benefits and costs of chapter two, as well as examine data on local attitudes toward protected areas. I outline the socioeconomic characteristics associated with those who are knowledgeable about protected areas, those reporting benefits, those reporting costs, and those with positive attitudes of protected areas. I then point out what this larger picture of conservation suggests in terms of project success and future policies. Furthermore, I show the benefits of using more than just attitudinal data in evaluating conservation strategies.

Chapter 1: Socioeconomics of Serengeti: an analysis of the daily lives of local people

Tanzania contains some of the richest wildlife areas in the world and is also one of the poorest countries in the world. The country has a long history of conservation focusing on both a fences-and-fines approach that employs antipoaching units to make arrests, as well as a community-based approach that focuses on giving benefits from conservation back to local people. In 1998, the Tanzanian government institutionalized community-based conservation through the creation of wildlife management areas that are explicitly designed to involve local people in conservation revenue streams. Increasing incomes from natural resources and conservation is also an important goal of Tanzania's poverty reduction strategy designed in 2005. The strategy, known by its Swahili acronym as MKUKUTA, seeks to combat the pervasive poverty that plagues the country. It is an open question whether these policies will be successful in pursuing the dual goals of conservation and development in rural areas of Tanzania. This chapter describes current socioeconomic status for three areas in the ecosystem, providing a baseline for future monitoring and evaluation of conservation and development projects. I find that people in the Serengeti ecosystem daily use natural resources such as fuelwood, grazing lands, and water. Local people often also use other natural resources such as medicinal plants, building poles, and bushmeat. Most conservation and poverty alleviation strategies seek to capitalize on these natural resources in increasing local incomes. However, to date these natural resources contribute very little to household income and no mechanism is in place to ensure sustainable use. Income and assets levels are meager, houses modest. Education levels are lower for adults than children, though secondary education is still rare for all people in the ecosystem. Villages participating in wildlife management areas and those not are very similar, though some evidence suggests natural resources are in greater supply, or of greater quality, in wildlife management area villages. Continued socioeconomic monitoring is imperative to maneuver the tradeoffs of conservation and development in the ecosystem.

Introduction

The Serengeti ecosystem has both national and international importance. It is home to the world's largest herd of migrating ungulates, over 500 species of birds, 14 large carnivore species, and has consequently been internationally recognized as a United Nations World Heritage site (Sinclair 1995). The core of the ecosystem, the Serengeti National Park, is a prime tourist destination with revenues exceeding five million dollars a year (Thirgood et al. 2004). Local people encircle the park, some living within a few kilometers of the park or other protected area boundary. These people are predominantly poor rural agriculturalists and/or pastoralists whose daily lives are intertwined with the ecosystem. Wild animals bring crop destruction, livestock depredation, and disease to these people, but they are also a source of food. The ecosystem helps maintain natural ecosystem processes, but the protection of the area has limited local access to fuelwood, grazing land, and other natural resource uses. Conservation of this ecosystem is of utmost importance, but so too is alleviating the poverty of the local people. Only by gaining an understanding of the daily lives and challenges faced by these local people can policy makers address conservation and development concerns.

Conservation in Tanzania

Conservation in Tanzania includes aspects of both fences-and-fines and community-based conservation. Historically, conservation has focused on a fences-and-fines approach that emphasizes enforcement of resource use restrictions through barriers and legal penalties (Oates 1999; Terborgh 1999). The "national park" is the quintessential fences-and-fines tool that effectively separates people from wildlife. In the early 1900s, the Tanzanian colonial government established many parks and other protected areas that restricted human settlement and natural resource uses. The modern day monitoring of these areas by antipoaching patrols seeks to maintain this separation of people and wildlife. Antipoaching patrols punish illegal natural resource users through fines and/or arrests. As a matter of national pride, there are no fences surrounding protected areas in Tanzania. There is some evidence that this fences-and-fines approach of parks and antipoaching are effective tools for conservation (Caro et al. 1998; Bruner et

al. 2001; Hilborn et al. 2006). However, there are also many critiques of the fences-and-fines approach that claim it has failed to result in widespread cessation of illegal hunting, timber harvesting, and other natural resource use (Hackel 1999; Songorwa 1999; Hulme & Murphree 2001; Loibooki et al. 2002; Nielsen 2006).

In response to the critiques of the fences-and-fines approach to conservation, many policy makers and organizations have turned to community-based conservation. Rather than punishing resource use, community-based conservation seeks to increase the benefits local people receive from the resources (e.g. money from photo tourism of wildlife). Tanzania set up one of the earliest forms of community-based conservation through the creation of the Ngorongoro Conservation Area (NCA) in 1959, a multiple use area in which local Maasai cohabitate with wildlife (Sinclair 1995). However, community-based conservation has had mixed success in Tanzania. In some areas, community-based conservation has led to a positive shift in attitudes toward conservation, but researchers have not adequately linked these attitudes to overall improvements in conservation (Gillingham & Lee 1999; Songorwa 1999; Hilborn et al. 2006). Critics of community-based conservation note that local benefits are not linked to changes in conservation behaviors, causing a lack of success in community-based conservation projects. For example, building a road to promote conservation benefits poachers and non-poachers alike; everyone gets to use the road regardless of their hunting behaviors. Consequently, there is no change in the behavior of individual decision makers (Barrett et al. 2001; Johannesen 2006; Schmitt 2006).

Despite the problems with community-based conservation, the government of Tanzania fully embraced the notion of community-based conservation in the late 1990s with their 1998 Wildlife Policy. The goal of the wildlife policy is to promote sustainable utilization of natural resources, involve all stakeholders in wildlife conservation including local people, and provide fair and equitable benefit sharing. The policy also established Wildlife Management Areas (WMAs). These areas give wildlife user rights to local villages, allowing them to gain direct benefits from the resource. WMAs have the opportunity to change the conservation paradigm by focusing on sustainable natural resource use, improving local livelihoods, and maintaining or restoring biodiversity. The

initial notion for a WMA was a group of villages zoning their village lands for grazing, agriculture, settlement, and conservation. Upon establishing the WMA and these zones, the Wildlife Division (WD) of the central government would then give a certain number of quotas for wildlife hunting to the villages. The villages could either use these quotas themselves, or sell them to a tourist hunting company (Nelson 2007).

Unfortunately, setting up a WMA is a lengthy and administratively complicated twelve-step process that has often required the facilitation of a third party (Nelson 2007). There were originally four WMAs outlined for the Serengeti ecosystem, and the Frankfurt Zoological Society (FZS) has been the third party facilitator for three of these WMAs: Ikoma, Makao, and Loliondo. The Ikoma WMA, located in Serengeti district northwest of the Park was gazetted in 2006, although it did not begin receiving income from investors until 2007/2008. Makao WMA, located in Meatu district southwest of the Park was gazetted in June 2009 and has yet to receive any income. Villages in Ngorongoro district to the east of the park initially rejected the creation of a Loliondo WMA and have been working with FZS on other conservation projects. The fourth WMA, Lake Natron, lacked cohesive interest by villages and third parties. Consequently FZS never pushed for establishment, though villages now seem interested in considering a WMA.

Poverty Alleviation in Tanzania

Despite its wealth of natural resources, Tanzania is one of the poorest countries in the world. The World Bank estimates that as of 2007 36% of the population is living below the basic needs poverty line (World Bank 2008). The predominance of these poorest households are in rural areas that rely on agriculture (GoT 2005). Tanzania's gross national per capita income in 2007 was US $400, well below the sub-Saharan Africa average of 2007 US $952, and also below the low-income country average of 2007 US $578 (World Bank 2008). Consequently, poverty reduction has become a primary focus for the Tanzanian government and it has emphasized poverty reduction through its National Strategy for Growth and Reduction of Poverty (known by its Swahili acronym as MKUKUTA). Finalized in 2005, MKUKUTA focuses on three clusters: I) economic growth and reduction of income poverty, II) improving the quality of life and

social well-being of its citizens, and III) governance and accountability. Tanzania's poverty reduction strategy also fully supports the Millennium Development Goals of addressing poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women. These goals are a product of the United Nations Millennium Summit held in September 2000 and have been signed by 147 countries including Tanzania.

With the dual goals of poverty reduction and conservation, Tanzania, and the Serengeti ecosystem especially, will be a microcosm of the tradeoffs, conflicts, and mutual benefits of conservation and development. Unfortunately, little data exist on the current socioeconomic conditions around the ecosystem and monitoring of conservation and development projects is uncommon (Kleiman et al. 2000; Ogle 2001). One notable recent socioeconomic survey was conducted by Harrison (2007). Harrison reported on the socioeconomic status of ten villages in three districts across the ecosystem at the request of FZS. The three districts in Harrison's (2007) study are located in the northwest, southwest and east of the ecosystem and his study provides a good comparison to the findings in my study.

This chapter describes the socioeconomic conditions facing the local people of the Serengeti ecosystem, with references to how my baseline data sheds light on WMA and MKUKUTA goals. However, my study was not designed to specifically address WMA monitoring or MKUKUTA development goals, nor does the timing of my data allow for evaluation of these projects. Regardless, insight provided by the baseline data I report can provide a starting point for understanding how well villages in the Serengeti ecosystem are faring in terms of both conservation and development.

Study Area

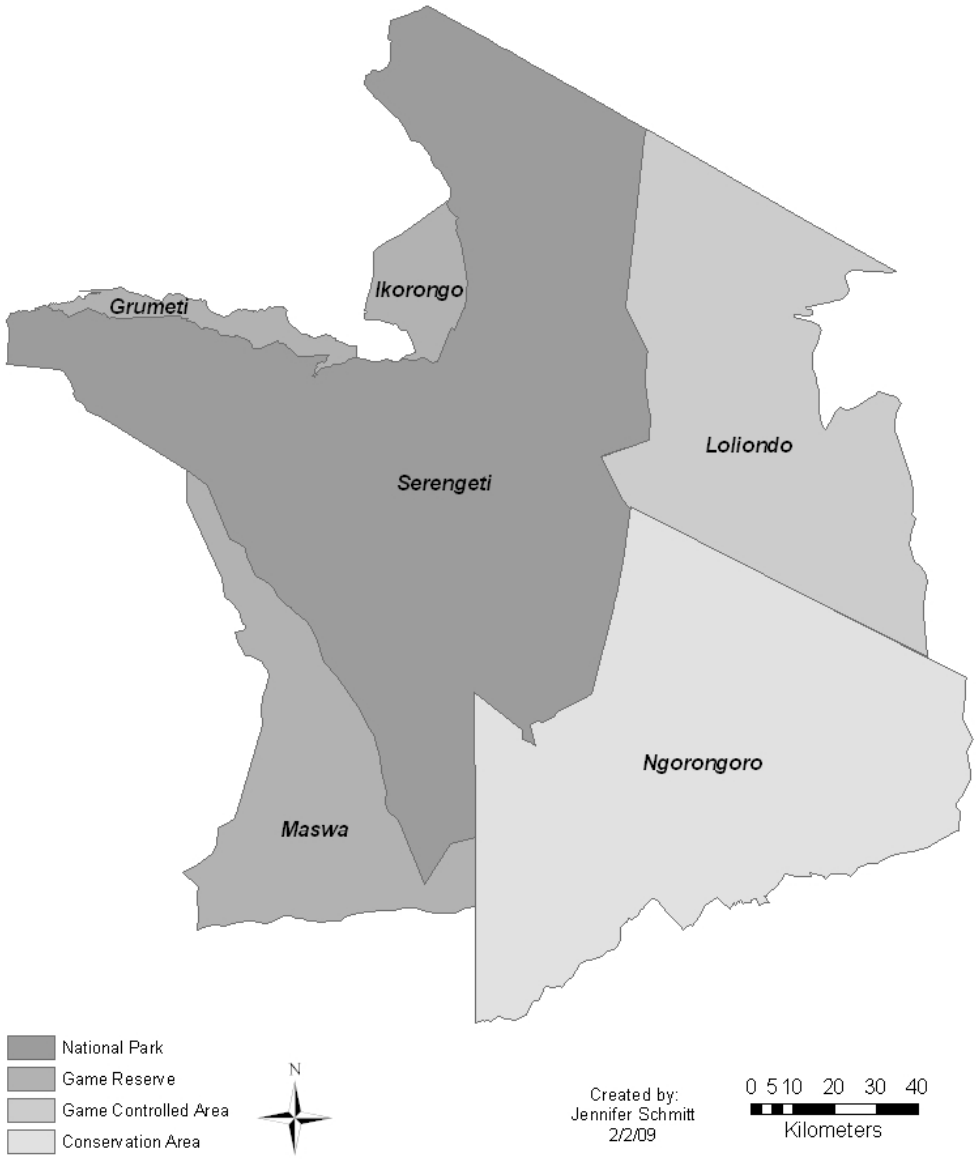
The Serengeti ecosystem is approximately 25,000 square kilometers, centered on Serengeti National Park. The annual migration of over a million wildebeest defines the ecosystem, and the ecosystem is a United Nations Educational Scientific and Cultural Organization World Heritage Site (Sinclair 1995). The ecosystem consists of five different types of government run protected areas, each with varying restrictions on

resource use and thus conservation levels (Table 1-1). The most restrictive area, in terms of use, is the national park at the core of the ecosystem. Game reserves, a game controlled area, and the NCA, each with different use restrictions, provide a buffer zone around the park. Some of the villages within the ecosystem and within my sampling of villages have set up, or are in the process of setting up, the fifth form of protected area, WMAs. WMAs can only be set up in open areas (areas with no restrictions on resource use) or game controlled areas and are still in their infancy and thus not shown on the proceeding map of the ecosystem (Figure 1-1).

Table 1-1: Protected areas and their restrictions on natural resource use

Protected area	Restrictions on use
National Park – Serengeti	• No permanent settlement • No hunting • No other consumptive natural resource use
Game Reserves – Maswa, Ikorongo, and Grumeti	• No permanent settlement • Hunting allowed by licensed government sanctioned hunting companies • No other consumptive natural resource use
Game Controlled Area – Loliondo	• Allows human settlements • Hunting by liscensed governmetn sactioned hunting companies and Tanzanian residents with a permit
Ngorongoro Conservation Area (NCA)	• Allows human settlements by local Maasai peoples • No hunting • Agriculture limited to subsitence scale
Wildlife Management Areas (WMA) – Ikoma and Makao	• Resource use allowed as designated by village land use plans and WMA agreements among villages and the government

Figure 1-1: The Serengeti ecosystem



In the game reserves and game controlled area around the park, hunting companies play a large role in conservation. To the northwest of the park, Singita Grumeti Reserves, a hunting/photographic safari company, has the lease for the Grumeti and Ikorongo Game Reserves, Ikoma WMA, as well as a private land holding. The WD

has split the Maswa Game Reserve and the adjacent Makao Open Area / Makao WMA into three hunting blocks and leases them to three different private tourist hunting companies (Big Game Safaris, Tanzanian Game Tracker Safaris, and Robin Hurt Safaris). Each of these companies, as well as Singita Grumeti Reserves, has a nonprofit organization associated with the private hunting company that focuses on conservation. Some of these nonprofits perform their own antipoaching and all of them provide benefits to communities around their hunting concession. To the east of the park is the Loliondo Game Controlled Area, which is a hunting block leased to Otterlo Business Corporation. Otterlo Business Corporation provides benefits to communities in their hunting block. The other major players in these areas are the photographic safari companies that have tours, tented camps, and/or lodges throughout the ecosystem.[2]

Along with the government and private business, various non-governmental organizations are also stakeholders in the ecosystem and involved in conservation. The main stakeholder for the national park is the FZS. The FZS provides financial backing for park management and conservation and has facilitated the establishment of WMAs around the ecosystem. Through their Serengeti-North Luangwa Ecosystem Management Project (SLEMP), FZS has been integrating conservation, development, and landscape management initiatives in Tanzania and Zambia. Through SLEMP, FZS is working with Tanzania National Parks (TANAPA) and the WD to focus on communities and conservation around the Serengeti ecosystem. Their Serengeti Ecosystem Management Project (SEMP) has been meeting with communities around the park to facilitate the creation of two WMAs (SEMP has also provided funding for my research). Under SEMP, FZS is required to "undertake socioeconomic surveys and community consultations to provide foundation for sustainable livelihood analysis".

Outside the national park, numerous conservation, religious, development, and other organizations work with communities throughout the ecosystem. The villages in my study cited an average of five other organizations working in their villages (range

[2] This study did not exhaustively identify all the photographic safari companies operating in the area. They are numerous and may operate in more than one area. Some photographic safari companies also give money to villages through bed night fees, sale of local craftsmanship to tourists, etc.

from 2 – 12). The northwest has the lowest average number of organizations working in the villages (4.6 per village). The southwest villages cited an average of 5.3 organizations, and the eastern villages cited the most organizations with an average of 5.8 per village. In total, the villages mentioned 53 different organizations. Over half of the organizations were development focused.[3] Religiously focused organizations made up thirty percent of those mentioned and only a quarter of the organizations mentioned had an environmental focus.[4]

The ecosystem has more than a hundred villages located along the outside of the game reserves and park and within the game controlled area or the NCA. Many people in the ecosystem have been around since before the parks inception in 1959, having their traditional grazing lands taken away by the establishment of the park. However, immigration into the area is common and thus many people and groups are new to the ecosystem.

Methods

The data for this study come from a compilation of four different questionnaires. The four questionnaires focused on the following groups: households, village leaders, village resource groups, and head teachers. I worked with a local nongovernmental organization, Savannas Forever Tanzania (SFTZ), to design, pilot, administer, and record the questionnaires. The SFTZ field team consisted of two teams of three Tanzanian researchers and one Tanzanian driver who conducted each interview in Swahili, or when necessary in Swahili with the help of a village translator to translate into the local language.[5]

Sampling Design

I worked with the SFTZ field team to choose the study villages. We focused on three areas of the ecosystem: the Northwest, the Southwest, and the East (i.e. Loliondo Game Controlled Area) (Figure 1-2). For each area, we randomly selected villages

[3] I defined development broadly to include those involved in education and health.
[4] Five organizations were both environmentally and developmentally focused and counted in both categories. One organization was developmentally and religiously focused and counted in both categories.
[5] This was necessary in 51 of 489 cases.

within five kilometers of the national park, one of the game reserves, or game controlled area. We also selected from villages within the game controlled area. This method allowed for a sampling of villages from around the ecosystem, capturing the variation throughout the study area. However, there are a few areas in the ecosystem not included in this study because of logistical and financial constraints. These areas include the whole of the NCA as well as villages at the very northwestern part of the ecosystem near Kenya in Tarime district, and areas between the northwest and southwest study area in Bunda, Magu, and Bariadi districts. Our study consisted of 20 villages, eight in the Northwest, six in the Southwest, and six to the East (Table 1-2). The average population for the study villages was 3,800, with a range from 1,215 to 10,274. The study villages range from one and a half (Bukore) to 74 (Engaresero) kilometers from Serengeti National Park, with an average distance of 29 kilometers.[6] The average distance to the park was closest for villages in the Northwest at nine kilometers. Villages in the Southwest were an average of 39 kilometers from the park and villages in the East were the furthest at an average of 46 kilometers. The average distance to each study village's respective closest protected area was five kilometers, ranging from zero to 25 kilometers. Villages in the East were closest with an average distance of four kilometers including three villages located within Loliondo Game Controlled Area. Villages in the Northwest also averaged four kilometers from their respective closest protected area. Southwest villages averaged the furthest distance at eight kilometers.

Within each village, we randomly selected five subvillages or all subvillages if a village had fewer than five. From each subvillage we randomly selected households using the village roster; or if the village roster was not available, by systematically sampling households in a given compass direction. For each subvillage we sampled enough households to ensure that we had 20 – 27 households sampled in each village. Our sampling method makes the data stratified (by area) and clustered (at the village and subvillage level). The SFTZ field team collected the data between August 2006 and January 2007.

[6] These are approximate distances from village centers where the SFTZ field team recorded their global positioning system (GPS) reading. Households and village lands may be closer or further away.

Figure 1-2: Study areas and villages

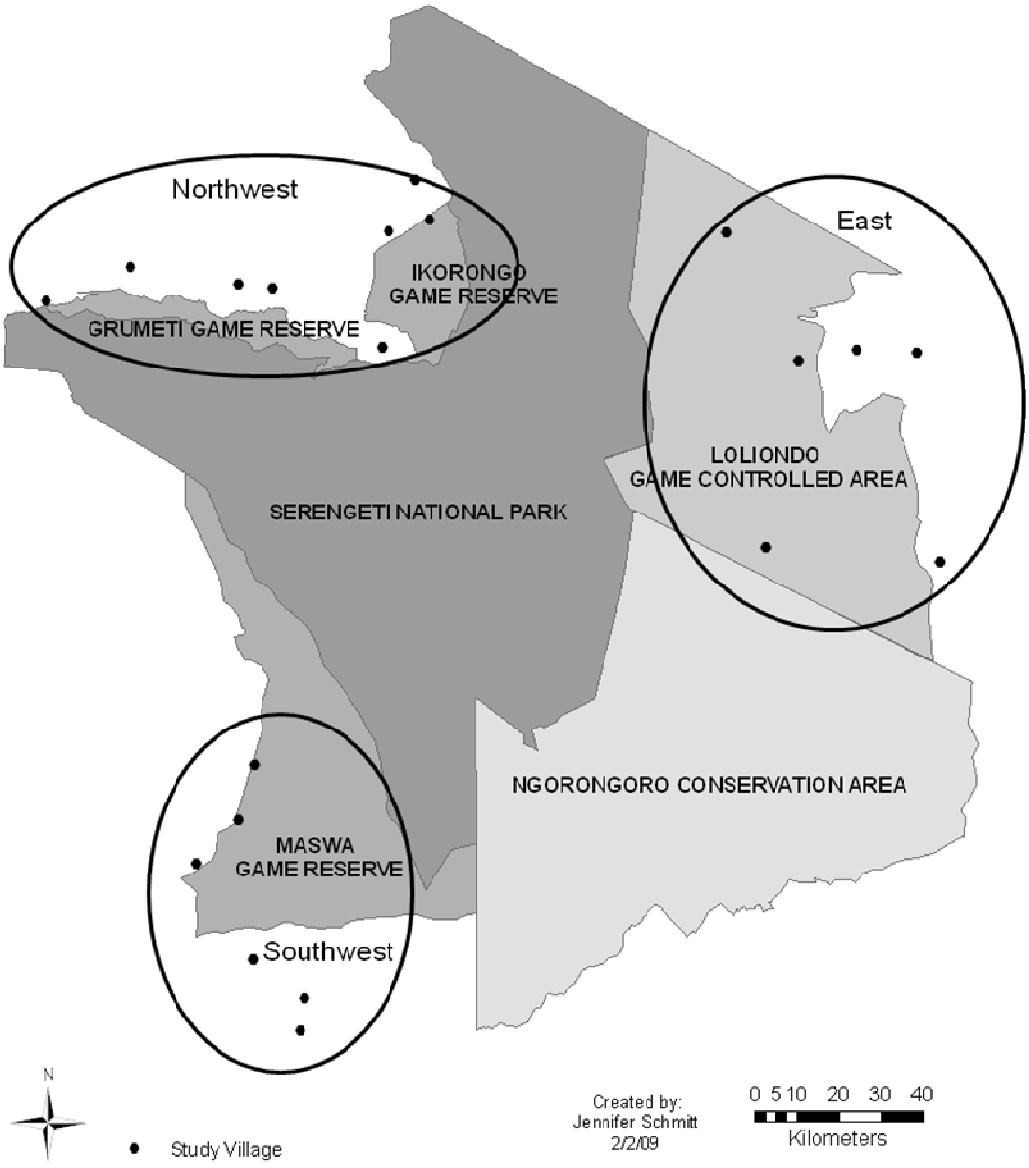


Table 1-2: Study areas and villages

Area	Villages
Northwest	Bonchugu, Bukore, Mariwanda, Misseke, Nata Mbiso, Nyamburi, Robanda, Singisi
Southwest	Iramba Ndogo, Mbushi, Mwamhongo, Nyanza, Sakasaka, Sapa
East	Engaresero, Oldonyosambu, Oloirien Magaiduru, Piyaya, Samunge, and Soitsambu

Household Level Data

We defined a household as a group of individuals that eat together from the same pot.[7] At each household, the interviewer asked for the household head. If unavailable, the field team interviewed someone else in the household over age 18 who was most knowledgeable about household affairs. The household questionnaire included questions on demographics, household economics, natural resource use, livestock, human wildlife interactions, poaching, knowledge of areas, benefits and costs to conservation, attitudes toward conservation, and house construction (Appendix I). The survey was administered to 489 households, 188 households in the Northwest, 154 households in the Southwest, and 147 households in the East. Of the 489 interviewees, 50.3% were male and 49.7% were female. The average age of the interviewees was 42, with a range from 18 to 90.

Village Level Data

Three to seven village leaders, with the village chairperson and/or village executive officer always being present, answered the village head questionnaire (Appendix II).[8] Others present were often subvillage chairpersons and/or members of the different village committees. The village resource questionnaire (Appendix III)

[7] Defining a household, especially in the developing world, can be difficult as households may contain more than one wife, members who live elsewhere, but contribute substantially to household wealth, relatives of household members, servants, etc. We tried to simplify our definition as much as possible by focusing on a tangible link among people, namely eating from the same cooking pot. This definition may ignore strict familial ties, but identifies those that contribute to daily household productivity and consumption by their presence within the study areas. This was used consistently across the sample. For a detailed discussion on the definition of a household see (Bender 1967 and Casley & Lury 1981).

[8] The village chairperson is the highest village elected position and the village executive officer is the highest ranking politically appointed position.

respondent group consisted of two to eleven village committee members, always including a member from the village environmental committee.

In each village, the SFTZ field team administered a head teacher questionnaire to a primary school teacher (Appendix IV). The SFTZ field team interviewed the primary school head teacher when possible, but when they were unavailable, they interviewed another teacher who had taught at the school for more than a year. If more than one primary school was present in the village the field team tried to interview a head teacher from each school. In total, 23 teachers were interviewed with two villages in the East, one village in the Northwest, and two villages in the Southwest having two schools and thus two teacher questionnaires. Two villages in the Northwest had no teacher interviewed.

Statistical Analysis

The SFTZ field team entered the data into Microsoft Excel and a second person double-checked the original entry. I performed analysis with STATA 10.0, which allowed me to properly account for the stratified, clustered sampling design. The data were stratified across three areas (Northwest, Southwest, and East) and clustered within village and within subvillage. Because villages have different population sizes and areas have different numbers of villages, sampling weights were used for each household to more accurately assess population averages. The clustering and stratification affect the standard errors, and the weighting of data affects point estimates as compared to an assumption of a simple random sample. Accounting for these deviations from simplified random sampling prevents falsely rejecting the null hypothesis because of the non-random sampling design. However, STATA's assumption about the degrees of freedom for variance estimation makes the statistical analysis conservative (Korn & Graubard 1999).

Villages were sampled independently in each stratum to improve the efficiency of the statistical design. Stratification will yield greater precision and thus smaller standard errors than a simple random sample when the strata variable and variable of interest are closely related (UCLA 2009).

The clustered nature of choosing households from within subvillages from within villages suggests there is likely to be correlation among household responses. The correlation is likely to be stronger between two households who live in the same village than across different villages, and stronger still within a subvillage. The correlation increases the standard errors relative to a simple random sample (UCLA 2009).[9] Consequently, assuming a simple random sample would understate the standard errors, leading to a false rejection of the null hypothesis.

I used sample weights for each household because of the unequal sampling rate for villages and subvillages. The sample weights were defined as the inverse of the probability of being included in the sample due to the sampling design. Therefore, the probability weight (PW) was:

$$PW = \frac{N_v(area)}{N_v(sampled)} * \frac{N_{sv}(village)}{N_{sv}(sampled)} * \frac{N_h(subvillage)}{N_h(sampled)}$$

where:

$N_v(area)$ = number villages in an area

$N_v(sampled)$ = number villages sampled

$N_{sv}(village)$ = number subvillages in a village

$N_{sv}(sampled)$ = number subvillages sampled

$N_h(subvillage)$ = number households in a subvillage

$N_h(sampled)$ = number households sampled

For ten of the 20 villages I had data about the number of households in each subvillage. However, for the other ten subvillages I only knew the total number of households in the village and the number of subvillages. For these villages, I assumed an equal number of households in each subvillage.[10]

[9] Because households are likely correlated, sampling lots of households within a village is a waste of resources, 200 households probably will not be any more informative then 100.

[10] While such estimation is not ideal, obtaining actual subvillage household numbers for the remaining ten villages was logistically impossible, highlighted by the fact that for some subvillages the data did not exist. Furthermore, the data are not sensitive to this assumption. I used a different method of estimation (having

In the following sections, I provide descriptive statistics on households in the three areas of our study. For those questions comparing means, I ranked the three areas' means and used a t-test to determine if the difference in the highest and lowest means was statistically significant. If statistically significant, I then also tested the difference between the highest and middle and middle and lowest means.[11] For comparison of percentiles I used a chi square test to determine if area and the variable's response percentages were independent. I report p-values for t-tests and chi square tests and use a 0.05 significance level for hypothesis tests.

Household Demographics

The Serengeti ecosystem is comprised of a diverse mix of people. Some have lived in the ecosystem for centuries, others are first generation immigrants. To the east of the park live more traditional pastoralist people, while agropastoralist and traditional hunters live to the west. Identifying and understanding the diversity of people in the ecosystem can assist in implementing conservation and development projects that work within the cultural framework of the local people. The following section outlines some basic human demographics of people in the Serengeti ecosystem.

Religion

A notable number of respondents did not identify themselves with any religion. Half of all the respondents said they had no religion, while those who were religious were predominantly Christian (Table 1-3). Area and religion had a statistically significant relationship (p-value = 0.030, n = 489). The Northwest was the most religious area with almost three-quarters of respondents saying they were religious. Less than a third of the Southwest was religions and half of East was religious. Only eleven of 489 people in the study were Muslim, eight of which lived in the Northwest. Respondents mentioned very few other religions, including traditional religions.

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a "high population", "low population", and middle level populations for the unknown subvillages) and my statistical conclusions rarely differed.

[11] Although some data were not normally distributed, Asymptotic Theory states that as the sample size goes to infinity the estimated means are normally distributed (DasGupta 2008).

Table 1-3: Religions of the people in the Serengeti ecosystem

Area	Christian	Muslim	None	Other
Northwest	68.0%	4.0%	26.4%	1.6%
Southwest	30.4%	1.4%	68.0%	0.2%
East	49.1%	1.4%	50.0%	0.0 %
All areas	48.3%	2.0%	49.3%	0.5%

n = 489

Ethnic Groups

Our data provide two sources of information on ethnic groups. Each village leader questionnaire asked the respondents to list the main ethnic groups in each village. We also asked each household interviewee for their ethnicity. All three areas have many ethnic groups and area and ethnic group had a statistically significant relationship (p-value = 0.000, n = 489). The East was predominantly inhabited by the Maasai, although 18% of the respondents were Sonjo. The Southwest was 85% Sukuma, while the Northwest had a more even mix of ethnic groups (Table 1-4). None of the ethnic groups in the Northwest make up more than 30% of the population.

Table 1-4: Ethnic groups throughout the Serengeti ecosystem

Area	Main ethnic groups according to village leaders (number village leader groups citing ethnic group)	Main ethnic groups of household respondents (percent of population, n = 489)
Northwest	Sukuma (7) Kurya (5) Ikoma (4) Nata (4) Taturu (4) Zanaki (4) Isenye (3) Jaluo (3) Ikizu (2) Zangita (2) Jita (1) Kusi (1) Malagori (1) Ngoreme (1) Zigua (1)	Kurya (29%) Sukuma (22%) Ikoma (17%) Nata (8%) Taturu (6%) Zanaki (4%) Isenye (3%) Ikizu (3%) Other (ethnicities less each than 3% of sample) – Iramba, Jaluo, Jita, Kalenjini / Lubwe, Kwanga, Maraguli, Meru, Mshasi, Nyamwezi, Nyantuzu, Rundi, Shashi, Simbiti, Simicha, Simijenga, Sizaki, Yao, Zangita
Southwest	Sukuma (6) Taturu (5)[a] Iramba (4) Jaluo (2) Tindiga/Hadzabe (2) Jita (1) Kurya (1) Mang'ati (1) Sanzu (1) Shashi (1)	Sukuma (85%) Tindiga/Hadzabe (9%) Sanzu (4%) Other (ethnicities each less than 3% of sample) – Iramba, Kurya, Nyamwezi, Nyantuzu, Rundi, Shashi
East	Maasai (5) Sonjo (5) Iraqw / Mbulu (3) Chaga (2) Hehe (1) Iramba (1) Kalenjini / Lubwe (1) Kurya (1) Mang'ati (1) Meru (1)	Maasai (74%) Sonjo (18%) Arusha (4%) Other (ethnicities each less than3% of sample) – Kalenjini / Lubwe, Meru, Taturu, Yao

a – No households reported being Taturu in the Southwest. We may have missed sampling Taturu peoples if they all lived in one subvillage (as was the case with the Hadzabe people) and if we then failed to sample in that subvillage (we only sampled five subvillages per village). It may also be that the village leaders over emphasized the presence of the Taturu ethnic group, when in reality they were only a small fraction of the population and thus by simple random chance we did not sample any Taturu households.

Immigration

Populations in all three areas are growing. Serengeti district, overlapping much of my Northwest study area, has an annual population growth rate of 3.1%. Meatu district, overlapping the villages in the Southwest, has an annual population growth rate of 3.2%. Ngorongoro district, covering the villages in the East, has an annual population growth rate of 4.5% (Polasky et al. 2008). Some of this population growth rate is due to immigration and according to the village leader questionnaires over ninety percent of villages had immigration into their village, with 79% having seasonal immigration into village lands. At the household level, 50% of the population was born in the village they were living in; only 10% were born outside the region of their village (Table 1-5). Therefore, while people are immigrating to these villages, they do not appear to be immigrating from far away. Area and place of birth had a statistically significant relationship (p-value = 0.000, n = 489) indicating that immigration varies significantly between the different areas. The East had the lowest levels of immigration with over three-quarters of the population being born in their current village of residence. However, villages in the Northwest and Southwest had almost two-thirds to four-fifths of residents being immigrants respectively. These findings are similar to those of Harrison (2007) who found that 58% of household heads were born in their current village of residence and also found that immigration was lower in the East.

Table 1-5: Birthplace of respondents throughout the Serengeti ecosystem

	Birthplace				
Area	**Village**	**Ward**	**District**	**Region**	**Elsewhere**
Northwest	34.2%	9.0%	16.6%	20.1%	20.2%
Southwest	22.2%	6.5%	24.0%	35.3%	11.9%
East	76.6%	5.9%	9.0%	5.6%	3.0%
All areas	50.0%	6.8%	15.3%	18.0%	9.9%

n = 489

The primary reason given by households for immigration was for grazing and/or cultivation (Table 1-6), which supports the findings of Harrison (2007). However, immigration into the East differed from that in the Northwest and Southwest in that the primary reason for immigration into the East was marriage. However, this difference was not statistically significant (p-value = 0.417, n = 286). Only one respondent (in the

Southwest) cited natural resources as a reason for immigration and only one household mentioned moving to find a primary school. Conservationists often worry that benefits from community conservation projects will draw people toward conservation areas. However, this does not seem to be the case for these areas, most likely because of the low level of knowledge of the protected areas and low level of benefits received from these areas.[12]

Table 1-6: Reasons for immigration into the Serengeti ecosystem

Area	Marriage / follow family	Employment	Grazing and/or cultivation	Settlement	Other*
Northwest	39.8%	3.7%	41.6%	2.1%	12.9%
Southwest	30.1%	2.7%	53.0%	4.0%	10.3%
East	46.2%	8.4%	28.6%	5.9%	10.9%
All areas	36.8%	4.2%	44.0%	3.7%	11.3%

*Other includes: Getting away from conflict, villigization (whereby the government actively relocated rural populations to larger village centers), do not know, access to traditional healer, change of environment, disease, primary school, food, return to his origin, parents/family member passed away, searching for life, wealth, or wild animals (only one person, a hunter-gather Hadzabe, responded they immigrated to search for wild animals).
n = 286

Livelihoods

Understanding the livelihoods of local people is an important element in designing conservation strategies. Conservation strategies that are not consistent with the way local people go about making a living are unlikely to be successful. Furthermore, understanding livelihoods is also essential for designing policies to overcome poverty. The following section describes the livelihood characteristics of people in the study villages.

The agriculture sector dominates the Tanzanian economy, providing livelihoods to 82% of the population and making up 45% of Tanzania's gross domestic product (GDP) and 60% of Tanzanian export earnings (GoT 2005). Agriculture is the predominant livelihood source throughout the Serengeti ecosystem as well. The SFTZ field team asked each household interviewee the main occupation of the household head.

[12] I discuss the lack of knowledge of protected areas and lack of benefits from these areas in Chapters Two and Three.

Almost everyone reported an occupation of farming or livestock keeping, many reporting both. Over 90% of the household heads were farmers, 56% were livestock keepers (Table 1-7). Differences among areas in the percentage of household heads that were farmers were not statistically significant because virtually everyone was a farmer (p-value = 0.606, n = 474). However, area and having a livestock owner as a household head had a statistically significant relationship (p-value = 0.000, n = 475). Less than a third of household heads in the Northwest and Southwest were livestock owners, but over 90% of household in the East were livestock owners. Having a household head farmer and livestock owner were not mutually exclusive. Ninety-three percent of the livestock owners were also farmers, with 94% and 100% of livestock owners in the Northwest and Southwest being farmers respectively. Ninety percent of the livestock owners in the East were also farmers. These results support the results of Harrison (2007) who also found agriculture and livestock dominate livelihood strategies. In my analysis, only 18% of the household heads' main occupation included something other than farming or livestock. The differences among areas in the percentage of household heads doing something other than farming or livestock were not statistically significant (p-value = 0.693, n = 489). There was not a particular area that has more non-subsistence occupations. However, 72% of household heads with an "other" occupation also had farming or livestock mentioned as one of their main occupations. The most common "other" occupation was "businessman" with 35% of responses. Laborers (14%) and teachers (9%) were other frequent answers.

Table 1-7: Household head occupations throughout the Serengeti ecosystem

Area	Percentage of farmers	Percentage of livestock owners	Percentage of respondents with "other" occupation
Northwest	91.4%	28.9%	16.9%
Southwest	94.6%	30.3%	13.7%
East	88.8%	90.7%	20.8%
All areas	91.3%	55.9%	17.7%

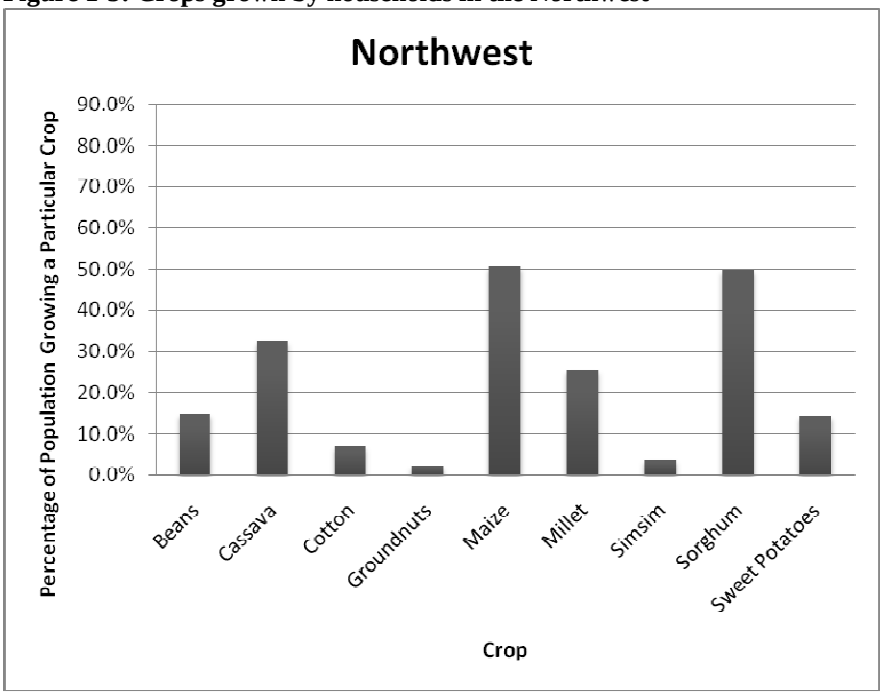
n (farmer) = 474, n (livestock owner) = 475, n(other occupation) = 489

Subsistence Farming

Virtually all households in the study area were farmers, although most function only at a subsistence level. Therefore, the main household crops grown were primarily

food crops rather than cash crops. The most commonly grown crops throughout the study were maize, sorghum, and beans. All districts grew maize and used it as a subsistence and cash crop. Beans were predominantly grown in the East, and sorghum predominantly in the Southwest and Northwest. A small number of households grew various other crops, usually clustered in a particular area (Figures 1-3, 1-4, 1-5).[13] The Northwest and Southwest grew more variety of crops compared to the East. The Northwest was the only area with a substantial number of households growing cassava and millet. Cotton was the only nonfood cash crop grown by numerous households and the Southwest was home to the majority of cotton growers (Figure 1-4). These results support those found by Harrison (2007).

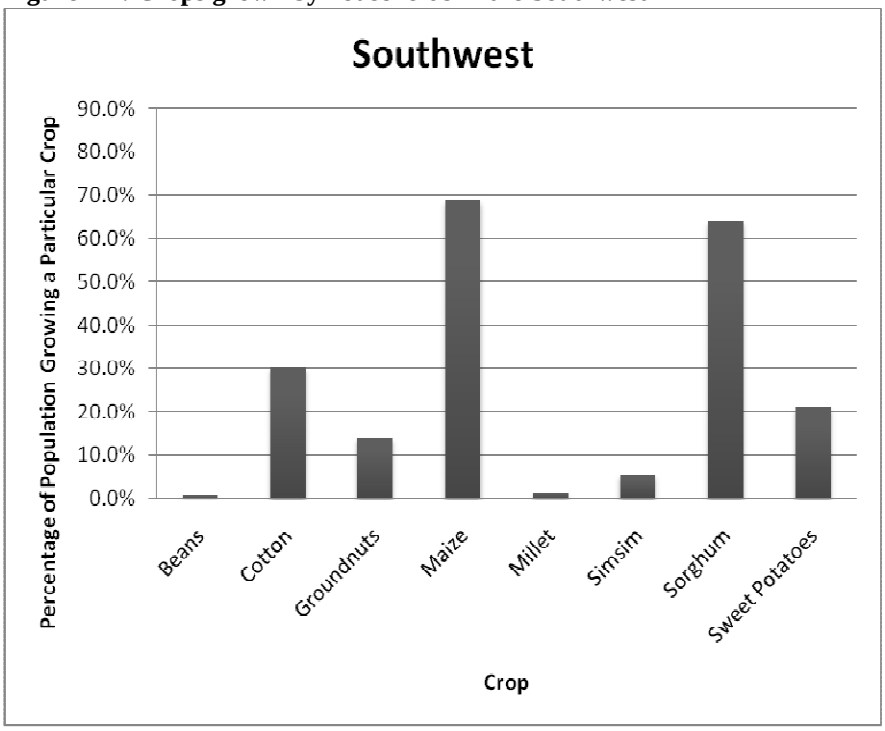
Figure 1-3: Crops grown by households in the Northwest



n = 489

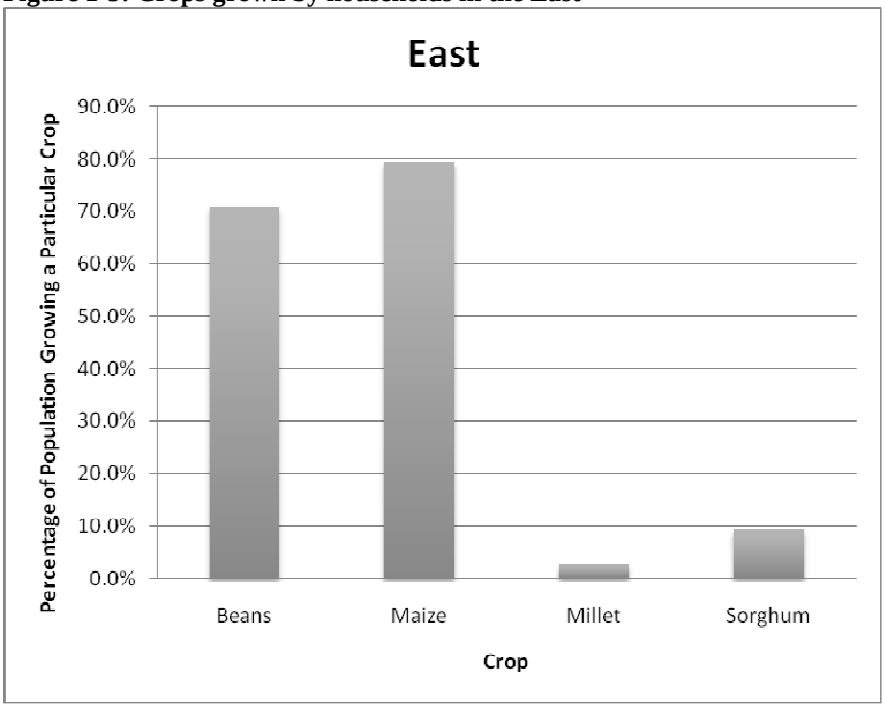
[13] Other crops were also grown in a few households (less than 2%) including: paddy, sunflowers, onions, tobacco, tomatoes, vegetables (general), bananas, mangoes, papaya, and fruit (general). Among areas, none of the differences in the percent of households growing these particular crops were statistically significant.

Figure 1-4: Crops grown by households in the Southwest



n = 489

Figure 1-5: Crops grown by households in the East



n = 489

Almost everyone owned or rented a farm, especially in the Northwest and Southwest (Table 1-8). In the East, 10% of the population did not have a farm, while only 5% did not have a farm in the Southwest and less than one percent did not rent or own a farm in the Northwest. Most people owned a farm as opposed to renting a farm. Farm ownership and area had a statistically significant relationship (p-value = 0.004, n = 489). No one rented in the East and only 2% rented a farm in the Northwest. However, renting in the Southwest was more common with 16% of the population renting farms. The average size for a farm was 3.2 hectares (SE = 0.3). The difference between the average farm size in the Southwest and both the East and Northwest was statistically significant (p-value = 0.001 and 0.005 respectively, n = 472). The difference in farm sizes between the Northwest and East was not statistically significant (p-value = 0.059, n = 472).

Not all land was cultivated in the 12 months prior to our survey. When asked about cultivation, the average area cultivated was 1.6 hectares, just over half of the average farm size. The difference in the amount of area cultivated for the Southwest and both the East and Northwest was statistically significant (p-value = 0.000 for both pairwise comparisons, n = 466). However, the difference in amount of area cultivated for the Northwest and East was not statistically significant (p-value = 0.133, n = 466). Households in the Southwest cultivated an average of 2.7 hectares. Households in the East cultivated the least amount of land, which fits with their primary focus on pastoralism. Despite their pastoral livelihoods, 90% of the population owns a farm in the East and thus, farming is obviously still an important livelihood strategy.

Table 1-8: Farm ownership and size throughout the Serengeti ecosystem

Area	Percent respondents owning a farm	Percent respondents renting a farm	Average farm size (hectare) (SE)	Average area cultivated in last 12 months (hectare) (SE)
Northwest	93.4%	1.9%	2.6 (0.2)	1.5 (0.2)
Southwest	73.9%	16.3%	5.8 (1.0)	2.7 (0.1)
East	90.2%	0.0%	1.8 (0.3)	1.1 (0.2)
All areas	86.2%	5.3%	3.2 (0.3)	1.7 (0.1)

n (farm ownership and rental) = 489, n (farm size) = 472, n (area cultivated) = 466

Livestock Keeping

As expected, cattle ownership was highest in the East with 87% of the households owning cattle. The average herd size for households that owned livestock was 54 cows. Area and cattle ownership had a statistically significant relationship (p-value = 0.000, n = 489). Furthermore, the difference in the average number of cows owned by households owning cows for the East and Northwest was statistically significant (p-value = 0.037, n = 318), although not between the East and Southwest (p-value = 0.092, n = 318) or between the Northwest and Southwest (p-value = 0.886, n = 318). The number of cows owned in the East was more than double the average number of cows for the Southwest and Northwest (Table 1-9). The differences between the East and both the Northwest and Southwest were also pronounced for shoats (sheep and goats counted together) and chickens and/or chicks. Area and both shoat ownership and chicken/chick ownership had a statistically significant relationship (p-value = 0.000 for both, n = 489 and 488 respectively). An estimated 93% of households in the East owned shoats while only 27% owned chickens and/or chicks. The Northwest and Southwest showed the opposite trends with more households owning chickens and/or chicks and less owning shoats (Tables 1-10 and 1-11). Households in the East also had significantly more shoats, with an average of 87 per household compared to only 18 and 11 for the Southwest and Northwest respectively (Table 1-10). These differences between the East and both the Southwest and Northwest are statistically significant (p-value = 0.000 for both, n = 361), but again the difference between the Northwest and Southwest is not statistically significant (p-value = 0.251, n = 361). All three areas owned similar amount of chickens and chicks (p-value = 0.856, n = 316) (Table 1-11). These results are similar to those of Harrison (2007), although my results suggest slightly higher average numbers of livestock.

In general, households did not sell much livestock. Households in the Northwest sold the highest proportion of their cows and shoats, but still only sold 14% of their cattle and a fifth of their shoats in the year prior to our study (Table 1-9 and 1-10). Households in the Southwest sold 9% of their cattle and 18% of their shoats. Households in the East, which had higher numbers of livestock, sold only 10% of their livestock. The East sold a statistically significant higher number of cattle than the Southwest (p-value = 0.000, n =

312) and more than the Northwest (p-value = 0.051, n = 312). There was no statistical difference in the number of cattle sold between the Northwest and Southwest (p-value = 0.459, n = 312). The East sold a statistically significant higher number of shoats than the Northwest and Southwest (p-value = 0.000 for both, n = 356). There was no statistical difference between the Northwest and Southwest (p-value = 0.621, n = 356). The higher absolute number of cattle and shoats sold in the East helps explain the higher livestock and total incomes reported in the East.[14] All areas sell similar numbers of chickens and chicks (p-value = 0.317, n = 318), although overall very few households are selling chickens and chicks (Table 1-11).

Table 1-9: Household cattle ownership and sale throughout the Serengeti ecosystem

Area	Percentage households owning cattle	Average # cattle for those households owning cattle (SE)	Average # cattle sold (SE)
Northwest	60.0%	20.1 (8.9)	2.9 (1.0)
Southwest	51.2%	22.4 (13.0)	2.0 (0.5)
East	86.5%	54.4 (12.3)	5.4 (0.6)
All areas	69.5%	40.0 (9.1)	4.1 (0.5)

n (% ownership) = 489, n(owned) = 318, n(sold) = 312

Table 1-10: Household shoat ownership and sale throughout the Serengeti ecosystem

Area	Percentage households owning shoats	Average # shoats for those households owning shoats (SE)	Average # shoats sold (SE)
Northwest	66.9%	13.6 (2.6)	2.9 (0.7)
Southwest	59.8%	17.9 (2.5)	3.3 (0.4)
East	92.6%	87.2 (9.1)	8.6 (1.1)
All areas	76.6%	55.1 (9.4)	6.1 (0.8)

n (% ownership) = 489, n(owned) = 361, n(sold) =356

[14] See "Income" section.

Table 1-11: Household chicken and chick ownership and sale throughout the Serengeti ecosystem

Area	Percentage households owning chicken / chicks	Average # chicken / chicks for those households owning chicken / chicks (SE)	Average # chicken / chicks sold (SE)
Northwest	79.7%	14.6 (0.7)	1.1 (0.4)
Southwest	73.2%	14.4 (1.1)	0.7 (0.1)
East	27.0%	14.4 (1.7)	1.5 (0.8)
All Areas	53.7%	14.5 (0.7)	1.0 (0.2)

n (% ownership) = 488, n(owned) = 316, n(sold) = 318

While cows, shoats, and chickens are by far the most common livestock, there are a few other species kept by households in the ecosystem. Donkeys were common in the East with 47.8% of households owning an average of six donkeys (SE = 1.1). Only two other households, both in the Southwest owned donkeys. Ducks were another livestock species owned by some households, with 10% of households in the Northwest, 8% in the Southwest and 2% in the East owning ducks. Differences in duck ownership among areas were not statistically significant (p-value = 0.060, n = 489). Households who owned ducks owned an average of 3.6 ducks (SE = 0.5). Households owning ducks in the Northwest owned a statistically significant higher number of ducks than owners in the Southwest (p-value = 0.012, n = 32) with averages of 4.2 and 2.7 respectively (SEs = 0.4 and 0.3 respectively). None of the households owned pigs at the time of our survey.

Livestock Loss

The majority of households owned livestock, often using this livestock as a savings account for household wealth. Unfortunately, when storing wealth in livestock, a household's wealth is subject to external factors that can increase loss, e.g. disease, drought, theft, and depredation. Half of all the households lost cattle and shoats to disease in the 12 months prior to our survey (Table 1-12). Households in the East fared worst than elsewhere, with a higher percentage of households losing higher average numbers of cattle and shoats. More households in the Southwest and Northwest lost chickens. However, more households in the East owned cattle and shoats and more households in the Northwest and Southwest owned chickens. Consequently, livestock loss reflected ownership. Fourteen percent of households in the East also lost donkeys in the 12 months prior to our survey.

Table 1-12: Livestock loss to disease in the 12 months prior to the survey

	Cattle		Shoats		Chicken and/or chicks	
Area	**Percent households losing livestock**	**Average number lost in 12 months prior (SE)**	**Percent households losing livestock**	**Average number lost in 12 months prior (SE)**	**Percent households losing livestock**	**Average number lost in 12 months prior (SE)**
Northwest	38.7%	2.4 (0.8)	37.0%	3.1 (0.9)	46.1%	6.3 (0.8)
Southwest	40.8%	1.8 (0.7)	31.3%	2.5 (0.5)	44.6%	6.9 (1.9)
East	61.0%	9.0 (2.3)	58.6%	23.6 (13.4)	7.2%	0.6 (0.3)
All areas	49.6%	5.2 (1.2)	45.2%	12.3 (6.0)	27.8%	3.8 (0.8)

n(cattle) = 485, n(shoats) = 486, n(chicken/chick) = 485

Wild animals also were a common cause of livestock death, especially in the East. Over a fifth of all the households lost cows to wild animals, while almost a third lost shoats to wild animals (Table 1-13). Losing cattle, shoats, and chickens and/or chicks all had a statistically significant relationship with area (p-values = 0.000, 0.001, and 0.000 respectively, n = 484, 485, and 478 respectively). Despite its prevalence, wild animals did not kill many livestock, especially compared to disease. For example, wild animals killed an average of less than one cow and less than one shoat per household in the 12 months prior to our survey (Table 1-13). Households in the East lost more cattle and shoats than the Northwest and the Southwest. All pairwise comparisons of mean cattle lost were statistically significant (p-values = 0.000 for the East and both Southwest and Northwest, p-value 0.017 for Northwest and Southwest, n = 484). Only the differences between the East and Northwest and East and Southwest for shoats lost were statistically significant (p-values = 0.000 for both, p-value for Northwest and Southwest = 0.762, n = 485). Eight percent of households lost an average of 0.2 donkeys to wild animals in the East (SE = 0.1, n = 483). The Northwest and Southwest, with their higher amount of chicken ownership, lost more chickens than households in the East. Over a third of all households in the Northwest lost an average of 3.4 chickens to wild animals, while 20% of households in the Southwest lost an average of 1.2 chickens in the 12 months prior to our survey. Pairwise comparisons between the Northwest and both the East and Southwest for the mean number of chickens and/or chicks lost were statistically

significant (p-value = 0.000 and 0.002 respectively, p-value for Southwest and East 0.051, n = 478).

Hyenas were responsible for more livestock losses than any other species and all areas equally cited hyenas as a problem (Figure 1-6). Households reported that hyenas kill both cattle and shoats. Along with hyenas; leopards, lions, and wild cats[15] were also responsible for the majority of livestock losses. Wild cats exclusively killed chickens, while leopards and lions almost exclusively killed cattle. Baboons, wild dogs, jackals, and cheetahs also killed shoats, while kites and some jackals killed chickens and/or chicks. Other animals mentioned included snakes, hawks, eagles, monitor lizards, honey badgers, servals, and caracals, although these animals were only responsible for one or two livestock deaths in the 12 months prior to the survey.

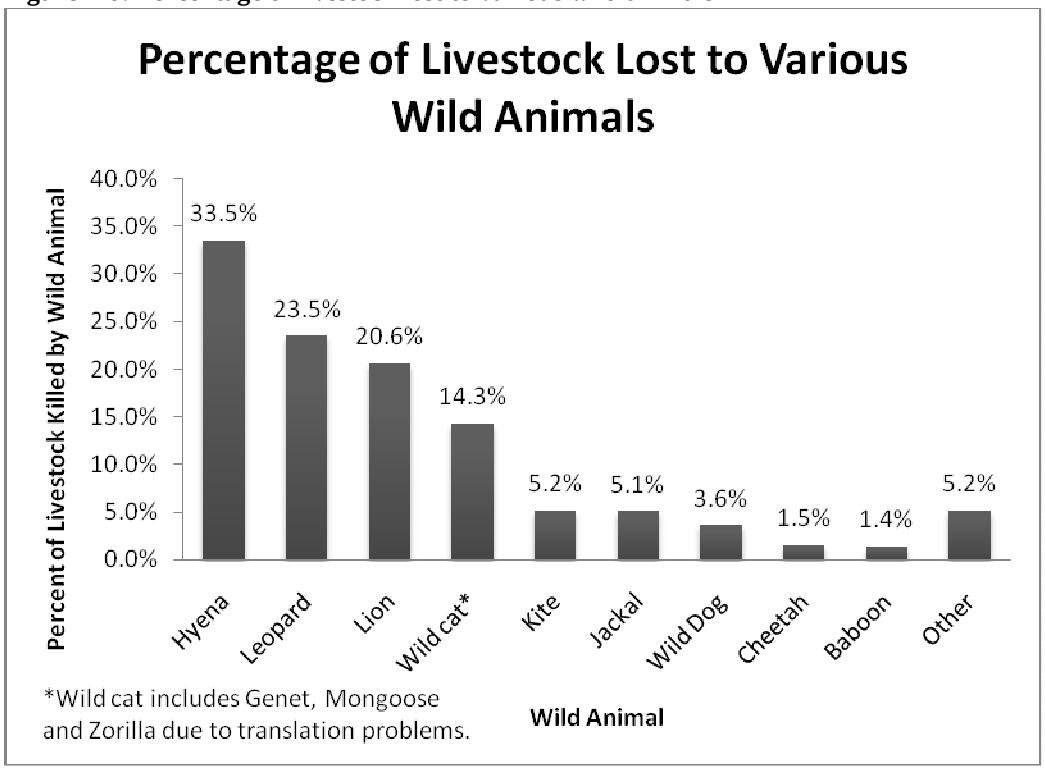
Table 1-13: Livestock loss to wild animals in the 12 months prior to the survey

	Cattle		Shoats		Chicken and/or chicks	
Area	**Percent households losing livestock**	**Average number lost in 12 months prior (SE)**	**Percent households losing livestock**	**Average number lost in 12 months prior (SE)**	**Percent households losing livestock**	**Average number lost in 12 months prior (SE)**
Northwest	5.9%	0.1 (0.0)	17.8%	0.8 (0.2)	36.3%	3.4 (0.5)
Southwest	3.3%	0.0 (0.0)	22.0%	0.8 (0.2)	20.2%	1.3 (0.4)
East	44.2%	1.5 (0.3)	41.6%	3.1 (0.4)	6.6%	0.4 (0.1)
All areas	22.8%	0.7 (0.2)	30.0%	1.8 (0.3)	17.8%	1.4 (0.2)

n(cattle) = 484, n(shoats) = 485, n(chicken/chick) = 478

[15] "Wild cats" includes genets, mongoose and zorillas because the words for each animal were not translated consistently and thus I could not separate out the different animals.

Figure 1-6: Percentage of livestock lost to various wild animals



n = 341

Two other external factors, theft and drought, also decreased livestock numbers in my study area. Drought was common only in the East, although it did affect the Northwest to a lesser extent. Over half of households (55.8%) in the East lost cattle to drought while 27.9% lost shoats to drought.[16] In the Northwest, 15.6% of households loss cattle to drought, while 12.0% lost shoats to drought. Both cattle loss and shoat loss had a statistically significant relationship with area (p-values = 0.000 for both cattle and shoat loss, n = 484 and 483 respectively). Drought claimed an average of 14 cattle (SE = 5.1) as well as nine shoats (SE = 2.7) for 28% of households and less than one donkey (0.2 donkeys, SE = 0.2) for seven percent of households. Drought did not greatly affect chickens, only claiming chickens from two percent of households in the Northwest.

Theft was common only in the East and thus the percentage of households suffering from theft of cattle and shoats both had a statistically significant relationship with area (p-values = 0.026 and 0.000 respectively, n = 483 and 484 respectively). An estimated nine

[16] In early 2006 Northern Tanzania was affected by a severe drought.

percent of households in the East lost less than one cattle to theft (0.3 cattle, SE = 0.1) while an estimated 14.2% lost less than one shoat to theft (0.6 shoats, SE = 0.1). Theft of chickens and donkeys was not an issue.

Paid Employment

The low level of non-agricultural/livestock occupations coincides with a low level of paid employment in the villages. The average household had less than one person earning income through paid employment (mean = 0.70, SE = 0.14). Paid employment was most likely in the Northwest with a mean number of 1.17 household members earning pay (SE = 0.12) and was statistically significantly different than the lowest mean in the East (mean of 0.28, SE = 0.09, p-value = 0.000, n = 487). The Southwest had a mean of 0.96 (SE = 0.21) and was also statistically significantly different from the East (p-value = 0.008, n = 487). Only 19% of households had income coming from paid employment, contributing an average 2006 Tanzanian Shilling (Tsh) 225,000 to household incomes.

The minimal amounts of paid employment and low level of jobs other than agriculture and livestock (both of which tend to be subsistence) underscore the need for job creation in rural areas. According to national statistics, unemployment and underemployment are pervasive in Tanzania. In 2000/01, the rate of underemployment[17] was 11.2% and the unemployment rate was at 12.9% (GoT 2005). Increasing employment opportunities, especially for women, is a key MKUKUTA goal. According to our data, focusing on underemployment seems of primary importance because only two households in our survey reported the household head as unemployed.

Natural Resource Based Livelihoods

Of particular interest for both conservation and development is the amount of livelihood activities based on natural resources. The notion behind WMAs is to increase the contribution of sustainable natural resource uses to household livelihoods. MKUKUTA also seeks to increase income derived from sustainable processing and

[17] Defined as "persons who worked less than 40 hours a week due to economic reasons, but were available for more work in the reference week" (National Bureau of Statistics 2009a).

marketing of natural resources. To obtain a general sense of the role of natural resources in rural livelihoods the SFTZ field team asked the village leader groups for the most common village livelihood strategies. Thirty-five percent of village leader groups cited natural resources as an important form of livelihood strategies for their villagers. The natural resource livelihoods mentioned were making charcoal, beekeeping, bushmeat hunting, conservation[18], and tourism. Only one village mentioned making charcoal and only one mentioned tourism, although both were ranked as the second most important livelihood strategy in the village. Charcoal and poaching are likely not sustainable forms of natural resource livelihoods (due to population growth and stochastic environmental factors, e.g. Barrett & Arcese 1998), although beekeeping, conservation, and tourism are potential sustainable natural resource livelihoods due to their non-consumptive nature.

Natural Resource Use

Agricultural lands, grazing lands, water sources, bushmeat, fuelwood, etc. all contribute to the subsistence livelihoods in the ecosystem. Many of these resources are used frequently. Most households in the Serengeti ecosystem use both fuelwood and grazing lands virtually every day. Over 90% of households used firewood every day in all three study areas. Differences in firewood use in the last year and area were not statistically significant (p-value = 0.178, n = 489). Seventy percent of households had used grazing grass within the last year. Area and grazing grass usage had a statistically significant relationship (p-value 0.000, n = 489). A statistically significant higher number of households in the East, where cattle ownership is higher, use grazing grass. Households use firewood for local brews and charcoal at different frequencies. Firewood for local brew is used by an estimated 11% of households with no statistical difference between the usage in the different areas (p-value = 0.216, n = 489). Households used firewood for local beer brewing at different frequencies, but the most common frequency was on a monthly basis with an estimated five percent of households using at that frequency. Charcoal use was rare with only three percent of the respondents using it on

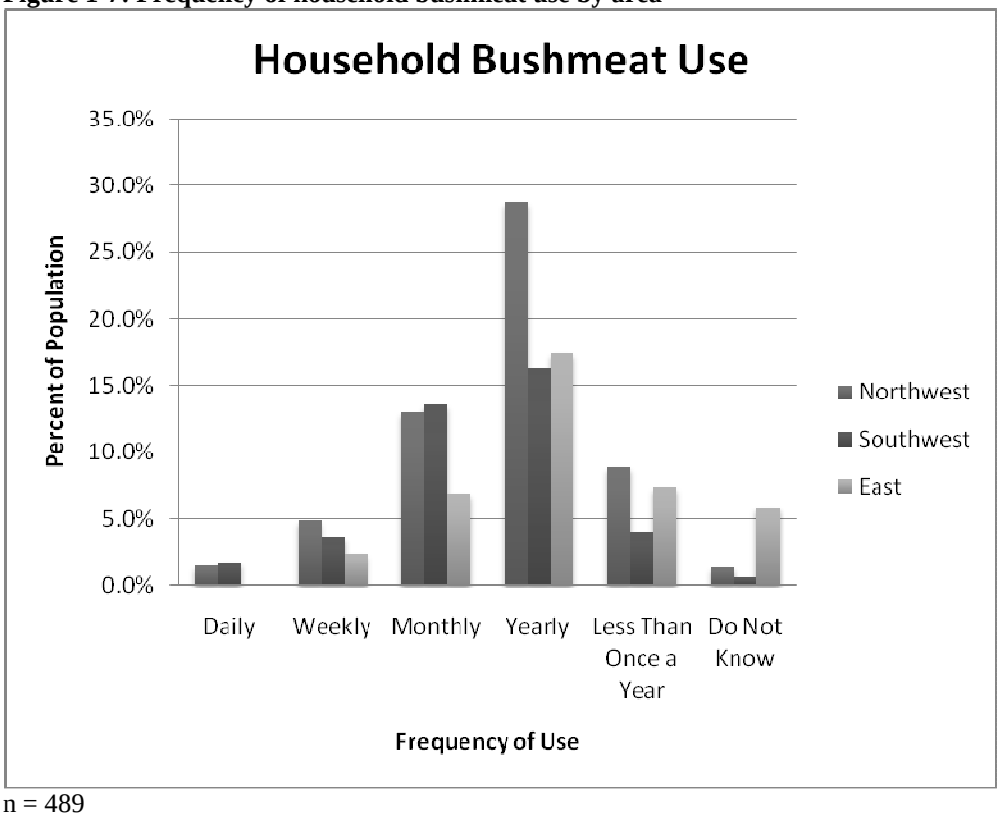
[18] The village leader group simply said conservation. What this equates to in terms of a livelihood is unknown, although likely refers to either engaging in the tourism industry or working for a conservation organization.

a yearly or more frequently basis. Despite the low usage, area and charcoal use had a statistically significant relationship (p-value = 0.038, n = 489). The East had the highest use at almost six percent. Those who were using charcoal were using it on a weekly, monthly, yearly, or less than yearly basis, no one used it every day.

Bushmeat Hunting

An estimated 35% of households used bushmeat at least once a year, although this estimate is likely a low estimate because of the illegal nature of bushmeat hunting. There were no statistically significant differences in bushmeat use among the areas (p-value = 0.117, n = 489). However, the Northwest had the highest bushmeat use with an estimated 48% of households using bushmeat at least once a year. Only 35% of households in the Southwest and 27% of households in the East had used bushmeat in the year prior to the survey. The most common frequency of bushmeat use was yearly (Figure 1-7). The differences in frequency of resource use among all areas were not statistically significant.

Figure 1-7: Frequency of household bushmeat use by area



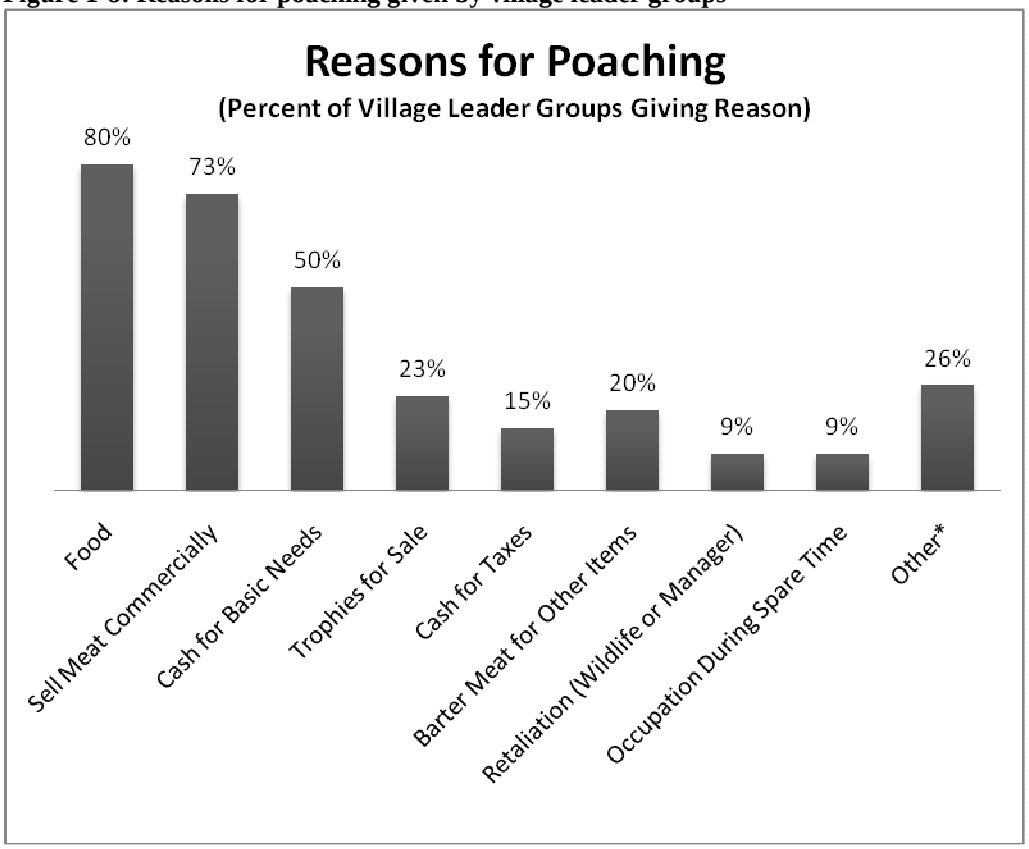
n = 489

Though most households did not report daily or weekly bushmeat use, bushmeat hunting is likely one of the most common natural resource livelihood strategies. Most households considered themselves farmers and/or livestock keepers, but poaching in some of these areas (especially the Northwest) is common (Loibooki et al. 2002; Hilborn et al. 2006; Knapp 2007). Because poaching is illegal it is not surprising that no one mentioned it as a household head occupation, and it makes gathering data on the importance of poaching to rural livelihoods difficult. To overcome this difficulty, we did not ask respondents directly if they were poachers, but asked respondents and village leaders to discuss poaching in terms of other people. Only 18% of village leader groups claimed poaching was an important activity for people in their village, while one village did not know. Interestingly, one village claiming poaching was important was located on the east side of the park, traditionally seen as "Maasailand" with little poaching and where 74% of the households were pastoralist Maasai. Their response may have been attributable to the poaching of lions (rather than bushmeat) since Maasai hunt lions for cultural reasons. However, when asked why their villagers need to poach the village leaders replied for food, contrary the conventional wisdom that Maasai do not eat bushmeat. Despite a reported lack of importance in most other villages, 95% of village leaders reported poaching happens on their village lands and in areas surrounding their village. Eighty-two percent of village leader groups claimed that the poachers were coming from their own village, while 91% said the poachers were coming from surrounding villages.[19] Just under a third of the village leader groups said the poachers were coming from larger towns (e.g. Arusha, Bariadi, Mugumu, Musoma). When asked why their villagers need to poach, the main three reasons were for food, to sell the meat commercially, and to get cash to meet basic needs (Figure 1-8).[20] Two village leader groups suggested their villagers poach in retaliation against crop damage or against protected area managers.

[19] Respondents could give more than one answer.

[20] Selling bushmeat commercially refers to selling bushmeat outside of the immediate area to larger demand centers such as Mugumu, Arusha, and Kenya and suggests a profession of bushmeat hunting. Using bushmeat as a means to obtain cash for basic needs refers to local, smaller scale selling of bushmeat done, not as a profession, but as a way to supplement household income.

Figure 1-8: Reasons for poaching given by village leader groups



*Other includes one village mentioning each of the following: tradition, poor education, and no reason. Village Leaders could offer more than one response.
n = 20

The SFTZ field team also asked the households about the poaching activities of others. Only an estimated seven percent of the population considered poaching an important activity for people in their village. Area and whether poaching is believed to be important had a statistically significant relationship (p-value = 0.004, n = 339), highlighted by the fact that the majority of the population believing poaching is important came from households in the Northwest and Southwest. Only 0.2% of people in the East believe poaching is an important activity for others in the village. Seven percent of the population did not know if poaching was an important activity, although this was higher in the Southwest with 11% of households not knowing if poaching was an important activity (Table 1-14). Despite the low level of households that believed poaching is an important activity in the village, when asked where poachers were coming from 69% of the population believed that poachers were coming from their own village and 66% of

households said that poachers were coming from neighboring villages (Table 1-15).[21] Area and households thinking poachers were coming from a neighboring village had a statistically significant relationship (p-value = 0.001, n = 195). Only 11% of households in the East thought poachers were coming from neighboring villages and they were less likely than the Northwest and Southwest to believe poachers were coming from their own village (although this difference was not statistically significant, p-value = 0.387, n = 195). Households in the East were more likely to think poachers were coming from larger towns and other areas (e.g. Kenya) than households in the Northwest or Southwest (Table 1-15). This difference was statistically significant for both larger towns (p-value = 0.044, n = 195) and for other areas (p-value = 0.010, n = 195).

Table 1-14: Percentage of people who believe poaching is an important activity for other villagers

Area	Not Important	Important	Do not know
Northwest	78.6%	12.8%	8.5%
Southwest	75.7%	12.8%	11.4%
East	96.7%	0.2%	3.1%
All areas	85.7%	7.4%	7.0%

n = 339

Table 1-15: Origins of the people poaching on village lands

Area	This village	Neighbor village	Larger town	Other*
Northwest	68.3%	79.4%	6.6%	9.2%
Southwest	80.4%	75.4%	2.0%	7.5%
East	49.3%	10.6%	19.3%	40.3%
All areas	69.3%	65.5%	7.2%	14.2%

*Other includes: Kenya, Uganda, and other regions, districts, and towns.
n = 195

Beekeeping

Beekeeping is potentially a sustainable solution to increase non-farm income from natural resources as well as a sustainable natural resource use for WMA villages and is mentioned specifically in the MKUKUTA poverty targets. However, only ten of the 489 households in our sample were currently producing honey and only 3% of households used beehives at least once a year. Village leaders in the Northwest and Southwest did not report beehives as an important source of cash for people in their village. Beehive

[21] Respondents could give more than one response and thus answers were not mutually exclusive.

use was highest in the East with 5% of households using beehives at least once a year, although the percentage of beehive use among areas is not statistically significant (p-value = 0.139, n = 489). Three of the households producing honey came from one village in the East, suggesting beekeeping may have already taken hold in one village. The village leaders of this same village ranked beekeeping as the third most important form of livelihood strategies for their villagers. The low number of beekeepers in the ecosystem may bode well for beekeeping projects because of the apparent lack of honey suppliers. However, the low number of beekeepers may also be an indication that beekeeping is not a desired or otherwise viable occupation and thus promoting such activities for conservation or development reasons will be difficult.

Natural Resource Management

The reliance households have on natural resources means that local people can be greatly harmed by stochastic environmental effects like drought. Local people are also at risk from overharvesting and overgrazing. Consequently, natural resources need to be managed in ways that promote sustainable natural resource. This section outlines the current institutions in place to promote sustainable use as well as discusses evidence of natural resource scarcity, giving an indication of the viability of sustainable natural resource use.

Village Land Use Plan

One of the beginning steps to sustainable resource use is to have a land use plan. A land use plan is part of the requirement for establishing a WMA. Land use planning is also encouraged under MKUKUTA to reduce negative impacts of development on the environment and people's livelihoods. Overall, only half of villages had land use plans for their village. The percentage of villages with a land use plan was lowest in the Southwest, with only a third of having a land use plan, while 50% of villages in the Northwest, and 80% of villages in the East had land use plans. Most of the existing land use plans were set up recently, between 2000 and 2006. However, three of my study villages had land use plans created before 2000, two in 1975 and the other in 1998.

Natural Resource Governance

It is up to villages themselves to govern the natural resources on their village lands. All twenty study villages, and thus presumably almost all villages in my study area, had a committee on natural resources and/or the environment. The role of these committees is to oversee the management of village natural resources. While having such a committee is the norm in my study area, the functionality of the committees (e.g. how often they meet, actions they take, etc), is unknown.

Some villages also had village level game scouts who play a role in antipoaching efforts in and around the villages. These positions are often unpaid and lack resources like radios, uniforms, and transportation. However, their job is to monitor for poaching on village lands, sometimes assisting the hunting companies with their antipoaching efforts. Most villages in the Northwest had village game scouts, they were nonexistent in the East, and were present in about a third of villages in the Southwest.

Natural Resource Scarcity

The SFTZ field team inquired about the species of plant or animal each household used for different natural resource uses, the species they prefered to use, and if there were any preferred species that were no longer available. The unavailability of preferred species may indicate overuse of those resources. While no resource had more than 20% of households reporting a scarcity, many resources were reported as scarce by approximately 10% of households. Wood resources including for firewood (for cooking and making local brew), wood for burning bricks, building equipment, and timber all had more than eight percent of households stating they could no longer find their preferred species, suggesting scarcity in wood resources. The differences in the reporting of scarcity of these resources among areas were almost all not statistically significant, but were predominantly reported as more scarce in the Northwest and Southwest. The higher reported scarcity in the Northwest and Southwest is likely because of the different house constructions used in the East and West, supported by the finding that building equipment scarcity had a statistically significant relationship with area (p-value = 0.0352, n = 438) with very few households in the East reporting scarcity (Table 1-16). Firewood for cooking was also statistically significantly more scarce in the Northwest and Southwest

(p-value = 0.039, n = 466). Preferred bushmeat species were not available for an estimated 12% of households, although bushmeat scarcity seems to be predominantly a problem in the Northwest where 18% of households reported no longer finding their preferred species (Table 1-16). The most commonly cited animal no longer available for bushmeat was buffalo (mentioned by 13 households). Eight households mentioned zebra, seven mentioned giraffe, six mentioned impala/gazelle, and five households mentioned eland. Four households mentioned rhino. Elephant, hippopotamus, topi, porcupine, warthog, klipspringer, and wildebeest were only mentioned by three or fewer households.[22]

Table 1-16: Percent of households no longer able to find their preferred species*

Area	Firewood for cooking (n = 466)	Firewood for local brew (n = 61)	Medicinal plants (n = 286)	Wood for brick building (n = 43)	Building equipment (n = 438)	Bushmeat (n = 202)	Timber (n = 19)
Northwest	20.5%	6.1%	17.6%	9.2%	14.6%	17.9%	36.7%
Southwest	25.7%	11.0%	12.7%	10.3%	12.1%	12.0%	50.0%
East	9.9%	22.1%	4.8%	0.0%	3.2%	7.4%	0.0%
All areas	17.0%	13.0%	9.6%	8.5%	8.4%	12.1%	15.1%

* Other resources were mentioned by 5% or fewer households and were also not statistically significantly different among areas, i.e. grazing grass 2.1% (n = 301), beehives 3.5% (n = 46), charcoal 0.0% (n = 12), grass for roofing 4.7% (n=301)

Income

Tanzania is one of the poorest countries in the world, with over a third of its population below the national poverty line. The majority of these poorest of the poor are in rural agricultural areas similar to those found in parts of the Serengeti ecosystem. The Tanzanian government has institutionalized poverty reduction through MKUKUTA and the adoption of the Millennium Development Goals. Obtaining baseline data on income and assets is essential for being able to describe trends and for knowing whether conservation projects, WMAs, MKUKUTA projects, or any other myriad of development actions improve the lives of rural Tanzanians. This section provides a snapshot of the current assets and income of the households in each area.

[22] Households could list more than one species.

Assets

The household questionnaire asked about each household's assets as a means of comparing the relative wealth of different areas. In subsistence communities households produce much of the food and other necessities they consume without buying or selling in a market. Income does not provide a complete picture of household wealth, and assets such as radios, cell phones, solar power, etc. may give a better picture of household wealth. Consumer durables including bicycles, radios, and cell phones provide the best indicators of wealth, though purchase of these goods is a function of both a desire for the item and the ability to pay for the item.[23] However, of these assets, only bicycle ownership showed a statistically significant difference among the areas (p-value = 0.000, p-values for radio = 0.253 and cell phone = 0.113, n = 488). Households in the East had statistically lower bicycle ownership than the Southwest and Northwest, possibly suggesting lower wealth in the East.

The remaining assets also suggest households in the East may be poorer, though again this maybe due to preferences for different goods rather than ability to purchase the goods. The Northwest and Southwest had higher percentages of farming assets than the East, but farming was also much more common and of a larger scale in the Northwest and Southwest. The Northwest had higher levels of electricity/cooking assets with statistically more kerosene and improved charcoal stoves (p-values = 0.000 and 0.004 respectively, n=488). The Southwest had more transportation assets with statistically more carts and bicycles (p-values = 0.043 and 0.000 respectively, n=488). None of the other assets were statistically different among the areas. No one had a boat, only one respondent owned a tractor (in the Southwest), and only one respondent owned a car (in the East). None of the areas had statistically significant amounts of power sources (generator or solar power) or water tanks, suggesting a lack of indoor plumbing and electricity (Table 1-17). These results underscore the impoverished conditions in Tanzania's rural villages.

[23] The asset index approach to measuring poverty is more complex than simply looking at one asset. Most often, a suite of assets are combined and weighted to generate a composite index that can be measured over time (e.g. Sahn & Stifel 2000; Bibi 2005; Booysen et al. 2008).

Table 1-17: Household assets throughout the Serengeti ecosystem

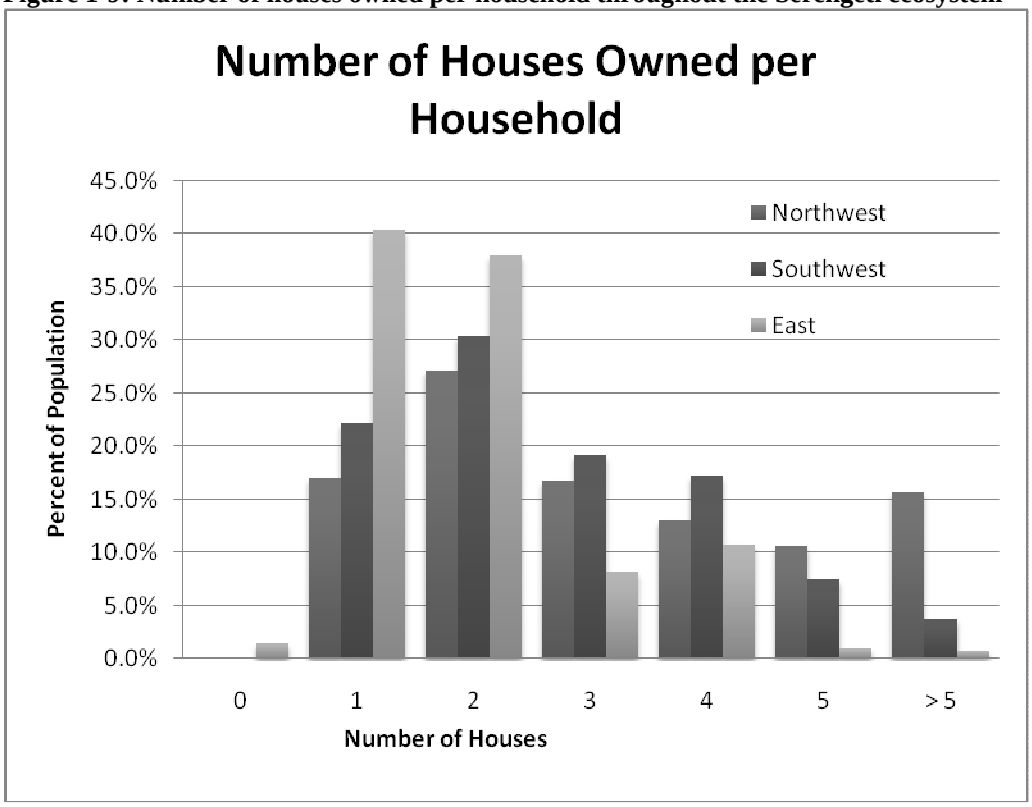
Category	Assets	Percentage of households having one or more of each asset			
		Northwest	***Southwest***	***East***	***All areas***
Farming:	Hoe	98.7%	97.3%	88.0%	93.4%
	Plough	50.8%	52.8%	46.5%	49.4%
	Wheel barrow	5.7%	6.1%	1.6%	4.0%
Transportation:	Cart	2.1%	17.0%	6.2%	8.4%
	Motorcycle	1.3%	0.8%	1.5%	1.3%
	Bicycle	57.1%	70.6%	19.4%	43.9%
	Car	0%	0%	1.4%	0.6%
Electricity / cooking:	Kerosene stove	16.6%	1.7%	3.6%	6.2%
	Improved charcoal stove	11.7%	2.1%	3.0%	4.9%
	Generator	2.0%	2.6%	1.4%	1.9%
	Solar power	0.3%	0%	1.9%	0.9%
Communication:	Radio	55.9%	49.8%	41.9%	47.7%
	Cell phone	10.1%	4.7%	11.3%	9.1%
Other:	Sewing machine	2.7%	2.2%	0.7%	1.6%
	Water tank	1.2%	1.2%	0%	0.7%
	Gun*	1.6%	0%	0.2%	0.5%
	Chicken coop	10.7%	13.1%	16.4%	14.0%

*Owning a gun is illegal without a permit and thus ownership may be underreported.
n = 488

Only one respondent did not have a house.[24] Most households owned one or two houses (Figure 1-9).[25] The mean number of houses for respondents in the Northwest was 3.3 (SE = 0.4). The Southwest had slightly lower house ownership at 2.8 (SE = 0.3) and the East had the fewest houses per household at 1.9 (SE = 0.1). The difference in the number of houses owned in the Northwest and East was statistically significant (p-value = 0.002, n = 488) as was the difference for the Southwest and East (p-value = 0.016, n = 488), but not for the Northwest and Southwest (p-value = 0.226, n = 488).

[24] The respondent was renting a house.
[25] Separate structures within a common area were counted as different "houses". It is common in rural Tanzania for one structure to house a kitchen and possible dining area / crop storage area and a second structure to house bedrooms and/or other "living" areas. It is also common for one wife to live in one structure and another to live in another structure.

Figure 1-9: Number of houses owned per household throughout the Serengeti ecosystem



n = 488

Housing Materials

Another possible indicator of household wealth is housing materials. However, some of the materials that suggest more expensive homes, e.g. walls of sheet metal, wood, or lime and stone were virtually nonexistent. For the most part, houses in each area were similarly constructed and variation among areas is likely due to the traditional methods for building houses. For example, 97% of the house walls in the East were mud and poles, which included cow dung, a traditional building method for Maasai. Overall houses were made from natural materials (rather than cement, metal, etc.) and my findings are similar to those of Harrison (2007), although our categories for house materials were different and so direct comparison is not possible.

Along with housing materials, the type of toilet gives an indication of household wealth (because of its suggestion of indoor plumbing). However, only two households, one in the Northwest and one in the East had a flush toilet. Just under half of the households had outdoor pit toilets, although this percentage is misleading because

households in the East predominantly did not have toilets (Table 1-18). Presence of a pit toilet and study area had a statistically significant relationship (p-value = 0.000, n = 487), highlighting the difference between the populations to the West of the ecosystem and those to the East. It is common in pastoral areas not to have a toilet and 82% of households in the East did not have a toilet. Only about a fourth of all households in the other two areas were without a toilet.

Table 1-18: Percentage of households without a toilet throughout the Serengeti ecosystem

Area	Percentage of households without a toilet
Northwest	27.4%
Southwest	27.4%
East	82.0%
All areas	52.5%

n=487

Income

Income is difficult to measure especially in the developing world where most people live subsistence livelihoods and do not earn paid wages.[26] Furthermore, even in developed countries income is difficult to gather because most people do not want to share exact income levels with interviewers. We therefore asked for income ranges for six areas: farming, livestock, natural resources (e.g. beekeeping, charcoal, etc), other activities (e.g. wage labor), other income (e.g. rental property, business owner, etc), and remittance (e.g. gifts or assistance from relatives). However, due to inconsistencies in how the SFTZ field team collected this data I chose to recalculate farming and livestock income from other questions in the household questionnaire. The inconsistencies arose in that some field team members asked respondents directly for the amount of income they received from farming and livestock while others calculated the income based on previous responses in the questionnaire. Furthermore, in calculating the incomes, some members asked the respondents for prices, while others calculated the income after the interview using prices given in the village resource questionnaire.

To determine farming income for each household I calculated the value of the household's agricultural harvest for the 12 months prior to our survey. Each household

[26] A subsistence livelihood is one in which the household produces only enough to meet household consumption.

reported units harvested per crop, which I then multiplied by unit price data to determine total farming income. The unit prices were reported village level prices for each crop taken from the village resource questionnaires (questionnaire – Appendix III, prices and price determination – Appendix V). The use of single-time reported prices given by village leaders limits the reliability of the absolute values of the income data. Prices for different crops fluctuate year round and thus selling crops at different times can yield very different incomes. However, the consistent method of calculating income does provide a means of comparing relative incomes across households. I assumed no crop inputs, including no irrigation, farming supplies or chemical use. Only four percent of land in sub-Saharan Africa is irrigated (FAO 2005). Only one person in our survey owned a tractor, supporting findings that mechanized agriculture in rural Africa is still low (FAO 2008). Average annual chemical fertilizer consumption in Africa is 10 – 15 kilograms per hectare, which is well below the use in every other area of the world.[27] Furthermore, most of this fertilizer is used on a few export crops, not on the subsistence crops that dominate the study area (Pinstrup-Andersen et al. 1999).

Determining livestock incomes was more difficult because livestock are in effect a savings account for rural Tanzanians. I ignored the "savings account" value of the livestock and sought to determined livestock income by examining the value of the livestock each household sold and the value of the products the livestock produced. Each household reported the number of animals they sold in the 12 months prior to our survey as well as the number of units they sold of animal products (i.e. eggs and milk). Using the price data collected at the village level from the village resource groups I calculated the income each household received from selling their livestock and animal products. I did not have data on the number of livestock bought and thus admittedly any livestock sold to buy more livestock were counted as income rather than considered as an equal swap. However, livestock are often sold for cash to purchase grains and food (especially during the dry season or drought) or to invest in land or small business, rather than sold to buy more livestock (Sieff 1999; Fratkin 2001; Ellis & Mdoe 2003). My calculation of

[27] For comparison, fertilizer use in the mid 1990s for East Asia was >216 kilograms / hectare, 77 kilograms / hectare in South Asia and 65 kilograms / hectare in Latin America (Bumb & Bannate 1996).

income also does not consider the "interest" gained by each household as their stock of livestock grows or the financial loss they suffer from the death of their livestock. Finally, if a household sold their entire herd they would appear to have substantial income, but this income would not be sustainable and household wealth would decline with the reduction in assets.[28] Therefore, as with the agricultural incomes, my calculation of livestock income is not a perfect representation of livestock income, but it provides a common measurement across households.

Caution should be applied in using the absolute value of the reported incomes for policy or assessment purposes. The assumptions I had to make in calculating farming and livestock income, along with the fact that other incomes were only reported as a range (and thus incorporated as averages of the range), highlights the shortcomings in the absolute income numbers. However, incomes were consistently measured or calculated across households and thus act as a relative indicator of income. Asset data suggested that the Northwest was the wealthiest area in the Serengeti ecosystem. However, the income data shows that the East was by far the wealthiest area. The average total individual income for the East was almost three times greater than in the Southwest and more than three times greater than the Northwest (Table 1-19). The differences between incomes in the East and the Southwest and the East and Northwest were statistically significant (p-value = 0.005 and 0.003 respectively, n = 480). However, the difference between the Northwest and Southwest was not statistically significant (p-value = 0.780, n = 480). Livestock generate higher incomes than agricultural products and given the predominance of pastoralism in the East their incomes should be higher. Individual livestock income was statistically higher in the East than in the Northwest and Southwest (p-value = 0.006 and 0.001 respectively, n = 489). However, the average agricultural income for individuals in the East was higher by more than a factor of three for the Northwest and incomes between the two areas were statistically different (p-value = 0.044, n = 489). Agricultural prices tended to be higher in the East, accounting for some of the difference. However, they were never as high as the three to one ratio between the

[28] No household in our survey sold off their entire herd in the 12 months prior to our survey.

Northwest and East (Appendix V). Furthermore, the Southwest often had the lowest agricultural prices, yet they have the second highest agricultural income.

Table 1-19: Average annual individual incomes in 2006 Tanzanian Shillings

Area	Average annual individual agricultural income in Tsh (SE)	Average annual livestock household income in Tsh (SE)	Average annual total* household income Tsh (SE)
Northwest	21,952 (4, 513)	34,739 (10,207)	75,819 (11,600)
Southwest	53,302 (17,362)	16,165 (5,444)	81,403 (15,921)
East	76,723 (24,765)	151,464 (35,304)	241,600 (47,118)
All areas	56,229 (13,662)	82,560 (17,263)	154,101 (25,442)

*Total income included agricultural, livestock natural resource products, employment, remittance and any other income mentioned by the household.
n (agricultural and livestock income) = 489, n (total income) = 480

Using an average conversion rate for my study period shows that the average individual makes less than a dollar a day at 2006 US $0.32.[29] Individuals in the East are best off at 2006 US$0.50 a day, though this is still half the dollar a day poverty line often used by development agencies. It is also less than the International Monetary Fund's poverty line for Tanzania, US 2006 $0.76 a day (Tanzanian Authorities 2000). Households in the Northwest and Southwest are even worse off with averages of 2006 US $0.16 a day and 2006 US $0.17 a day respectively.

Only individuals in the East made average monthly incomes above the 2006 basic needs poverty line of Tsh 7,739 as defined by the Tanzania National Bureau of Statistics (2002).[30] The monthly average income for individuals in the East was 2006 Tsh 20,133. The 2006 monthly average incomes for both the Southwest and Northwest were below the basic needs poverty line at Tsh 6,784 and Tsh 6,318 respectively. Furthermore, about three out of four households in the Northwest and Southwest have individual monthly incomes below the basic needs poverty line (Table 1-20). This is well above the Tanzania National Bureau of Statistics' (2002) finding that 39% of rural populations were below the basic needs poverty line.

[29] The average conversion rate or the study period was 1 US$ = 1332 Tanzanian shillings.
[30] The basic needs poverty line for the National Bureau of Statistics was 2001 Tsh 7,253. I used a 6.7% inflation rate given on their website to adjust to 2006 prices (National Bureau of Statistics 2009b).

Table 1-20: Percent of households with individual monthly incomes below the basic needs poverty line of Tsh 7,739 per month

Area	Percent of households with individual monthly incomes below the basic needs poverty line
Northwest	75.1%
Southwest	71.0%
East	26.3%
All areas	51.3%

n = 480

Although households in the East are much better off than those in the Northwest and Southwest, the income data suggests that some of Tanzania's poorest populations live around the Serengeti ecosystem. However, measuring of incomes varies and people may not be truthful in revealing their actual incomes.[31] Regardless, poverty in the Serengeti ecosystem appears prevalent.

Income from Natural Resources

Natural resources do not make up a large proportion of income in these areas. Only five percent of households received income from natural resources, making up an average of two percent of total household income. The Northwest had the highest contribution of natural resources to income at 3.6%. The Southwest had 2.4% of income coming from natural resources and the East only averaged natural resources contributing one percent of total income. There was no statistical difference in the mean natural resource income of the three areas (p-value = 0.263, n=459). However, for households receiving income from natural resources, its contribution to total household income was considerable at 38%. My analysis cannot definitively determine what makes up this natural resource income and it is possible the income comes from poaching, illegal fuelwood collection, or some other resource use that is of conservation concern. The small role of natural resources in rural income is problematic for meeting MKUKUTA goals that promote an increase in rural incomes through sustainable natural resource use. The household data suggests there is significant room to increase natural resource incomes in rural communities.

[31] Individuals may lie in the hope of getting assistance, in fear of getting taxed, or to hide illegal money (e.g. bushmeat sales).

Our village level data on natural resource income contributions points out the more important of the natural resources for obtaining household cash. The SFTZ field team asked village leaders to rank the following natural resource sources of household cash in their order of importance: charcoal, game meat, medicinal plants, timber building poles, thatching grass, firewood, beehives, and alcohol. Table 1-21 gives the incident index for each cash source. The incident index shows the proportion of respondents that identified a particular cash source as important. A value of zero indicates no village mentioned the cash source, a value of one indicates everyone mentioned the cash source as important. Overall, village leaders mentioned thatching grass, charcoal, and medicinal plants the most. Two of these sources of cash, charcoal and medicinal plants, were only considered important in the Northwest and Southwest, along with game meat, timber and alcohol. Village leaders in the East cited building poles and firewood (along with thatching grass) as common cash sources, with most leaders ranking these cash sources as the top three most important. While charcoal was a commonly cited cash source in both the Northwest and Southwest, only a third ranked it in the top three most important cash sources. Medicinal plants were listed as one of the top three most important sources of cash by half of the villages in the Northwest and Southwest. Two villages, both in the Northwest ranked bushmeat as the most important source of cash for villagers.

Table 1-21: Incidence index of the importance of natural resources as a source of household cash

Natural resource	Area			
	Northwest	Southwest	East	All areas
Charcoal	0.67	1.00	0.17	0.61
Game meat	0.50	0.83	0.00	0.44
Medicinal plants	0/67	1.00	0.17	0.61
Timber	0.50	0.67	0.17	0.44
Building poles	0.33	0.50	0.83	0.56
Thatching grass	0.50	0.83	0.83	0.72
Firewood	0.33	0.67	0.67	0.56
Beehives	0.17	0.17	0.67	0.33
Alcohol	0.50	0.67	0.33	0.50

Education

Building primary schools and promoting education has been one of the main conservation actions of community-based conservation in Tanzania. This has likely

helped raise Tanzania's literacy rate to 69%, which is above the average literacy rate of both sub-Sahara Africa and low-income countries (59% and 61% respectively; see World Bank 2008). Tanzania also has higher gross primary enrollment than both the average of sub-Sahara Africa and the average of low-income countries (World Bank 2008). Despite these achievements, improving education is still integral to conservation and poverty alleviation. The following section discusses the state of the village schools and average education levels in the ecosystem.

Education Facilities

The SFTZ field team interviewed a head primary school teacher in each village and asked the village resource groups about distances to primary and secondary schools. Every village in this study had at least one primary school, with sixty-two percent of villages having more than one school. Only a quarter of villages had a secondary school at the time of our survey; however, the average distance students traveled to these secondary schools that were within the villages was 14 kilometers (SE = 3.4). The overall average reported distance for students from villages to a secondary school was 23 kilometers (SE = 6.9) ranging from two to 125 kilometers. Distances were shortest in the Northwest with an average of 10.5 kilometers (SE = 3.7). The Southwest averaged 14.8 kilometers (SE = 4.9) and the East had the longest average distance at 61.3 kilometers (SE = 29.1). Despite the lack of secondary schools and the consequent long distance students must travel, only nine percent of villages listed a lack of secondary schools as a village problem.

Although each village had a primary school, not every student attends. Average enrollment was 80%, with highest enrollment in the Southwest and lowest in the East (Table 1-22). Primary schools host grade levels Standard 1 – 7. Schools in both the Southwest and East had fewer classrooms than grade levels, at six classrooms each. Both areas also had fewer average teachers than grade levels with an average of six teachers in the Southwest and five in the East. The teacher shortage may be partially caused by a lack of teachers' housing. Southwest primary schools averaged only one teacher house. The Northwest had a higher number of classrooms, teachers, and teacher houses, possibly due to the larger role conservation programs have played in the area. These findings are

similar to those of Harrison (2007) who found a teacher student ratio of 1:60, compared to my results of an average ratio of 1:85.

One area of concern for education is the number of latrines available to students, particularly for female students who begin menstruation in the later years of primary school. Without private latrines, female students can become uncomfortable continuing their education. At the time of the study, the Northwest had three quarters of a male and female latrine per hundred students. The Southwest and East both had just over half of a male and female latrine per hundred students.

Table 1-22: Primary school characteristics throughout the ecosystem

Area	Average school enrolment (SE)	Average school attendance as a % of total enrollment (SE)	Average number of classrooms (SE)	Average number of teachers (SE)	Average number of teacher houses (SE)	Average number of latrines (SE)	
						Male	Female
Northwest	563.9 (87.0)	80.5% (2.0)	8.1 (0.8)	8.1 (0.9)	3.9 (1.2)	4.4 (0.4)	4.0 (0.4)
Southwest	650.1 (58.0)	82.2% (8.0)	5.8 (0.5)	6.3 (0.6)	0.9 (0.4)	3.4 (0.5)	3.8 (0.5)
East	418.5 (43.0)	76.6% (2.3)	6.3 (0.6)	5.4 (1.0)	3.3 (0.6)	2.5 (0.7)	2.3 (0.7)
All areas	**555.3 (41.3)**	**80.0 (3.4)**	**6.5 (0.3)**	**6.5 (0.5)**	**2.4 (0.4)**	**3.4 (0.3)**	**3.4 (0.3)**

n = 23

Education Levels

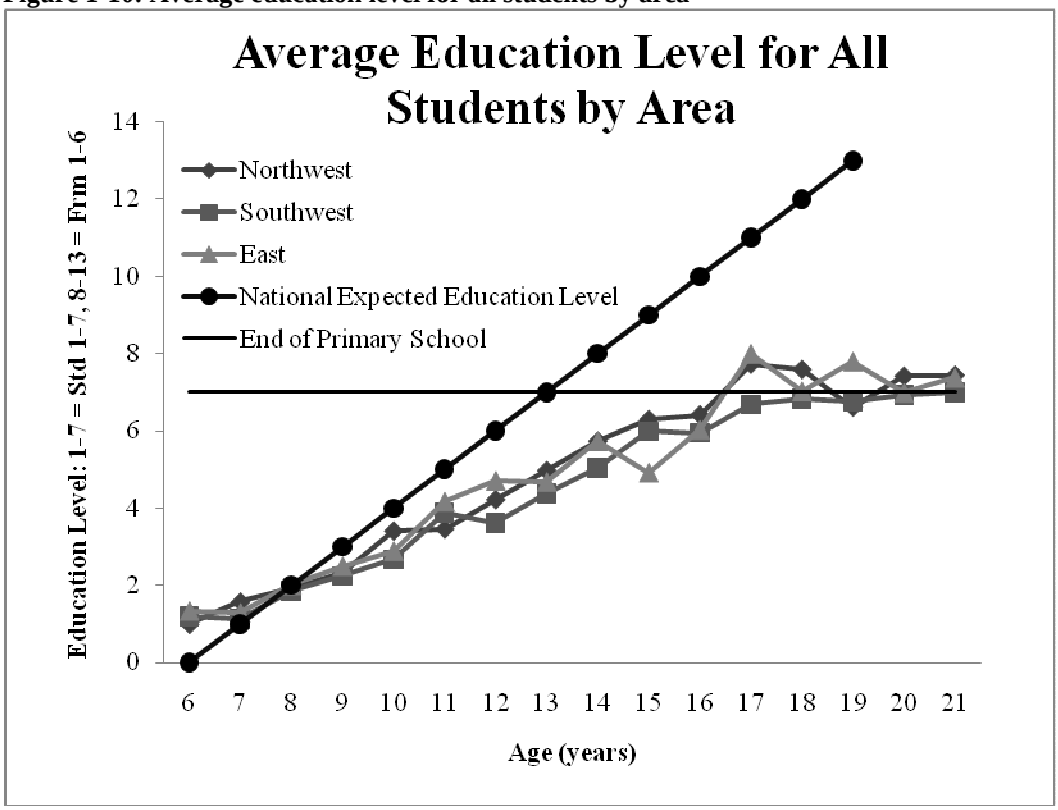
Education levels for adults are low in the villages. The average household head had four years of education (SE = 0.3). Household heads in the Southwest had the most years of education with 4.3 years (SE = 0.3). Northwest households heads had an average of 4.2 years (SE = 0.5) and household heads in the East had an average of 3.9 years (SE = 0.6). These differences are not statistically significant (p-value = 0.598, n = 471). Almost 40% of the adult population had no education. Fifty-four percent of respondents had some amount of primary school (from 1 to 7 years), while only six percent had some secondary school and only one percent had an education beyond secondary school. Male respondents had statistically significant more education than females with means of 4.7 and 3.4 years respectively (p-value = 0.007, n = 471).

The SFTZ field team also collected data on the education level of other household members. The Tanzanian education system begins at age seven with Standard 1. Primary school goes from Standard 1 to Standard 7. Secondary school "should" begin at age 14 with Form 1 and go through Form 6. Seventy-three percent of the children in this age group (i.e. 7 – 19) were in school in my study area. The Southwest had the highest percentage at 77%, the Northwest had 74% of its school age children in school and the East had 69% in school. However, there was no statistically significant relationship between area and whether students are in school (p-value = 0.307, n = 1199). These numbers are lower than those reported by Harrison (2007) for the Northwest and Southwest, but consistent for the East.

Although a seemingly high percentage of children are in school and despite the presence of primary schools in every village, students around the Serengeti ecosystem were not reaching their full education potential. Children in all areas were beginning school on time, but within two years the students were behind the national school level for age expectation. The gap only widened as the students got older with students around the Serengeti ecosystem diverging from the national expected trend at the end of primary school. For the most part children were only getting a primary school education (Figure 1-10). [32]

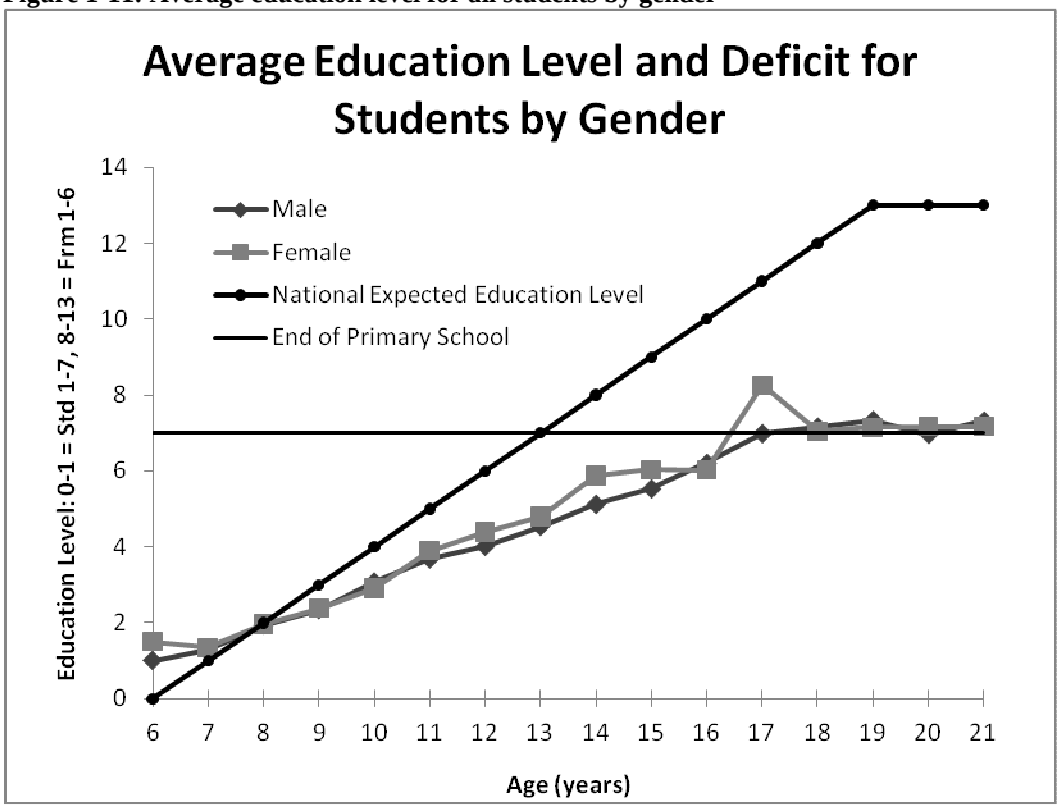
[32] My sample size is only 4 -51 students for each age/area.

Figure 1-10: Average education level for all students by area



There was not a large difference between male and female students. At age 19, when a student who met the expected levels of education would be in their last year of secondary school (Form 6), the average education level for both males and female was Standard 7. However, the maximum average grade level reached by females was Form 1 (8.3 years) at age 17, while the maximum for males was Standard 7 (7.3 years) at age 19. There is often a concern that females will stop going to school around the age of puberty, especially without private toilets. While the number of toilets was low, there was no dip in the average level of education for females through the puberty years (Figure 1-11).

Figure 1-11: Average education level for all students by gender



Although children in the Serengeti ecosystem suffer significant education deficits, overall education in the area is better than for the average rural Tanzanian as reported in the 2000/2001 Household Budget Survey of over 22,000 hosueholds around Tanzania (National Bureau of Statistics 2002). Eighty-four precent of the 7 – 13 year olds in the ecosystem were in primary school, compared to the national rural average of 56%. This number for the ecosystem is even greater than the urban average of 71%. Furthermore nine percent of 14 – 17 year olds were in Form I – IV, compared to a national rural average of 2%.

Wildlife Management Areas

Wildlife management areas are Tanzania's newest governmental form of community-based conservation. The Serengeti ecosystem had two WMAs in process at the time of this study, one in the Northwest involving the villages of Robanda and Nata Mbiso and one in the Southwest involving the villages of Iramba Ndogo, Mbushi, and

Sapa. As of January 2010, the WMA in the Northwest is operational and the WMA in the Southwest is close to functioning. Evaluating these WMAs and the role they play in conservation will require longitudinal data, although the data from this study provides a good baseline for future evaluations of project success. None of the WMAs were functioning at the time of this study and thus none of the villages were receiving income through the WMA. However, the villages in my study that were part of the proposed WMAs likely had more governmental and nongovernmental interest, some villages were likely courted by investors, and the villages involved in the WMA process were in areas with the best access to wildlife.

I have compared all of the household variables between those villages in the Northwest and Southwest that were part of a WMA and those villages not part of a WMA. Very little statistical difference exists, although some of the results in the data show a few interesting differences between WMA and non-WMA villages. These interesting differences appear in WMA household livelihoods and natural resources. These results are important to keep in mind once the WMAs are fully functional and their success evaluated.

Livelihoods

The livelihoods of households in WMA and non-WMA villages are very similar. One area of interest for conservation is immigration. Conservationists worry that benefits will act as a magnet and draw people toward protected areas. At the inception of the WMAs, WMA villages and non-WMA villages had similar number of immigrants , with 34% of respondents being born in their current village of residence compared to 24% for non-WMA villages (p-value = 0.198, n=0.342). Reasons for immigration were also similar for WMA and non-WMA villages (p-value = 0.143, n=253) with cultivation/grazing and family/marriage as the predominant reasons. Therefore, as of the start of the WMAs, people were not moving into WMA villages to reap the benefits of conservation. If WMA villages see a rise in their immigration rates after a few years of WMA implementation, especially if immigrants admit to immigrating for conservation benefits, then conservationists will have cause for concern over protected areas acting as magnets for immigration.

While household heads in both WMA and non-WMA villages are predominantly agropastoralists, more non-WMA household heads are livestock owners compared to WMA household heads (36% verses 19%, p-value = 0.024, n = 342). Livestock are a savings account, suggesting a higher number of non-WMA households have more "in the bank". However, the only livestock difference for WMA and non-WMA villages was chicken ownership. Non-WMA households owned a statistically significant higher percentage of chickens than WMA households, 83.5% versus 62.9% (p-value = 0.027, n = 341). Chickens are not very valuable "savings" and consequently, they likely were not making non-WMA households significantly better off. This is supported by my findings that households in WMA and non-WMA villages alike have similar assets, own similar numbers of houses, use similar building materials, and have similar incomes.

Natural Resources

One goal of WMAs is to increase income from natural resource use. However, at the onset of these areas, WMA households were already earning an annual average of 2006 Tsh 21,770 from natural resources, while non-WMA households only earn an annual average of 2006 Tsh 3,847. This difference in income, however, is not statistically significant (p-value = 0.184, n = 333). The mean percentage of overall income coming from natural resources is 6.1% for WMA households compared to only 1.2% for non-WMA households (p-value = 0.133, n = 333). Although not statistically significant, these results suggest more income from natural resources in WMA villages (the percentage of households earning natural resource income is almost the same at three percent and four percent for non-WMA and WMA households respectively). The higher incomes from natural resources in WMA villages may be because their natural resources are in better shape. My data suggest that preferred species for a variety of natural resource uses are more scarce for non-WMA villages (and thus the species they are forced to use are potentially lower quality and thus worth less). The higher incomes may also stem from charcoal or bushmeat consumption, both of which were more frequent in WMA villages, providing more demand for the resources and thus more income for the suppliers.

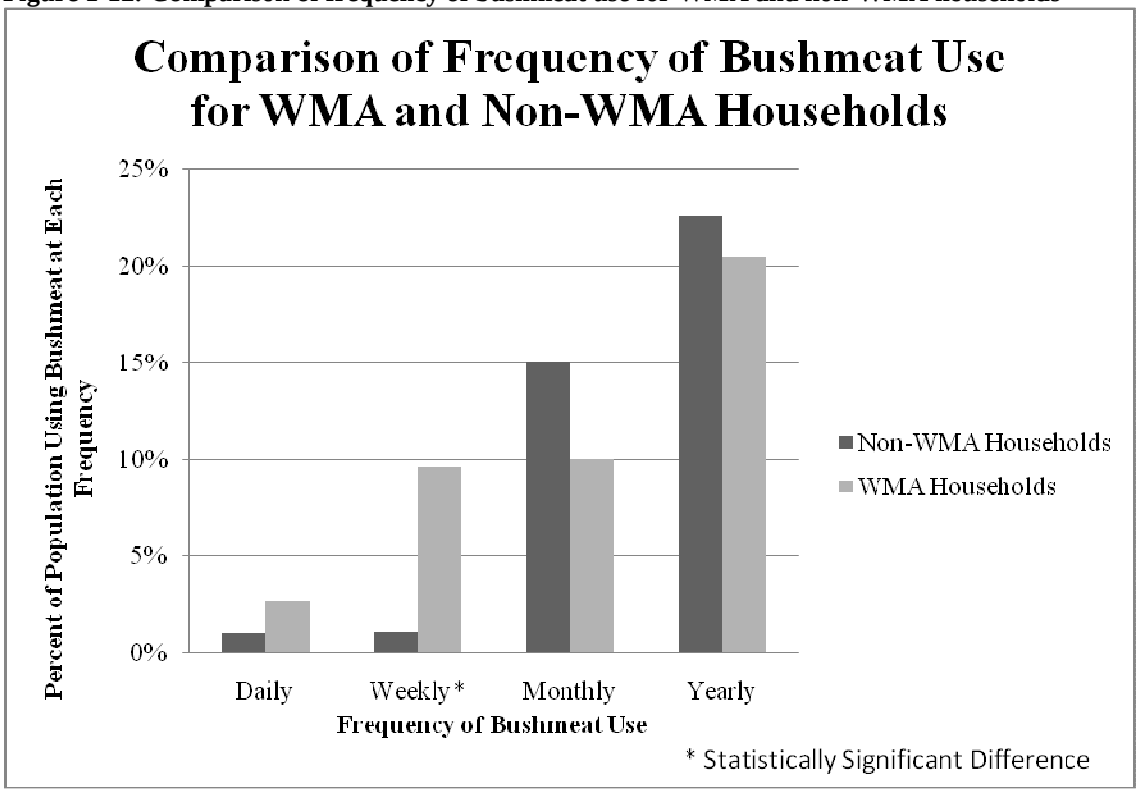
For almost all natural resources, non-WMA villages have a higher percentage of households unable to use their preferred species, although in most cases the differences in reported resource scarcity were not statistically significant between WMA and non-WMA villages. However, two natural resources, roofing grass and building equipment, were statistically significant. Resource scarcity and WMA status had a statistically significant relationship (p-value = 0.047 and 0.000, n = 271 and 299 respectively). For these two natural resources, non-WMA households have a higher percentage of households reporting a problem in finding their preferred species, supporting the trend seen in the other natural resources. The WMA villages either had higher levels of resources to begin with or they may be managing their resources better already, hence the lack of scarcity, possibly making them more inclined to participate in a WMA.

Income from charcoal may generate some of the difference between WMA and non-WMA villages. WMA status and charcoal use had a statistically significant relationship (p-value = 0.024, n = 342) with 2.4% of households in WMA villages using charcoal, mostly on a weekly basis, but also on a monthly or yearly basis, and no one using charcoal in non-WMA villages. There is a statistically significant higher number of improved charcoal stoves in WMA villages with 12.7% of WMA households owning an improved charcoal stove and only 3.1% of non-WMA household owning one (p-value = 0.028, n = 341). The use of charcoal is an important indicator to watch as the WMAs progress and presumably bring more income to households. With higher incomes more households will be able to afford better cooking assets. The switch from firewood to charcoal is a common first step. However, the switch from firewood and charcoal is a concern for conservation because of continued or increased deforestation. In some countries, as incomes have improved and charcoal demand has grown, deforestation has become pervasive (Hofstad 1997; Beukering et al. 2007). Conservationists should try to help villages skip charcoal stoves and move directly into kerosene and electric cooking stoves.

Bushmeat may also account for the higher natural resource income. Around 40% of both WMA and non-WMA households were using bushmeat at least once per year with (p-value = 0.789, n = 343). However, it does appear WMA households are using

bushmeat more frequently, with 9.6% of households using it on a weekly basis compared to only 1.1% of non-WMA households using it on a weekly basis (p-value =0.007, n = 343). There was no statistically significant difference between WMA and non-WMA households in the percentage of households using bushmeat on a daily, monthly or yearly frequency (Figure 1-12). There are also no differences in WMA status and poaching. In both areas just over ten percent of people believe poaching is an important activity for people in their village (p-value = 0.425, n = 246). Sixty-six percent of WMA households believe poachers are coming from their own village, while 78% of non-WMA households believe poachers are coming from their own village. The difference however is not statistically significant (p-value = 0.453, n = 172), but shows that households in both areas believe others in their village are poaching.

Figure 1-12: Comparison of frequency of bushmeat use for WMA and non-WMA households



WMAs seek to have sustainable use of wildlife resources and one such use that is commonly cited is beekeeping. Beekeeping did not play a role in natural resource incomes. None of the WMA villages have households that used beehives at least once a year.

Conclusion

The current state of livelihoods and natural resource use in the Serengeti ecosystem suggests households throughout the area can benefit substantially from conservation and development projects. Households are generally poor, subsistence agropastoralists or pastoralists, with only primary level educations and a high reliance on natural resources in the ecosystem. As WMA and MKUKUTA policies fully take effect in the ecosystem, these policies have the potential for significant impacts, although not all these impacts will likely be positive. Continued socioeconomic and natural resource use monitoring can evaluate these polices, assess the impacts, and possibly help mitigate negative consequences.

Natural resources are integral to the daily lives of people throughout the ecosystem. Virtually everyone is a subsistence farmer and the majority of people are livestock keepers, using village lands for the agriculture and grazing. Almost all households use firewood for cooking on a daily basis. Thirty-five percent of households admitted to using bushmeat at least once a year, thought other studies suggest this number is likely much larger (Loibooki et al. 2002; Hilborn et al. 2006; Knapp 2007). However, use of these natural resources can be a threat to conservation because of land conversion, deforestation, and bushmeat hunting (Homewood et al. 2001; Loibooki et al. 2002; FAO 2006; Hilborn et al. 2006). Furthermore, non-farming and non-grazing natural resources are not currently contributing significantly to rural incomes. Only 5% households were receiving income from other natural resources. Both MKUKUTA and WMA policies aim to increase rural incomes derived from natural resources.

Wildlife management areas and MKUKUTA seek to alter current livelihoods such that they promote sustainable resource and increase rural incomes. Beekeeping is the most commonly cited example of how rural communities can have sustainable natural resource use and income generation. However, virtually no one in the ecosystem is engaged in beekeeping and in the current WMA villages, no on uses beehives. Furthermore, institutional arrangements to promote sustainable use (e.g. land use plans) are not ubiquitous, and resource scarcities may already be occurring in villages.

Seventeen percent of households can no longer find their preferred fuelwood species and 12% of households can no longer find their preferred bushmeat species.

The most commonly used natural resources, land for agriculture and grazing are the predominant reasons for immigration, especially in the west of the ecosystem. These immigration trends are problematic for conservation in that increasing human populations leads to increasing demand for other natural resources like firewood and bushmeat. As immigration increases, the density of people, number of livestock, scarcity of agricultural land, and human-wildlife conflict will likely increase. Wild animals killed cows in over a fifth of households and killed shoats in just under a third of households. These conflicts fuel animosity toward wildlife and prevent households from escaping poverty because household wealth is often stored in livestock. Consequently, livestock loss is a loss to household savings.

One positive result from the immigration data is that despite the benefits from conservation provided by protected area managers as well as tourist hunting and photographic safari companies, people are not moving into the ecosystem to capture these benefits. As the WMAs in the ecosystem become fully functional and successful, people may see the benefits these villages capture from conservation and without proper immigration policies, immigration for conservation benefits may become a problem. However, if MKUKUTA and other poverty alleviation policies work in tandem with WMAs, improved incomes and livelihoods throughout Tanzania can prevent the benefits of WMAs from attracting immigration.

Other aspects of MKUKUTA and other poverty alleviation programs will likely benefit the villages in the Serengeti ecosystem. The households in the ecosystem are poor and people have much to gain from poverty assistance. With the low levels of paid employment and subsistence livelihoods, income generating activities have the potential to significantly contribute to rural incomes. Continued education assistance has the potential to improve the quality of education and to overcome the current plateau of education levels at a primary education. Poverty alleviation goals aimed at improving basic needs like electricity and indoor plumbing can drastically improve rural livelihoods, removing the need to travel long distances for firewood and water.

As important as all these outcomes are, poverty alleviation will provide new challenges to conservation and continued monitoring of household socioeconomics and natural resource use is imperative to navigate these challenges. As incomes increase, households will likely increase their use of charcoal, bushmeat, and possibly other natural resources. However, if incomes rise further, households may switch to kerosene stoves and consumption of domestic meat. How exactly the rise in income will affect resource use is unknown and thus monitoring incomes and resource use over time is vital in identifying and mitigating any negative consequences to conservation from improvements in rural livelihoods. Similarly, as livelihoods improve, there will likely be a switch to large scale agriculture and the use of fertilizers, herbicides, pesticides, and irrigation. The costs of this switch could be significant. In Kenya the switch to large scale agriculture decreased the wildebeest population by 75% (Homewood et al. 2001). Conservation managers need to be mindful of this switch to mechanized agriculture and large scale farming and conservation and development projects should aim to assist in the production and marketing of smaller scale, organic agricultural products.

The Serengeti ecosystem is an internationally recognized wildlife asset and the villages in the ecosystem are in the quintessential area for uniting conservation and development. However, these goals do not necessarily work in tandem and maneuvering through the tradeoffs in conservation in development is a key challenge for Tanzania. Understanding the daily lives and livelihoods of people in the Serengeti ecosystem is an important step in being able to manage conservation and development policies. While my study only provides a one-time snapshot of data on the socioeconomics of the ecosystem, it does show that the current state of the ecosystem could greatly benefit from improved poverty alleviation and conservation measures. Long term socioeconomic monitoring is necessary to assist in the monitoring and evaluation of how WMAs, MKUKUTA, and other conservation and development policies interact and affect local people, their lives, and the natural resources in the ecosystem.

Chapter 2: Decisions about conservation: understanding the costs and benefits of conservation facing local people around the Serengeti ecosystem, Tanzania

(with Stephen Polasky)

Local people living near protected areas can either be a threat to conservation or allies in conservation. Whether they take actions consistent with conservation or detrimental to conservation depends on the costs and benefits associated with each action. Conservationists and protected area managers have implicitly tried to alter the cost-benefit structure facing local people. The fences-and-fines approach to conservation imposes costs on local people for illegal natural resource use. Community-based conservation provides benefits from conservation to local people. This chapter examines the current costs and benefits of the actions of local people to determine if conservation policies have had any influence on the decisions and actions of local people in the Serengeti ecosystem. We analyzed household surveys that reported on knowledge of protected areas and the costs and benefits from wildlife and protected areas in the Serengeti ecosystem. The results show little evidence that conservation polices have altered costs and benefits to local people or actions affecting conservation. Over two-thirds of households were unaware of the existence of Serengeti National Park or other protected areas. Less than half of the population reported receiving benefits from conservation and the benefits local people report receiving are ineffective at changing behavior. Benefits from conservation are often provided at the village, not individual, level. However, the costs of human-wildlife conflict are widespread. Further, the benefits from illegal resource use appear to exceed the costs. The evidence suggests current conservation polices are not sufficient to alter the costs and benefits facing local people or change the behavior of local people in ways more favorable to conservation. To alter the costs and benefits will require greater resources than have been devoted to date, better communication between local people and managers of protected areas, and more focus on making benefits conditional on conservation performance.

Introduction

Local people living near protected areas are part of their ecosystem, making them key players and potentially key allies in conservation. Local people interact with the wildlife and the ecosystem on a daily basis, using natural resources as part of their livelihoods. Village lands and surrounding protected areas provide wood for cooking, charcoal, and building materials. The ecosystem provides land for crops, food for livestock, and water for the people and livestock. For many households, the wildlife provides a key source of protein (Barrett & Arcese 1998; Barnett 2000). In several areas, local people have co-existed with the ecosystem for hundreds or thousands of years. They have intimate knowledge of the landscape and wildlife. They have a sense of local pride and ownership and in some instances can effectively monitor natural resource use, enforcing local access and keeping out outsiders. Ignoring these interactions between people and the ecosystem ignores the heart of the conservation problem. Local people are intertwined with the ecosystem and conservation plans that ignore their role are unlikely to succeed.

Actions chosen by local people help determine the success or failure of conservation. Decisions about whether to hunt, grow crops, harvest fuelwood, or raise livestock impact the ecosystem. How and why humans make the decisions they do is a topic of debate among many disciplines. Economists focus on "rational choice" in which individuals or households make decisions to maximize their utility. Alternatives are evaluated based on the consequences they have in relation to the decision maker's preferences. March (1994) points out that rational choice theory matches with the way people usually explain their decision; that is, they choose alternatives that they claim make them better off. Even if individuals face uncertainty and do not know all the alternatives, rational choice theory contends individuals still maximize their utility based on the information they have (Mas-Colell et al. 1995). In a narrow interpretation of rational choice theory, individuals are assumed to be interested only in their own welfare and their behaviors are explained by tangible constraints such as money, rather than intangible constraints such as social approval (Opp 1999). In this sense, rational choice

theory fails to incorporate "irrational" behaviors such as those done out of duty, obligation, and altruism (Elster 1989). Alternatives to rational choice theory have emerged that broaden rational choice theory to include all preferences and constraints (e.g. altruistic preferences and social norms that constrain behavior) (Opp 1999). One such alternative is the notion of "bounded rationality" that highlights the fact that people have incomplete knowledge of alternative decisions and limited computing ability for making decisions (Simon 1997). Other approaches take a more "normative approach" to decision making focusing on how traditions, cultures, and other social institutions guide behaviors (Bell et al. 1988; Ellis & Thompson 1997; Ostrom 1998; Brocas & Carrillo 2004). Furthermore, psychologists debate rational choice theory, pointing out evidence that shows people do not behave as they are maximizing their expected utility (Kahneman et al. 1982). In this paper we will focus on rational choice whereby people make decisions based on material costs and benefits. Material costs and benefits refer to tangible costs or benefits, rather than the broader definition that would incorporate all things people value including emotional or spiritual factors.

Local people can make decisions that lead to actions that are beneficial for conservation. However, they can also engage in actions that are harmful for conservation. For example, an individual can choose to bushmeat hunt, which yields immediate benefits to the individual, but contributes to the long-run decline in wildlife populations. Alternatively, an individual can choose not to bushmeat hunt, forgoing immediate consumption benefits. Over the longer run, the individual may benefit from the tourism money provided from sustainable wildlife populations. Although not always explicitly stated, altering the costs and benefits has been at the heart of conventional conservation policies with practitioners aiming to affect local people's decisions through changing costs and benefits.

The fences-and-fines approach to conservation emphasizes increasing the costs for actions detrimental to conservation through mechanisms such as fining individuals for bushmeat hunting. These policies seek to minimize or eliminate the net benefits of illegal natural resource use. Community-based conservation emphasizes increasing the benefits local people receive from conservation through mechanisms such as monetary payments

provided from tourist income. By providing benefits, community-based conservation aims to help local people realize a net benefit from conservation. In principle, either strategy could dissuade individuals from harmful actions like bushmeat hunting. What is important for promoting conservation actions is whether the net benefits to an individual from conservation are greater than the net benefits to an individual of illegally using natural resources.

Both fences-and-fines and community-based conservation policies have been practiced for decades, yet land conversion and illegal natural resource use by local people remain major threats to conservation (Sinclair & Arcese 1995b; Hackel 1999; Homewood et al. 2001). We will examine why conservation policies have not had more success in altering the decision making and actions of local people around the Serengeti ecosystem.

Study Area

The Serengeti ecosystem is a world-renowned iconic area centered on the Serengeti National Park. A multitude of governmental, private, and non-governmental organizations have promoted conservation in the Serengeti ecosystem for decades through both fences-and-fines and community-based conservation policies. The Serengeti ecosystem encompasses Serengeti National Park at its core, game reserves (Grumeti, Ikorongo and Maswa), Loliondo Game Controlled Area, and the Ngorongoro Conservation Area. The ecosystem also includes over one hundred villages that surround these areas, and in the case of the game controlled area, are contained within the area. The various protected areas around the ecosystem are set up to promote conservation through restrictions on natural resource use and these restrictions vary depending on the area designation. Serengeti National Park has the most restrictions on natural resource use, prohibiting all consumptive uses including settlement, grazing, fuelwood collection, and hunting. The three game reserves lining the western edge of the park prohibit all forms of natural resource use except hunting. Hunting companies can obtain exclusive rights for hunting in areas that have been designated as a hunting block. Local people are not allowed to hunt in these areas. In Loliondo Game Controlled Area to the east of the park all natural resource uses are allowed except unpermitted hunting. This area is also a hunting block and thus one company and its clients have the user rights for hunting in the

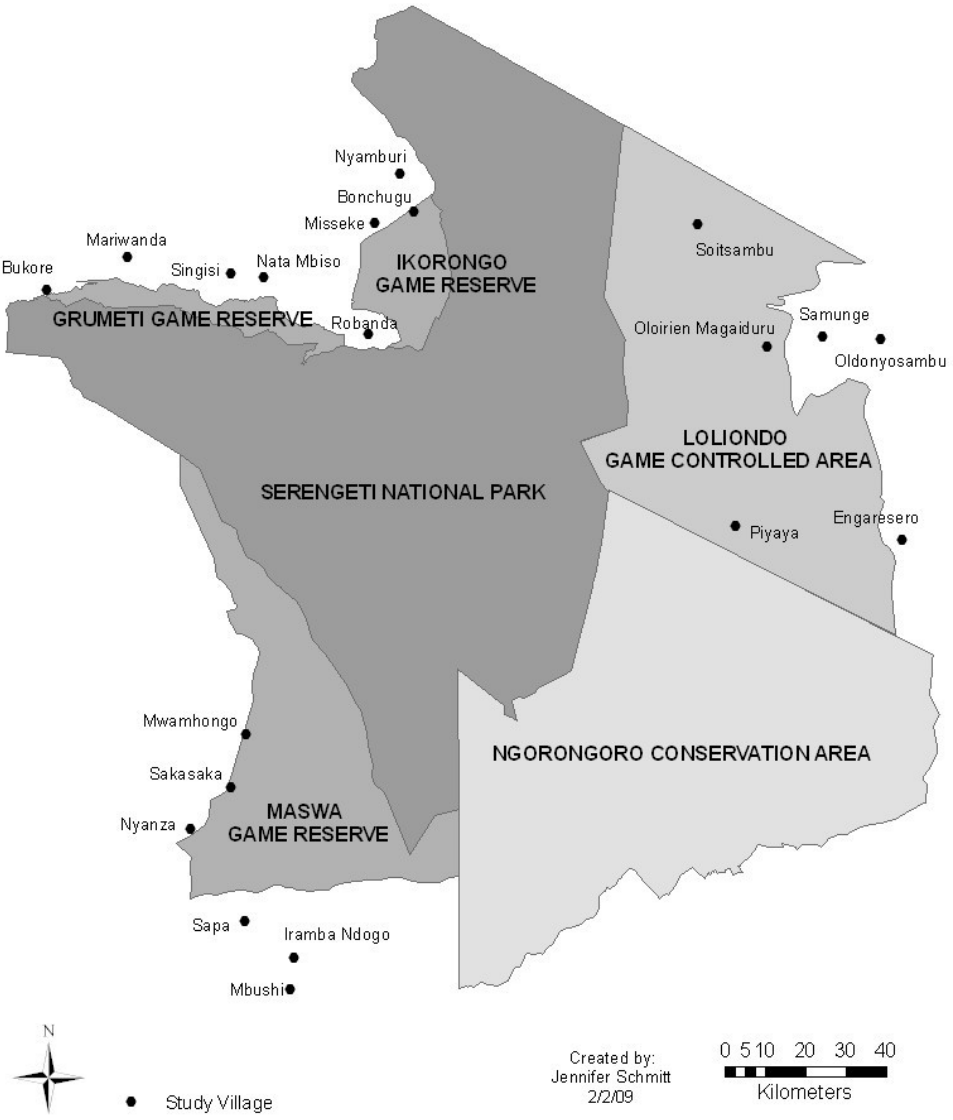
area. Just south of Loliondo is Ngorongoro Conservation Area, a multiple use area that allows traditional Maasai settlement, limited agriculture and grazing, but does not allow hunting.

This paper analyzes a survey of households living in twenty villages around the Serengeti ecosystem. The survey asked each household about the benefits and costs the household receives from wildlife and protected areas. Results show that current conservation practices have not sufficiently altered the benefit-cost equations facing local people. People do not know about protected areas and thus the costs and benefits from these areas. Furthermore, the benefits local people perceive from wildlife and conservation are modest, not linked to conservation consistent behaviors, and are provided at the village level. Human-wildlife conflict inflicts high costs on local people. Finally, while the benefits and costs from illegal natural resource use are actually influenced by individual behaviors, the costs are insufficient to overcome the benefits.

Methods

We worked with a local nongovernmental research organization, Savannas Forever Tanzania, to design, pilot, administer, and record the questionnaires. The Savannas Forever field team consisted of Tanzanian researchers who conducted each interview in Swahili. The field team used a village translator if a respondent did not speak Swahili (this was only necessary in 51 of 489 cases). We stratified our data collection across the ecosystem, conducting questionnaires in villages located in the Northwest, the Southwest, and the East of the Serengeti ecosystem (Figure 2-1).

Figure 2-1: Serengeti ecosystem and survey villages



For each area we randomly selected villages that were inside or within five kilometers of a protected area. Protected areas included Serengeti National Park, Grumeti Game Reserve, Ikorongo Game Reserve, Maswa Game Reserve, and Loliondo Game Controlled Areas. The survey was conducted in 20 villages, eight in the Northwest, six in the Southwest, and six in the East (Figure 2-1). The villages in this study range from one and half to 74 kilometers from the boundary of Serengeti National Park, with an average distance of 29 kilometers. All but two villages have a game reserve or game controlled area between them and the national park. Villages range from

zero to 25 kilometers from a game controlled area or game reserve. All distances are measured from village centers where the GPS point was taken.

For each of the study villages, the field teams randomly chose five of the villages' subvillages. If a village had five or fewer subvillages the field teams interviewed households in every subvillage. Within each subvillage the field team used the village roster to randomly choose one to nine households, or when a roster was not available they systematically sampled households in a given compass direction. This sampling ensured we had over 20 households per village, for a total of 489 questionnaires. At each household, the interviewer asked for the household head. If unavailable, the field team interviewed someone else in the household over the age of 18 who was most knowledgeable about household affairs. Data were collected from August 2006 through January 2007.

The household survey included questions about demographics, income, livelihood, human wildlife interactions, attitudes and knowledge about protected areas, and the benefits and problems associated with protected areas (Appendix I). After households answered these socioeconomic questions, the enumerator asked respondents about the benefits they receive from wild animals and their problems with wild animals. These questions were not prompted and households could list as many as desired. We then asked each household (unprompted) to list any protected areas near their village. We could not simply ask people if they knew of Serengeti National park or any other protected area by name without affecting the results. Furthermore, any translation into Swahili of the general term "protected area" required using a word like park or reserve that would also indicate the name of a protected area to the respondent. Therefore, the actual question that was used was "Are there any areas in or near your village where the use of natural resources is restricted". One issue raised by the wording of our question about knowledge is that people may have known of Serengeti or their closest protected area, but not known about, or connected them with, restrictions on resource use. In this paper, we will assume that respondents did not know of a protected area if they were unaware of areas with resource restrictions. Responses that referenced protected areas in some fashion or referenced the relevant managers were counted as knowledgeable. For

example, some respondents referred to the national park as "TANAPA", the Tanzania National Parks administration that manages the park. Other respondents mentioned the name of a river that borders a protected area, which we then counted that as knowing of protected area. Because of the thorough deciphering of responses and because people near and far from the park mentioned the park we believe our estimates are a fair approximation of knowledge.

Only if a household mentioned a protected area were they then asked about benefits and costs of the protected area. Benefits and costs were not prompted and respondents could list as many as they desired. In analysis of the knowledge, benefits and cost questions, responses were coded into two categories, Serengeti and "closest protected area", defined as the closest protected area to a village besides Serengeti National Park (Table 2-1).

Table 2-1: Closest protected areas for the twenty villages

Area	Villages	Closest Protected Area
Northwest	Bukore, Mariwanda, Nata Mbiso, Singisi	Grumeti Game Reserve
	Bonchugu, Misseke, Nyamburi, Robanda	Ikorongo Game Reserve
Southwest	Iramba Ndogo, Mbushi, Mwamhongo, Nyanza, Sakasaka, Sapa	Maswa Game Reserve
East	Engaresero, Oldonyosambu, Oloirien Magaiduru, Piyaya, Samunge, Soitsambu	Loliondo Game Controlled Area

Due to our sampling design, our data are stratified across the three areas (Northwest, Southwest, and East) and clustered within village and within subvillage. Because villages have different population sizes and areas have different numbers of villages, sampling weights were used for each household to more accurately assess population averages. The clustering and stratification affect the standard errors, and the weighting of data affects point estimates as compared to an assumption of a simple random sample. Accounting for these deviations from simplified random sampling prevents falsely rejecting the null hypothesis because of the non-random sampling design.

Villages were sampled independently in each stratum to improve the efficiency of the statistical design. Stratification will yield greater precision and thus smaller standard errors than a simple random sample when the strata variable and variable of interest are closely related (UCLA 2009). The clustered nature of choosing households from within

subvillages from within villages suggests there is likely to be correlation among household responses. The correlation is likely to be stronger between two households who reside in the same village than across different villages, and stronger still within a subvillage. The correlation increases the standard errors relative to a simple random sample (UCLA 2009). Consequently, assuming a simple random sample would understate the standard errors. We accounted for stratification and the problem of correlation from clustered data in our statistics using STATA's survey commands. STATA's assumption about the degrees of freedom for variance estimation makes our statistical analysis conservative (Korn & Graubard 1999).

We used sample weights for each household because of the unequal sampling rate for villages and subvillages. The sample weights were defined as the inverse of the probability of being included in the sample due to the sampling design. The probability weight (PW) was:

$$PW = \frac{N_v(area)}{N_v(sampled)} * \frac{N_{sv}(village)}{N_{sv}(sampled)} * \frac{N_h(subvillage)}{N_h(sampled)}$$

where:

$N_v(area)$ = number villages in an area

$N_v(sampled)$ = number villages sampled

$N_{sv}(village)$ = number subvillages in a village

$N_{sv}(sampled)$ = number subvillages sampled

$N_h(subvillage)$ = number households in a subvillage

$N_h(sampled)$ = number households sampled

By weighing the data, our results reflect characteristics about the estimated total population. For ten of the 20 villages, we had data on the number of households in each subvillage. However, for the other ten subvillages we only knew the total number of households in the village and the number of subvillages and thus assumed an equal number of households in each subvillage. We tested the sensitivity to this assumption by assuming a different method of estimation (having a "high population", "low population", and middle level populations for the unknown subvillages) and the point estimates were virtually identical.

Results

To evaluate the conservation policies in the Serengeti ecosystem we first examined individuals' knowledge of protected areas. We then sought to understand the benefits and costs of conservation and the benefits and costs of illegal resource use. Benefits and costs may be attributed in different ways by people. For example, if a protected area manager builds a school in a village because wildlife in the protected area generates tourist money, some people will attribute the benefit of the school to the manager who actually built the school. Others may attribute the benefit of the school to the wildlife because without the wildlife the manager would have never built the school. In the same way, costs too can be attributed to both protected areas and/or wildlife.

Knowledge of Protected Areas

Despite the fact that Serengeti is a world heritage site and is widely known around the world for its spectacular wildlife, only a small fraction of the local population knew of the existence of Serengeti National Park or other protected areas in the ecosystem when asked about areas of natural resource use restrictions. Twenty-seven percent of the population knew of Serengeti National Park and 30% knew of their closest protected area. It may be that more people are knowledgeable about these protected areas, but that only these small percentages of people associate the park and their closest protected areas with areas of natural resource use restrictions. Males were more knowledgeable than females about Serengeti National Park, though only 35% of males knew of Serengeti National Park. People located in the East were more knowledgeable of the national park than their closest protected area, while people located in the Southwest were more knowledgeable of their closest protected area than the national park. The only people who knew of both the national park and their closest protected area were located in the Northwest.

Benefits from Conservation

The benefits local people receive from conservation come from the non-consumptive benefits they see from wildlife and protected areas. These benefits include infrastructure projects (e.g. building schools, dispensaries, bore holes, etc), money (direct

payments to districts, villages, or households), and employment (Table 2-2). However, the majority of people reported that they did not see any benefit from conservation. Four out of five people reported no benefit from wildlife. Of the subset of the population that knew of Serengeti National Park, a majority of these (52%) reported receiving no benefit from Serengeti National Park. Of the subset of the population that knew of their closest protected area, 60% reported receiving no benefit from their closest protected area.

Infrastructure projects were the most commonly mentioned benefit from conservation in our study area. These projects were primarily schools, teacher houses, village offices, and dispensaries, and were more commonly associated with protected areas than wildlife. Thirty-eight percent of the population reported infrastructure projects as a benefit from the national park and 28% reported them as a benefit from their closest protected area. Seven percent of the population listed infrastructure projects as a benefit from wildlife, which demonstrates an understanding that the benefit was given because they live close to a protected area supporting wildlife populations.

Money was the second most common benefit mentioned. Twelve percent of the population cited money in the form of cash from tourism as a benefit from wildlife. Money as a benefit from protected areas consisted of direct payments to households and/or villages from protected area managers. Six percent of the population cited direct payments as a benefit from Serengeti National Park and seven percent cited direct payments as a benefit from their closest protected area.

Employment was rarely cited as a benefit from wildlife or from protected areas. Only one percent of the population reported employment as a benefit from wildlife, three percent reported it as a benefit from Serengeti National Park, and five percent reported it as a benefit from their closest protected area. Individuals mentioned a variety of other benefits in response to questions about benefits from wildlife and protected areas (e.g. aesthetics, cultural benefits, existence benefits). None of the other reported benefits were mentioned by more than five percent of all respondents.

Costs Incurred from Conservation

Human-wildlife conflict imposes costs on people living near protected areas. There are no fences in the ecosystem to restrict the movements of wildlife so wildlife is

routinely found in village lands. Wildlife destroys crops, kills livestock, and injures and/or kills humans. Most people attribute human-wildlife conflict costs to wildlife, though some also attribute the costs to protected areas. Eighty-five percent of the population reported a cost from wildlife. Of the population that knew of Serengeti, 45% reported a cost from Serengeti National Park. Of the population that knew of their closest protected area, 33% reported a cost from their closest protected area.

Conflicts with destructive and deadly animals affected the majority of the population (Table 2-2). Sixty-four percent of the population cited crop destruction as a cost from wildlife. Almost 40% of the population cited livestock disease and depredation. Thirteen percent of the population reported human injury/death from wildlife as a cost from wildlife.

Although wildlife is the perpetrator of crop destruction and livestock depredation, about a quarter of those knowledgeable about Serengeti National Park and their closest protected area blamed protected areas for these costs (because of the responses from households, we could not differentiate crop destruction and livestock depredation and/or disease and thus combined them in the category of "source of destructive animals"). Some households also blamed protected areas for human injuries and/or death from wildlife. Five percent of the population mentioned human injury and/or death from wildlife as a cost from Serengeti and six percent mentioned it from their closest protected area. Other responses on costs were mentioned by less than five percent of households (e.g. elephants destroying trees, bushmeat butcher incomes have decreased, companies do not help villages).

Table 2-2: Percentage of population reporting benefits and costs from conservation[a]

	Source of benefit or cost		
	Wildlife	**Serengeti National Park[b]**	**Closest protected area[b]**
Benefits (n)	486	120	180
Infrastructure (e.g. schools, dispensary, etc) [c]	6.6%	38.3%	27.7%
Money[d]	12.0%	5.9%	7%
Employment	1.1%	2.5%	5.4%
Costs (n)	482	119	180
Destructive Animals[e]	Crops – 64.0%	26.7%	24.8%
	Livestock – 38.6%		
Human injury / death	13.0%	4.2%	6.3%

a – Percentages reported are weighed percentages estimating population characteristics as outlined in methods.
b – Only includes households knowledgeable about the protected area
c – Infrastructure project for wildlife is any "environmental conservation project".
d – Money includes cash from tourism for wildlife and refers to money from the managers for Serengeti and closest protected areas.
e – Source of destructive animals includes crop destruction, livestock depredation and disease and could not be teased apart for Serengeti or closest protected area due respondent answers.

Benefits from Illegal Natural Resource Use

Local people also receive benefits from the use of natural resources, often illegally, which may be harmful to conservation (Table 2-3). Natural resource use is not necessarily an impediment to conservation, but without sustainable management and with increasing human populations, natural resource use in the Serengeti ecosystem and throughout much of the world is considered a threat to conservation (Sinclair & Arcese 1995b; Hackel 1999; Homewood et al. 2001). Natural resource benefits from wildlife (i.e. bushmeat) provide benefits to 18% of the total population. Benefits of natural resource use from protected areas included bushmeat as well as other natural resources such as firewood, charcoal, medicinal plants, etc. Very few people mentioned natural resource benefits from Serengeti and only four percent of those knowledgeable of their closest protected area mentioned natural resource benefits. However, natural resource use in the park and gamer reserves is illegal and thus likely leads to under reporting.

Costs from Illegal Natural Resource Use

Fences-and-fines strategies strive to increase the costs of illegal natural resource use through arrests and fines. Most local people understandably did not link these costs to wildlife, but blamed protected areas (Table 2-3). Thirteen percent of the population mentioned getting arrested and/or caught as a cost from Serengeti National Park, and 21% mentioned it as a cost from their closest protected area.

Table 2-3: Percentage of population reporting benefits and costs to from actions detrimental to conservation[a]

	Source of benefit or cost		
	Wildlife	**Serengeti National Park[b]**	**Closest protected area[b]**
Benefits (n)	486	120	180
Natural Resource Use[c]	17.9%	1.2%	4.3%
Costs (n)	482	119	180
Arrests	1.2%	13.3%	20.9%

a – Percentages reported are weighed percentages estimating population characteristics as outlined in methods.
b – Only includes households knowledgeable about the protected area
c – Natural resource use for wildlife includes cash from bushmeat, gift of bushmeat, consumption of bushmeat, and purchase of bushmeat. Natural resource use for Serengeti and closest protected area can be any type of natural resource use including bushmeat, firewood, etc.

Heterogeneity in Benefits and Costs

The population averages presented above represent an overview of the costs and benefits associated with conservation and illegal natural resource use for the general population. However, there were a few significant demographic and spatial differences within the sample. Men and those with higher education levels (who are usually men) were statistically more likely overall to report both benefits and costs. Households with higher incomes were more likely to report benefits from infrastructure projects.

There were key differences in the three areas we sampled around the ecosystem and these differences also came out in demographic characteristics that correlate with these areas. In terms of benefits from conservation, households in the East reported employment and money more so than infrastructure, corresponding to a historical pattern of monetary benefits in the East. Households in the Southwest were significantly more likely to report infrastructure as a benefit and rarely mentioned money or employment,

corresponding to a historical pattern of infrastructure benefits in the area. Furthermore, the dominant ethnic group in both the East and the Southwest also correlated with these historical patterns of benefit schemes. The Maasai people, only found in the East, rarely mentioned infrastructure as a benefit to aiding conservation whilst the Sukuma people, who made up 85% of households in the Southwest, were significantly more likely to report infrastructure benefits.

Reported costs from conservation areas also show linked spatial and demographic differences. Households in the East reported more costs due to livestock depredation, which correlates to Maasai households and those with higher incomes (according to our income data, the Maasai have incomes almost three times higher than people in the Northwest and Southwest). Households in the Northwest and Southwest reported more crop destruction as did the correlated variables of Sukuma and Kurya people and those with lower incomes (all of who are primarily found to the west of the ecosystem).

In terms of the benefits and costs from illegal natural resource use, fewer demographic differences existed and no spatial differences were significant. Those with higher education levels were more likely to cite natural resource use benefits. For costs, the Sukuma and Kurya people were more likely to report being arrested, as were those with lower incomes. The Sukuma and Kurya people are virtually all in the Southwest where incomes are lower and thus correlated with these two ethnic groups.

Discussion

Natural resource use and land conversion by local people continue to be a threat to conservation in the Serengeti ecosystem. The response from conservation managers has been to implement policies aimed at altering the material costs and benefits that local people receive. In fences-and-fines policies conservation managers seek to increase the costs of illegally harvesting natural resources. In community-based conservation policies managers seek to increase the benefits local people receive from conservation. For over two decades protected area managers and conservation initiatives have tried both of these approaches in the Serengeti ecosystem. Many different players, the government, private businesses, and non-governmental organizations have spent significant amounts of

money, time, and effort to alter the benefit-cost ratios facing local people. In this paper, we sought evidence to determine whether or not these efforts have been successful. The evidence from our data shows that conservation policies have not sufficiently changed the cost-benefit equation facing local people in a manner sufficient to deter illegal natural resource use and promote conservation. The vast majority of local people do not even know of the protected areas near their villages. For those that do know of the areas, the reported level of benefits from conservation is moderate at best. These benefits are not conditional on conservation performance and are given at the village level, which prevents individual choices from affecting benefits. The costs from conservation are high, with wildlife routinely causing crop damage and livestock depredation. Overall, the benefits of resource use are higher than the costs. Antipoaching efforts appear to be insufficient to deter many people from illegal natural resource use. Our findings support and expand upon previous studies in the ecosystem that have also found the costs and benefits facing local people are not conducive with conservation (Emerton & Mfunda 1999; Hofer et al. 2000; Kaltenborn et al. 2008).

Prior studies in the Serengeti ecosystem have not included knowledge of protected areas in their assessments. However, this is a fundamentally important question because without knowledge of these areas, the benefits provided by protected areas cannot be linked to conservation and consequently will not affect local people's decision making regarding conservation. Furthermore, because our knowledge question asked people to identify areas of natural resource use restrictions, the lack of knowledge suggests that antipoaching patrols that enforce natural resource use restrictions are not known by the majority of the population and thus most people have little deterrent to poach.

Benefits from conservation are provided by the government, local conservation organizations, tourist hunting companies, and photographic safari companies. However, there was a small level of reported benefits from the conservation areas associated with these benefactors. With less than half of the population reporting benefits from conservation areas it seems that despite the many benefits provided, people either do not perceive them as benefits, do not know of the benefit, or do not link the benefit with the

conservation areas. All three reasons suggest a deficiency in community-based conservation policies. Furthermore, managers are not sufficiently linking conservation benefits with the wildlife that draws the income to the area; evidenced by the fact that so few individuals reported conservation benefits from wildlife. Conservationists need to focus more efforts on ensuring that local people hear about the schools they build or money they donate. They also need to spend more time in villages making the link between the benefit, the conservation areas, and the wildlife that generated the money for the conservation areas.

Another problem with the benefits provided to local people is that there is a lack of conditionality of benefits on conservation performance. Villages are given benefits because of governmental decree or because villages are located near a particular area or private company. Furthermore, monitoring and enforcement of conservation performance is virtually nonexistent. Unfortunately making benefits conditional is difficult because it requires identifying appropriate conservation measures at the village level and monitoring the conservation measures over time. Furthermore, changing the status quo of benefit streams runs the risk of upsetting villages, making them hostile to further conservation projects.

Even if village level conservation performance measures were in place, the nature of current benefit streams would still not likely promote conservation. Around the Serengeti ecosystem benefits have primarily taken the form of infrastructure projects such as schools, bore holes, dispensaries, etc. and direct monetary payments (usually used to build infrastructure) as evidenced by the higher percentages of people reporting these benefits in this study. These benefits do not alter an individual's incentive structure for the very reason that they are given to everyone, regardless of an individual's actions. Bushmeat hunters and non-bushmeat hunters can both send their children to the new school built by the protected area. Village level benefits provide only very weak incentives at the individual level even if village level benefits are tied to village level performance, which typically they are not.

Few conservation benefits accrue directly to individuals and they were rarely mentioned. Employment was only cited by a handful of households, mostly in the

Northwest where there are permanent tourist companies located. While employment is a tangible linked benefit, the number of people that can be employed by the tourism industry or directly in conservation is limited.

Providing more benefits at the individual level is a daunting task. Entrenched conservation policies of building village infrastructure likely maintains the status quo of building schools, teacher houses, offices, and giving money to village leaders. Protected area managers know the costs and logistics to providing these benefits, and they are often demanded by communities, making it difficult to adopt new conservation policies. Managers also face limited budgets and staffing shortages and thus have the incentive to provide benefits in the easiest manner possible, which is often by simply providing money. Despite these hurdles, conservation managers should focus on the individual when providing benefits and linking them to conservation performance. Doing so gives the individual direct influence over the benefits they receive, thus affecting their decision making and behaviors. One means to achieving an individual link to benefits and conservation perforce is to employ the villages to provide the benefits and enforce their conditionality on conservation actions. This would lessen the logistical and financial burdens for conservation mangers. For example, conservationists could provide a bore hole to provide water for the village and make routine maintenance and future bore holes conditional on the village enforcing a tax on arrested bushmeat hunters that want to use the bore hole. In this case, there are individual level benefits and conservation conditionalities which are enforced by the village. The village does the enforcement because future benefits are conditional their participation and the conservation manager only has to monitor village enforcement rather than every single individual.

Improving the benefits from conservation is only part of cost-benefit equation that affects individual actions. The costs to households stemming from conservation can be great. Well over fifty percent of households reported crop damage as a problem with wildlife (there is no compensation scheme in this area and thus no strategic reason to over report crop damage). Our results are similar to other studies of crop damage in Tanzania (Newmark et al. 1994; Kaswamila et al. 2007). Almost forty percent of households cited wildlife as a problem for their livestock and our results from the Northwest are congruent

with a similar study in the same area (Holmern et al. 2007). The costs of crop destruction and livestock depredation are significant. Kaswamila et al. (2007) found that the wildlife damage to crops equaled a two month loss of food and a 1.3% reduction in a household's cash income. Holmern et al. (2007) found the cost of livestock depredation equaled 19.2% of a household's annual income.

Thirteen percent of the population reported human injury or death as a cost from wildlife. Our question did not ask respondents about actual instances of human injury or death, but rather determined if, in general, people felt human injury or death was a problem they face from wild animals. Another study, in the Kilombero Game Controlled Area in south central Tanzania, found 19.9% of households reported a household member had been injured or killed by lion, buffalo, crocodile, hippopotamus or elephant; suggesting our results are not an over-estimate of the problem (Haule et al. 2002). Injury or death impose huge costs on households and although few individuals may actually incur these costs, most households incur related costs associated with fear of injury and/or death and preventative actions such as needing two or more people to walk together. The magnitude of these costs make the magnitude of benefits required to alter one's incentive structure all the greater.

The high level of wildlife-related costs is of concern because it may be a window into a key unintended consequence of increasing knowledge of protected areas and increasing knowledge of the linkage between benefits and conservation areas. Eighty-two percent of the population reported either crop damage or livestock depredation as a problem from wildlife. However, with knowledge levels of protected areas so low, protected areas are not blamed for wildlife conflict even though such areas are the source of many of the destructive animals. This is not the case around the Selous Game Reserve in southern Tanzania where most people perceived the crop damage they received from wildlife as a direct result of their proximity to the protected area (Gillingham & Lee 2003). A few households in the Northwest also explicitly stated that they think protected areas increased wildlife and thus lead to more crop destruction. Protected areas may or may not lead to increased wildlife populations (depending on many other factors such as size, enforcement, wildlife species, etc.). However, as people become more aware of

protected areas, more individuals are likely to link wildlife damage and protected areas. As individuals put more blame on protected areas for wildlife damage it will become harder for protected area managers to work with local people and achieve conservation objectives outside of protected areas.

To help ameliorate the costs of conservation more benefits should focus on minimizing the costs of supporting conservation. Local people are losing crops and livestock to wildlife, yet only three individuals mentioned pest animal assistance as a benefit from Serengeti National Park, Ikorongo, and Grumeti game reserves. Furthermore, two individuals mentioned a lack of pest animal assistance as a problem with their closest protected area. If protected area managers take a more active role in assisting individuals with the largest cost to living near a protected area it may help alter the benefit-cost equation. Furthermore, if local people see managers taking an active role in assisting with pest animals it may prevent the transposition of blame from wildlife to protected areas.

In setting up such benefits, managers need to be mindful of the problem of moral hazard whereby people given benefits do not change their behaviors or internalize their risk (Coase 1960; Baumol & Oates 1988). If conservationists simply provide pest animal assistance, local people will have no incentive to improve their agricultural or livestock practices because any costs they suffer will be covered by conservation payments. However, if problem animal assistance is conditional upon individual actions that help minimize the problem then local people will change their agricultural and livestock practices to minimize the risk they face from wild animals. Such benefits might be providing loans for improved animal husbandry that reduces the risk of livestock depredation and giving preference or better interest rates to those individuals that already keep their livestock enclosed at night. These types of conditionalities will ensure local people remain responsible for the risk they face.

Along with benefits and costs from conservation, individuals face benefits and costs to illegally using natural resources. Unlike the benefits and costs from conservation, those from illegal natural resource use are directly influenced by individual actions. Individuals engaged in bushmeat hunting or purchasing bushmeat gain benefits

and are the only ones incurring the costs of being arrested and fined. Consequently, the current conservation policies aimed an arresting and fining individuals for illegal natural resource use can alter individual behaviors. However, the current benefits from natural resource use seem larger than the costs.

Bushmeat benefits were a common benefit listed for wildlife with one in five households benefitting from the very actions conservation is trying to prevent. Furthermore, our results are likely a low estimate of bushmeat use due to the illegality of bushmeat hunting. Conservation managers need new strategies that substitute for, and compete with, natural resource use. Substitutes to natural resources need to be readily available in local markets. Protected area managers can facilitate ways for local people to have access to, and afford, goods such as kerosene stoves to replace the need for fuelwood and bricks to replace the need for wood and building poles. Managers should encourage reducing local livestock to limit overgrazing and provide access to monetary savings accounts; enabling people to eat their livestock rather than continue with the status quo of storing wealth in livestock ownership. If people are eating their livestock their domestic meat consumption may decrease the demand for bushmeat.

Fences-and-fines conservation imposes costs on illegal natural resource use through arrests and fines. However, failure to know of areas of natural resource use restrictions suggests these arrests and fines are not considered by a vast majority of the population. Only four percent of the population (including both those knowledgeable of areas of natural resource use restrictions and those not knowledgeable) mentioned getting arrested as a cost from Serengeti and only six percent mentioned getting arrested as a cost from their closest protected area. These percentages of perceived costs are higher than the estimated one percent of hunters arrested in Serengeti National Park (Loibooki et al. 2002). Regardless, our results support the notion that the magnitude of these costs is still well below the magnitude of the benefits from consuming and selling bushmeat (Hofer et al. 2000).

In order for fences-and-fines conservation to be effective at deterring behaviors there needs to be a net cost to illegal natural resource use. Increasing the costs by increasing the probability of getting caught and the severity of the penalty is important to

ensuring the costs and benefits are adequately aligned to promote conservation. More active participation by local villagers in enforcement of illegal resource use restrictions can provide employment opportunities and potentially help defray the costs of improving enforcement. One private company in the Serengeti ecosystem has employed over a hundred ex-poachers to assist in their antipoaching patrols. While it is impossible for the protected area managers to employ all illegal natural resource users, employment can alter an individual's incentive structure by providing money to purchase substitutes for bushmeat, fuelwood, and other natural resources and can compete for labor currently allocated toward illegal resource use.

All the suggestions for improving conservation practices will require more money and resources than have been provided to date. While this requirement seems overwhelming, the Serengeti ecosystem itself might hold the answer to this financial requirement. The Serengeti ecosystem is one of the last intact ecosystems in the world with a large-scale migration of ungulates, and a unique, irreplaceable natural area. As Africa and the rest of the world continue to develop, a conserved, intact, Serengeti ecosystem will only become all the more unique. Unique natural systems are valuable, and their value will only increase as natural areas continue to become scarcer (Krutilla 1967). Consequently, the financial returns to maintaining the Serengeti ecosystem will increase over time. If conservation managers can capitalize on these increasing returns of preserving the Serengeti ecosystem, and especially if villages can also capitalize on the returns, then the ecosystem can pay for its own conservation.

If conservation managers continue their current policies of providing benefits that are not conditional on conservation performance and imposing costs that are not significant enough to outweigh the benefits of illegal natural resource, it is likely that the actions of local people will continue to threaten the Serengeti ecosystem. Furthermore, these threats are likely to grow as larger forces like market integration, urban demand, and human population growth create more demand for natural resources. The challenge for conservationists is to alter costs and benefits in a significant manner in ways that promote conservation. Only by tipping the scales in this way will local communities possibly become allies for conservation rather than threats to ecosystem sustainability.

Achieving this outcome will likely require different approaches to conservation such as individual based conditional benefits from conservation and require more resources than have been used to date. Finally, even if conservationists are able to affect tangible costs and benefits, conservation may still fail if other factors (e.g. culture, traditions, and emotions) are the main forces driving local decisions about conservation.

Conclusion

Although the Serengeti ecosystem has many different conservation actors, and despite decades of both fences-and-fines and community-based conservation policies, the tangible costs and benefits facing local people do not promote conservation. Over two-thirds of the population does not know of Serengeti National Park or their closest protected area. Those who are benefitting are receiving infrastructure projects or money that are not conditional on conservation behavior and provided at the village level. The costs of wildlife damage are substantial. Furthermore, local people are benefitting through unsustainable natural resource consumption and the costs of this illegal resource use do not appear to be sufficient to deter consumption. It is therefore unremarkable that conservation efforts in the Serengeti ecosystem have not had much success. Conservationists are going to have to invest significantly more resources into improving knowledge of protected areas, the linking of benefits to conservation performance and individual actions, and increasing the costs of illegal natural resource use.

Chapter 3: Evaluating conservation using knowledge, benefit, cost and attitudinal data

An important objective of community-based conservation is to provide benefits from conservation to local people. The success of community-based conservation in providing benefits is at best mixed, although a lack of monitoring and evaluation makes measuring success difficult. There have been many attitudinal studies suggesting that community-based conservation has succeeded in cultivating positive attitudes toward conservation within local communities. However, measuring attitudes alone is not sufficient to evaluate and improve conservation projects. Quantitative studies examining knowledge of protected areas and the benefits and costs from protected areas are needed. I use socioeconomic data from villages in the Serengeti ecosystem to examine four important aspects of conservation programs: knowledge, benefits, costs, and attitudes. Using multilevel mixed-effects regression analyses, I examine what socioeconomic characteristics are associated with these four aspects of conservation in the ecosystem. By examining knowledge, benefits, and costs along with attitudes a more holistic picture emerges of how conservation policies have succeeded and failed in improving attitudes. Exploring data on knowledge shows spatial discrepancies between the Northwest, Southwest, and East and suggests people are not distinguishing between different protected areas. The analysis of benefits and costs highlights problems in benefit streams and in the implementation of costs that underscore the ineffectiveness of current conservation policies. Local people are linking wildlife and protected areas as sources of benefits and costs, but only for the small number of individuals knowledgeable of these areas. Women and people in the west of the ecosystem are less likely to report benefits while people who are older and more educated were more likely to report costs. Finally, attitudes are improved with receiving benefits, but costs also play a significant role in determining attitudes. This suggests conservationists need to focus more attention on ameliorating the costs of human-wildlife conflict.

Introduction

In the last two decades, conservation managers have focused on incorporating local people into conservation efforts. They have emphasized the importance of involving local people in the management of conservation areas and in providing benefits to local people (Western et al. 1994; Hulme & Murphree 2001; Zimmerer et al. 2004). By providing benefits, conservationists have sought to improve attitudes toward conservation and offset the costs local people incur by living near protected areas (e.g. crop damage, livestock depredation, restrictions on resource use, etc.). While there have been some documented case studies of community-based conservation success (e.g. (MacKinnon 1997; Schwartzman et al. 2000), overall the record of community-based conservation has been largely unsuccessful (Kiss 1990; Wells & Brandon 1992; Hackel 1999; Songorwa 1999; Songorwa et al. 2000; Hulme & Murphree 2001). One of the major obstacles to success has been a lack of conditionality between conservation outcomes and benefits (Gibson & Marks 1995; Newmark & Hough 2000; Kiss 2004; Ouma & Stadel 2006). Linking benefits to conservation goals is rare for conservation projects. Most often the benefits of community-based conservation are infrastructure projects (i.e. schools, dispensaries, roads) that benefit everyone in the village regardless of whether they are aiding or hindering conservation efforts. Another major factor in the lack of success of community-based conservation projects has been a deficit in monitoring and evaluation (Kremen et al. 1998; Margoluis & Salafsky 1998). Without proper ecological and socioeconomic monitoring it is difficult to assess the effects of conservation projects.

One of the more common methods for evaluating success of community-based conservation has been the use of attitudinal studies of local communities around protected areas. These studies have commonly shown that community-based conservation leads to more positive local attitudes about protected areas (Newmark et al. 1993; Gillingham & Lee 1999; Infield & Namara 2001; Holmes 2003; Kideghesho et al. 2007). The authors find improving local attitudes is a positive sign for conservation and results from their studies can help shape future policy interventions.

Although attitudinal studies are an important component in evaluating community-based conservation, measuring attitudes is not sufficient to assess the success of community-based conservation projects. Several studies have suggested that local people are often not aware of protected areas, managers, or benefit streams (Gillingham & Lee 1999). Asking people about attitudes toward areas they do not even know about will not provide an accurate picture of attitudes or provide an effective evaluation of conservation projects. Furthermore, as many attitudinal studies have pointed out, linking attitudes to behavioral changes that would lead to improved conservation is difficult (Holmes 2003; Anthony 2007). Simply because local people view protected areas in a positive light does not suggest they necessarily have stopped harmful behaviors such as poaching, illegal firewood collection, etc. Additionally, the main problems of community-based conservation do not concern local people's attitudes. A lack of real benefits or the linkage of benefits to conservation outcomes inhibits community-based conservation success. Finally, community-based conservation is often used in areas that also have antipoaching patrols to arrest and fine those illegally using natural resources. Such actions may lead to the formation of negative attitudes, but do not necessarily signal a failure of community-based conservation or conservation in general.

The deficiencies in attitudinal studies suggest that conservationists need to examine more than just attitudes to accurately assess the success of community-based conservation. In this chapter, I assess conservation success by examining knowledge, benefits, costs, and attitudes. While these approaches are all indirect measures of conservation, I show that this multifaceted approach provides more insight into conservation success than attitudinal data alone. Furthermore, while direct measures of conservation success, such as wildlife population trends, are vital, they do not provide insight into why conservation policies may not be working.

Study Area

The Serengeti ecosystem is located in Northern Tanzania and is home to the annual migration of over one million wildebeest (Sinclair & Arcese 1995b). The area is approximately 25,000 square kilometers with the core of the ecosystem in the 15,000 square kilometer Serengeti National Park. The national park prohibits all settlement and

consumptive use of resources, relying on tourism for income generation. Surrounding the national park are many other protected areas that have different land use restrictions. To the northwest of the park are two game reserves (Ikorongo and Grumeti) and to the southwest a third game reserve (Maswa). As with the national park, settlement is prohibited in game reserves and all consumptive resource uses are prohibited except tourist hunting with the appropriate permits. Directly to the east of the park is Loliondo Game Controlled Area where hunting is also regulated; only permitted tourist and resident hunting is allowed. All other land uses are allowed. To the southeast of the park is the Ngorongoro Conservation Area, a unique multi-land use area that allows the Maasai people of the area to continue their traditional pastoral livelihoods. However, regulations prohibit hunting, large scale farming, and settlement by other people. Finally, to the north of the park is Maasai Mara Game Reserve in Kenya.

Methods

I worked with a local nongovernmental organization, Savannas Forever Tanzania, to obtain socioeconomic data from 489 households in twenty villages around the game reserves in the Northwest and Southwest, and in and around the game controlled area to the East. Every village is either within a protected area or within five kilometers of a protected area. The Savannas Forever field team administered structured questionnaires in Swahili or with the use of a village translator if the respondent did not speak Swahili (this was only necessary in 51 of 489 cases). Data were collected between August 2006 and January 2007.

At each household the Savannas Forever field team interviewed the head of household, or if not available, someone with the best knowledge about the household. Each questionnaire asked about demographics, household economics, natural resource use, livestock, human wildlife interactions, poaching, and house construction (Appendix I). The questionnaire contained both open-ended and fixed response questions. The Savannas Forever field team also asked each respondent if they knew of any areas in or near their village where the use of natural resources is restricted (because of translation issues we had to word our intended question of “are there any protected areas in/near

your village" in this way). One issue raised by the way the question was asked is people may not have mentioned Serengeti or their closest protected area because they did not know there were resource use restrictions, not because they did not know of the protected area. In this paper, I will assume that respondents did not know of a protected area if they were unaware of areas with resource restrictions. Responses to the question of knowledge of areas with resource restrictions were diverse ranging from the actual protected area names, to "park" and "game area", to local names for the areas (which I tried to identify as much as possible), and even names of rivers or dams that run along the border of the protected areas. Responses that referenced protected areas in some fashion or that referenced the relevant managers were counted as knowledgeable. For example, some respondents referred to the national park as "TANAPA", the Tanzania National Parks administration that manages the park. Other respondents mentioned the name of a river that borders a protected area, which I then counted as knowledgeable of the protected area.

From the question about knowledge of protected areas I created two dichotomous variables, one if the respondent had mentioned Serengeti National Park and one if they had mentioned their closest protected area. Closest protected area refers to the game reserve or game controlled area closest to the village, excluding Serengeti National Park (i.e. Ikorongo, Grumeti, or Maswa game reserves, or Loliondo Game Controlled Area).

Those respondents mentioning a protected area were then asked about benefits and costs from protected areas and attitudes toward protected areas. For the 120 respondents who knew of Serengeti National Park I created a dichotomous variable equal to one if they reported benefits and zero if they did not. Similarly I created a dichotomous variable corresponding to whether they reported costs or not and another dichotomous variable for whether or not they had a positive attitude toward the national park. For the 180 respondents who knew of their closest protected area I created the same three dichotomous variables for benefits, costs and positive attitudes as with the national park. I chose dichotomous variables over continuous because most people only mentioned one benefit or one cost.

From the questionnaire I also created 23 socioeconomic, wildlife, and resource use variables (Appendix VI). I used these variables along with variables for village as predictors in four regressions for each of the two types of protected areas (i.e. the national park and the closest protected area, for a total of eight regressions). The dependent variables for the four regressions associated with the two protected areas were 1) knowledge of protected area 2) reported benefits from protected area 3) reported costs from protected area and 4) attitudes toward protected area.

The sampling used a stratified clustered design. The data were stratified across three areas: Northwest, Southwest, and East. Within areas we randomly sampled villages, then randomly sampled subvillages within chosen villages, and finally randomly sampled households within chosen subvillages. Households were thus clustered within selected village-subvillage units. We randomly sampled eight villages in the Northwest, six in the Southwest, and six in the East. Within each village we randomly sampled five subvillages (if a village had five or fewer subvillages the field teams interviewed households in every subvillage). Within each subvillage we randomly sampled enough households to ensure we had 20 – 27 households per village. In total, we sampled 489 households. If a village roster was not available for random sampling, we sampled in random compass directions, making sure not to sample two adjacent households.

To account for the relationships in the stratified clustered sample, I used a multilevel mixed-effects linear regression. The data were stratified across the three areas (Northwest, Southwest, and East) and differences across areas were controlled for using area dummy variables. Households within the same village and subvillage are likely to be correlated in their responses. I used a Hausman test to determine whether village and subvillage should enter as fixed or random effects in the model. I tested the null hypothesis that the coefficients estimated in the random effects and fixed effects models are the same. The random effects model should be used if the null hypothesis fails to be rejected because it provides more efficient estimators. My results showed that village should enter the regression as a fixed effect and subvillage as a random effect (p-value = 0.002 for village and p-value = 0.357 for subvillage).

I used linear rather than logistic regression in spite of having a binary dependent variable because of convergence problems with logistic regression. The convergence problems were likely due to small sample size. Linear regressions are unbiased and consistent though require an assumption of homoscedasticity that is violated with binary dependent variables (Wooldridge 2002). The violation of this assumption affects the standard errors of the regression coefficients, but Hellevik (2009) found very small differences in the significance probabilities between linear and logistic regressions.

Results

Knowledge of Protected Areas

Knowledge of protected areas by local people around the Serengeti ecosystem is very low. Less than a third of the population knew about Serengeti National Park or their closest protected area when asked about areas with resource use restrictions. Two variables were statistically significant for explaining knowledge of Serengeti National Park and the closest protected area: gender and knowledge of another protected area (Table 3-1). Females were 16% less likely than males to know of the park and 12% less likely to know of their closest protected area. People who know about Serengeti National Park were 27% less likely than those who do not know of the park to know of their closest protected area. People who know of their closest protected area were 28% less likely than those who do not know of their closest protected area to know of Serengeti National Park. People who consider themselves livestock owners were 12% more likely than non-livestock owners to know of Serengeti National Park while people who believe crop damage is increasing were 15% more likely to know of their closest protected area than people who believe crop damage is decreasing. Livestock owners were also positively associated with knowledge of one's closest protected area and people who believe crop damage is increasing were also positively associated with the park, though neither variable was statistically significant.

Reported Benefits from Protected Areas

Reported benefits received from protected areas (e.g. infrastructure projects, money, employment etc.) are low. Restricting attention to the fraction of the population

that is knowledgeable about a protected area (i.e. knowledgeable about an area of natural resource use restrictions), over half of this knowledgeable population reported receiving no benefits from these areas. Only one variable showed a statistically significant relationship with reporting benefits from Serengeti National Park. People who reported receiving a benefit from wildlife (cash from tourism, bushmeat, building of schools, cultural, etc.) were 32% more likely to report benefits from the park. This variable was positive, but not statistically significant in reporting benefits from one's closest protected area. Females, and being Sukuma or Kurya (as opposed to any other ethnic group besides Maasai) were all negatively related with reporting benefits from one's closest protected area. These variables were all negative, but not statistically significant in reporting benefits from the park. Having a positive attitude toward one's closest protected area was positively correlated with reporting benefits from one's closest protected area (this variable was positive, but not statistically significant for Serengeti National Park).

Reported Costs from Protected Areas

Over half of those people knowledgeable of protected areas reported costs (e.g. wildlife conflict, restrictions on natural resource use, arrests, etc.) from these areas. Only one variable was statically significant for reporting costs from both Serengeti National Park and one's closest protected area. Having a positive attitude toward the park and one's closest protected area was negatively associated with reporting costs from each respective area. People who consider themselves livestock owners and people who report bushmeat benefits from wildlife (i.e. meat for food, cash from selling bushmeat, and gifts of bushmeat) were both more likely to report costs from Serengeti National Park by 44% and 36% respectively. Livestock owners also showed a positive association with reporting costs from one's closest protected area, though the variable was not statistically significant. Age, years of education, and believing crop conflict is increasing were all statistically positively associated with reporting costs from one's closest protected area. A 50 year old person was 30% more likely to reported costs from their closest protected area than a 20 year old person. Someone with a primary school education (seven years of school) was 25% more likely to report costs than someone with

no education. Finally, a person who believes crop conflict with wildlife is increasing was 37% more likely to report costs than someone who believes crop conflict is decreasing. Years of education and belief that crop conflict is increasing were also both positively associated with reporting costs from Serengeti National Park, though the variables were not statistically significant.

Attitude toward Protected Areas

Attitudes toward the protected areas are mixed. Fifty-one percent of households knowledgeable of Serengeti National Park reported a positive attitude toward the park, but only 37% of households knowledgeable about their closest protected area reported a positive attitude toward their closest protected area. Reporting benefits from one's closest protected area was positively associated with having a positive attitude toward Serengeti National Park and one's closest protected area, though was only statistically significant for the latter. Reporting costs from Serengeti National Park or one's closest protected area was statistically negatively correlated with having a positive attitude toward the park or one's closest protected area respectively. Living further away from one's closest protected area decreased the likelihood of having a positive attitude toward Serengeti National Park, as did being Kurya as opposed to any other ethnic group excluding Maasai or Sukuma. Distance from one's closest protected area was also negatively associated with having a positive attitude for one's closest protected area, though the variable was not statistically significant. Farm size was negatively associated with having a positive attitude toward the park and one's closest protected area, though only statistically significant for the former. Livestock owners were 46% more likely to have a positive attitude toward Serengeti National Park and though not statistically significant, were also more likely to have a positive attitude toward their closest protected area. Finally for Serengeti National Park, those who report bushmeat benefits from wildlife are 39% more likely to have a positive attitude. For one's closest protected area someone with a primary education (seven years of education) was 25% more likely to have a positive attitude than someone with no education and someone reporting any benefit from wildlife (i.e. cash from tourism, bushmeat, building of a school, culture etc) was 25% less likely to have a positive attitude toward their closest protected area than

someone not reporting benefits. A positive association with education and a negative association with reporting any benefit from wildlife were also seen for having a positive attitude toward Serengeti National Park, though the variables were not statistically significant.

Table 3-1: Multi-level mixed effects linear regression results.
Results from eight regressions, four different dependent variables for each of two protected areas. Regression coefficient listed in matrix, followed by SE in parenthesis. Asterisk signifies statistical significance at the 0.05 level. Variables reported as "dropped" were dropped due to collinearity. Regressors are dichotomous unless stated otherwise by providing a unit for continuous variables or identifying the ordinal data. For dichotomous variables test case is listed first = 1, followed by reference = 0.

Regression	Knew protected area		Reported benefits from protected area		Reported costs from protected area		Had a positive attitude toward protected area	
Protected Area[a]	SNP	CPA	SNP	CPA[b]	SNP	CPA[b]	SNP	CPA
Live in SW = 1, live in NW = 0	0.201 (0.393)	0.437 (0.402)	1.235 (1.581)	dropped	dropped	dropped	dropped	dropped
Live in E = 1, live in NW = 0	dropped	dropped	dropped	dropped	dropped	dropped	-2.888 (1.553)	dropped
Distance to SNP (km)	-0.007 (0.007)	-0.009 (0.008)	-0.005 (0.020)	-0.002 (0.024)	0.005 (0.022)	0.018 (0.025)	0.001 (0.021)	0.031 (0.024)
Distance to CPA (km)	-0.008 (0.009)	-0.010 (0.010)	-0.021 (0.024)	0.031 (0.036)	-0.039 (0.027)	-0.064 (0.037)	-0.051 (0.024)*	-0.026 (0.036)
Age (years)	$1.8e^{-4}$ (0.002)	0.001 (0.002)	0.005 (0.005)	0.001 (0.004)	-0.001 (0.005)	0.010 (0.004)*	-0.001 (0.005)	0.005 (0.004)
Female = 1, male = 0,	-0.155 (0.045)*	-0.120 (0.046)*	-0.044 (0.147)	-0.327 (0.099)*	0.137 (0.157)	0.097 (0.105)	0.125 (0.147)	0.008 (0.102)
Sukuma = 1, conglomerate of other ethnic groups = 0	-0.084 (0.072)	-0.003 (0.072)	-0.001 (0.241)	-0.351 (0.139)*	0.282 (0.260)	-0.126 (0.145)	0.026 (0.245)	-0.054 (0.141)
Kurya = 1, conglomerate of other ethnic groups = 0	0.141 (0.236)	0.010 (0.238)	-0.058 (1.711)	-0.761 (0.306)*	-2.170 (1.862)	-0.416 (0.317)	-3.793 (1.683)*	0.154 (0.308)
Maasai – 1, conglomerate of other ethnic groups = 0	-0.004 (0.190)	-0.275 (0.191)	0.312 (0.647)	dropped	-0.826 (0.693)	dropped	-0.157 (0.655)	dropped
Farmer =1, non-farmer = 0	0.046 (0.087)	-0.020 (0.087)	-0.529 (0.301)	0.094 (0.277)	0.424 (0.325)	0.172 (0.278)	0.457 (0.301)	-0.124 (0.267)
Livestock owner = 1,	0.119 (0.050)*	0.058 (0.051)	-0.147 (0.159)	0.099 (0.106)	0.442 (0.162)*	0.084 (0.108)	0.459 (0.148)*	0.121 (0.104)

non-livestock owner = 0								
"Other" occupation = 1, non-"other" = 0	0.013 (0.061)	-0.092 (0.061)	0.044 (0.152)	0.178 (0.153)	-0.027 (0.166)	0.292 (0.152)	0.137 (0.153)	0.114 (0.149)
Immigrant = 1, resident = 0	-0.003 (0.051)	0.013 (0.051)	-0.210 (0.140)	0.060 (0.100)	0.176 (0.151)	0.123 (0.100)	0.225 (0.140)	0.097 (0.097)
Amount of education (yrs)	0.008 (0.007)	0.010 (0.007)	-0.006 (0.021)	-0.027 (0.017)	0.029 (0.022)	0.035 (0.017)*[c]	0.026 (0.020)	0.036 (0.016)*
Member of village government	0.015 (0.052)	-0.016 (0.052)	0.046 (0.134)	0.077 (0.110)	0.009 (0.146)	-0.010 (0.111)	0.103 (0.135)	0.031 (0.106)
Total household income (Tsh)	$-2.0e^{-8}$ ($1.8e^{-8}$)	$-2.8e^{-8}$ ($1.8e^{-8}$)	$8.9e^{-8}$ ($5.4e^{-8}$)	$3.8e^{-8}$ ($1.0e^{-7}$)	$-1.1e^{-8}$ ($5.9e^{-8}$)	$6.7e^{-8}$ ($1.0e^{-7}$)	$-3.8e^{-8}$ ($5.5e^{-8}$)	$7.7e^{-8}$ ($9.7e^{-8}$)
Used bushmeat at least on a yearly basis = 1, did not use = 0	0.072 (0.047)	0.056 (0.047)	0.073 (0.130)	0.112 (0.103)	-0.260 (0.135)	0.159 (0.103)	-0.059 (0.130)	0.040 (0.100)
Reported preferred firewood species is no longer available = 1, still available = 0	0 .030 (0.058)	-0.016 (0.058)	-0.012 (0.164)	0.129 (0.116)	-0.028 (0.175)	0.016 (0.119)	-0.056 (0.162)	-0.122 (0.115)
Reported bushmeat benefits from wildlife = 1, did not report bushmeat benefits = 0	-0.049 (0.069)	0.035 (0.070)	-0.047 (0.162)	0.036 (0.141)	0.363 (0.169)*	-0.224 (0.140)	0.391 (0.155)*	-0.004 (0.137)
Reported any benefit from wildlife = 1, did not report benefit = 0	0.029 (0.057)	$3.3e^{-4}$ (0.057)	0.319 (0.155)*	0.172 (0.115)	-0.194 (0.172)	0.033 (0.116)	-0.264 (0.158)	-0.248 (0.109)*
Reported any cost from wildlife = 1, did not report costs = 0	0.032 (0.062)	-0.007 (0.062)	-0.140 (0.272)	-0.144 (0.180)	0.202 (0.296)	-0.126 (0.182)	0.111 (0.277)	-0.075 (0.176)
Farm Size (acres)	$-1.4e^{-4}$ (0.001)	0.002 (0.001)	-0.002 (0.016)	-0.003 (0.004)	-0.017 (0.017)	$2.5e^{-5}$ (0.004)	-0.035 (0.015)*	-0.007 (0.004)

Lost livestock to wildlife in previous 12 months = 1, did not lose livestock = 0	0.041 (0.047)	0.055 (0.047)	0.149 (0.139)	0.213 (0.109)	0.013 (0.151)	0.055 (0.112)	-0.100 (0.140)	-0.101 (0.108)
Belief about human-wildlife conflict (-1 = decrease, 0 = no change, 1 = increasing)	0.036 (0.057)	-0.048 (0.057)	-0.068 (0.139)	-0.009 (0.114)	-0.031 (0.147)	-0.112 (0.115)	-0.043 (0.136)	-0.137 (0.112)
Belief about crop-wildlife conflict (-1 = decrease, 0 = no change, 1 = increasing)	0.051 (0.036)	0.074 (0.036)*	0.116 (0.174)	-0.015 (0.095)	0.019 (0.188)	0.187 (0.093)*[c]	-0.118 (0.175)	-0.046 (0.091)
Belief about livestock-wildlife conflict (-1 = decrease, 0 = no change, 1 = increasing)	-0.040 (0.040)	-0.017 (0.040)	-0.130 (0.114)	-0.160 (0.105)	0.160 (0.122)	0.051 (0.106)	0.217 (0.112)	0.056 (0.102)
Knew other protected area = 1, did not know = 0	-0.274 (0.052)*	-0.275 (0.053)*	n/a	n/a	n/a	n/a	n/a	n/a
Reported benefits from protected area = 1, did not report benefits = 0	n/a	n/a	n/a	n/a	-0.026 (0.145)	0.058 (0.108)	0.188 (0.132)	0.208 (0.101)*
Reported costs from protected area = 1, did not report costs = 0	n/a	n/a	-0.036 (0.126)	0.053 (0.106)	n/a	n/a	-0.362 (0.117)*	-0.254 (0.100)*
Positive attitude toward protected area = 1, Negative attitude = 0	n/a	n/a	0.165 (0.133)	0.210 (0.107)*[c]	-0.415 (0.135)*	-0.271 (0.107)*	n/a	n/a
Regression results								
Log restricted-	-245.09	-246.78	-97.00	-121.69	-100.76	-122.85	-97.01	-120.04

likelihood								
Wald χ^2(df)	194.53 (44)	238.68 (44)	69.14 (40)	79.82 (39)	49.97 (40)	58.23 (39)	64.34 (40)	64.67 (39)
Prob> χ^2	0.0000	0.0000	0.0029	0.0001	0.1341	0.0245	0.0087	0.0060

* Statistically significant at $p<0.05$
Village variables not reported to protect the confidentiality of respondents and because they were only included to account for statistical similarities among households in the same village
a – SNP = Serengeti National Park and CPA = closest protected area
b – Convergence not achieved. Re-ran without random effects and convergence achieved.
c – Regressor not significant when re-ran without random effect (only applicable to benefit and cost regressions for closest protected area where convergence was not achieved)

Discussion

Knowledge of Protected Areas

Knowledge of protected areas in the Serengeti ecosystem, as represented by people who knew about areas with resource use restrictions, is quite low. Serengeti National Park is an iconic conservation site known around the world and yet less than one-third of the local population was aware of the existence of the park. Knowledge of other protected areas, which are all within five kilometers of village boundaries or sometimes contains villages within their borders, was even lower. Understanding who is knowledgeable about protected areas shows where conservation activities, both in giving benefits and imposing costs through antipoaching patrols, have succeeded and failed in having an impact on local communities.

My results show that females are less likely than males to know of both Serengeti National Park and their closest protected area. Males are more likely to engage in activities that bring them in connection with the park and their closest protected areas (e.g. bushmeat hunting, livestock grazing, collection of building materials) and consequently males are more likely to know the areas of restricted natural resource use. This suggests that there is some knowledge about restrictions on resource use for those most likely to use the resources. However, knowledge is still so low, even among males, that conservation activities are not sufficiently impacting local communities.

Somewhat surprisingly, knowledge of either Serengeti National Park or the closest protected area (game reserve or game controlled area) decreased the probability of knowing about the other. Households in the Southwest are buffered from Serengeti

National Park by Maswa Game Reserve and though some in the Southwest knew of Maswa virtually no one in the Southwest knew of Serengeti National Park. Conversely, people in the East knew about Serengeti, but not about their closest protected area. Only four out of 147 respondents knew of Loliondo Game Controlled Area despite the fact that many of the respondents actually live inside the game controlled area. This result is likely due to the fact that people in the East do not consider the game controlled area an area of natural resource use restriction because grazing (their main livelihood) is not restricted. Only people in the Northwest had knowledge of both the park and their closest protected area. Even there, however, only 26% of people knowledgeable about the park or their closest protected area knew of both and there was still a negative correlation between knowledge of the park and closest protected area. The close proximity households in the Northwest have to both their closest protected area and the park, the fact that villages in the Northwest area near a major road leading out of national park, and the fact that the game reserves are managed by a very active private company all likely explain why some households in the northwest knew of both areas. However, the relatively small portion of households in the Northwest that mentioned both protected areas suggests that people are lumping protected areas together, knowing that in general there are areas of natural resource use restrictions, but not necessarily knowing where one protected area begins and another ends.

The spatial discrepancy in knowledge is further highlighted by two other statistically significant results. Those who believe crop conflict is increasing are 15% more likely to know their closest protected area than those who believe crop conflict is decreasing. However, crop conflict is more of a concern to the west of the park because of the predominance of agropastoralists than it is to the east of the park where people are primarily pastoralists. This dichotomy mirrors the spatial differences in knowledge, with those in the Southwest knowledgeable about their closest protected area and those in the East not knowledgeable. Ninety percent of people in the East were livestock owners, compared to less than a third for other areas. Therefore, the result that livestock owners are more likely to know of the park corresponds to the spatial difference in knowledge of Serengeti National Park between the East and Southwest.

The results from the knowledge analysis suggest conservation activities in the Serengeti ecosystem are not fully engaging local people. The national park's community-based conservation and antipoaching activities are not affecting villages in any manner to promote conservation in the Southwest; evidenced by the fact these villages do not know about the park. Similarly, Loliondo Game Controlled Area, though providing revenue as a protected area to the government, is not linking this revenue back to local communities in the East in any significant way. The lack of knowledge about protected areas in the Serengeti ecosystem is a considerable hurdle for conservation efforts to overcome in trying to influence local people's behavior. In order to link benefits with conservation and thus influence people's behaviors, local people need to know about the protected areas providing the benefits.

The lack of knowledge of protected areas can skew studies that do not first identify those that are knowledgeable and those that are not. The findings from my study about benefits, costs and attitudes are a subset of my data, comprising only those knowledgeable about areas of natural resource use restrictions, i.e. the park or their closest protected area. Consequently, although some results suggest conservation has had some success, the success is only with the small percentage of people who knew of the protected areas.

Reported Benefits from Protected Areas

Despite decades of community-based conservation activities aimed at providing benefits to local people less than half of those knowledgeable of protected areas reported benefits from the areas; with 48% of the population reporting benefits from the park and only 40% reporting benefits from their closest protected area. Understanding who is more likely to report benefits can help identify aspects of current benefit streams that are or are not working. There was only one characteristic that had a statistically significant relationship with reporting benefits from Serengeti National Park. People who report benefits from wildlife (e.g. cash from tourism, bushmeat, building of schools, cultural, etc) are 32% more likely to report benefits from Serengeti. This suggests that the park's community-based conservation activities are linking the park and wildlife. This linkage

can benefit conservation by increasing the benefits local people see from wildlife, though to truly change behaviors benefits need to be conditional on conservation performance.

Characteristics correlated with reporting benefits from one's closest protected area show possible failures in current benefit streams. Females were 33% less likely to report benefits from their closest protected area than males, a finding supported by Gillingham & Lee (1999) who found women were less likely to perceive benefits from wildlife in Southern Tanzania. This finding suggests that community-based conservation has failed to convince women they benefit from conservation. The majority of all the benefits mentioned by men and women were infrastructure projects, which also showed a gender bias toward males reporting. Woman are therefore, not linking the benefits with conservation areas or simply do not perceive them as benefits from the areas. Gillingham & Lee (1999) attribute the gender difference to the marginalization of Muslim women in their study area and a similar effect may explain my results. The benefits from protected areas are given at the village level and men predominantly run village affairs. Consequently women may not be knowledgeable about the link between benefits and the protected areas. This gender difference needs to be investigated further, but meanwhile conservation managers can begin making more of an effort to make sure women hear about their infrastructure projects. Ensuring women are realizing benefits is important despite the fact that men predominantly engage in the illegal harvesting of natural resources. Women enter protected areas for water and fuelwood collection and community-based conservation arose with a humanitarian agenda that makes gender differences in benefit streams concerning.

My results also show that the Sukuma and Kurya people are less likely to report benefits as compared to other ethnic groups (not including the Maasai who showed no statistically significant difference in reporting benefits as compared other ethnic groups). The Sukuma people are primarily found in the Southwest and it thus appears that they are not benefitting from Maswa Game Reserve despite government revenues from tourist hunting that are legally mandated to be returned to the village. There may be a failure in returning money to the villages or more likely the village level benefits generated from the revenues are not known by individual households. The Kurya people are found in

villages further from the local private company's sphere of influence and thus are likely receiving fewer benefits.

Reported Costs from Protected Areas

Costs of living near protected areas can be significant (Holmern et al. 2007; Kaswamila et al. 2007). These costs come in many forms, but the most common are livestock depredation and crop destruction. Furthermore, antipoaching efforts seek to impose costs on local people through fines and arrests to deter illegal natural resource use. Examining the characteristics of who is reporting costs from protected areas can help identify problems with antipoaching efforts as well as identify populations of those incurring significant costs from living near conservation areas. Conservation managers may then decide to focus community-based conservation efforts on those incurring larger costs in an effort to more equitably align costs and benefits from conservation.

People who report bushmeat benefits from wildlife, i.e. most likely the people suffering the cost of getting arrested for poaching, are more likely to report costs from the Serengeti National Park. This outcome suggests the park's antipoaching efforts are at least effective in causing recognition in local people that there is a cost to poaching. However, simply because people report the cost does not mean that the cost is sufficient to stop poaching. Furthermore antipoaching costs as a deterrent is only effective for those who know that these areas have natural resource use restrictions.

Three groups of people were more likely to report costs, people reporting wildlife conflict, those who are older, and those with higher educations. Two variables that were statistically significant represent people who report wildlife conflict, livestock owners and those who believe crop conflict is increasing. The effect from both variables in the regression suggest that people reporting wildlife conflict were more likely to report costs from protected areas. Conservation benefits need to focus on those individuals incurring wildlife damage and should provide assistance to local people for this damage. However, these benefits need to be conditional on households taking measures to minimize their own risks of wildlife damage through such actions as improving the fences surrounding livestock pens and guarding their crops. Furthermore, the correlation between reporting of costs from wildlife and protected areas suggests that people are blaming protected

areas for wildlife damage. If conservation efforts increase the level of knowledge local people have of protected areas the increase in knowledge will likely coincide with increases in the reporting of costs from protected area.

People who are older and those who have more education are also more likely to report costs. Older people may simply be more likely to report costs from their closest protected area because they have had more chance to experience a cost. However, it may also be that older people remember the "good old days" of fewer restrictions on resource use, more ineffective antipoaching, and possibly less wildlife conflict, and thus are more likely to report costs because of their historical comparison.

My finding that people with more of an education are more likely to report costs is perplexing because people with more of an education are also more likely to have a positive attitude, but costs and having a positive attitude are negatively linked. People with a higher education may be reporting more costs from their closest protected area because they are more likely to link wildlife costs with protected areas and have the confidence to vocalize these concerns. Furthermore, their education may provide them with an appreciation for conservation and thus they also have a positive attitude, despite the acknowledgement that there are costs. This is an interesting hypothesis, especially in that it suggests more education can break the link between costs and attitude. However, I do not have a high degree of confidence in these results because education was not significant when I ran the cost regression without the random effects of subvillage (p-value = 0.082, though the coefficient had the same sign).

Attitude toward Protected Areas

By examining attitudes of local people living near protected areas, conservationists can obtain an indication of whether their efforts are affecting local communities. Community-based conservation has improved local attitudes in Tanzania (Newmark et al. 1993; Gillingham & Lee 1999; Songorwa 1999; Kideghesho et al. 2007). However, problems with wildlife also link with attitudes (De Boer & Baquete 1998; Kideghesho et al. 2007). My data reflect the interplay of costs and benefits on attitudes with only half of people having a positive attitude toward the park and less than 40% having a positive attitude toward their closest protected. Reporting costs from both

Serengeti National Park and one's closest protected areas were negatively associated with positive attitudes toward each respective area. Reporting benefits from one's closest protected area was positively associated with having a positive attitude. Consequently, community-based conservation may be providing benefits, but if the costs are high attitudes will still remain negative.

One interesting result that highlights this interplay of costs and benefits is that people reporting bushmeat benefits are more likely to have a positive attitude, even though they are also more likely to report costs. This suggests that while getting benefits from bushmeat increases the costs in terms of getting arrested, the food and cash benefits from bushmeat are still larger than the cost of arrest. These higher benefits then drive the positive attitudes.

There are three other characteristics, besides reporting costs from the park, that decrease the likelihood of having a positive attitude toward Serengeti National Park. Farm size, being Kurya, and distance from one's closest protected area. Larger farms have more to lose from wildlife damage and perhaps are consequently more negative toward the source of that wildlife. The Kurya people are traditional hunters in the ecosystem and may be more likely to have negative attitudes because of resentment about prohibitions on bushmeat hunting and because as noted in the benefits regression, they are less likely to report benefits. Finally, for those further from their closest protected area (correlated with an increased distance from Serengeti National Park for all but two villages), the cost-benefit ratio becomes more unbalanced toward costs, causing negative attitudes. Those further from the park have higher net costs because benefits from Serengeti decrease with distance while wildlife conflict may actually rise. As wild prey populations decrease further from the park, predators switch to hunting livestock. This is supported by my finding that people losing cattle to wildlife lived statistically *further* from Serengeti National Park than those who were not losing cattle (t-test, $p>|t| = 0.004$, $df = 17$).

Owning livestock increased the likelihood of having a positive attitude, although owning livestock also increased the likelihood of reporting costs. In the attitude regression I control for costs and thus for all people reporting costs (who are overall less

likely to have a positive attitude), those that are livestock owners are more likely to have a positive attitude. I control for many other variables including benefits, income, education, etc. However, due to collinearity with other variables, my two variables for people in the East (area and Maasai ethnicity) were dropped. People in the East are much more likely to be livestock owners since the majority of the people are traditional pastoralists. Consequently, the finding that livestock owners are more likely to have a positive attitude may represent people in the East. The people in the East are generally not bushmeat hunters and thus not coming into conflict with antipoaching patrols, unlike those people to the West.

There is a final result that has not been found in other studies and for which I have no plausible explanation. Reporting benefits from wildlife decreased the likelihood of having a positive attitude toward one's closest protected area. Other studies find that reporting benefits from one's closest protected area increased the likelihood of a positive attitude (Newmark et al. 1993; Gillingham & Lee 1999; Songorwa 1999; Kideghesho et al. 2007). Reporting benefits from wildlife should increase, not decrease, the likelihood of a positive attitude.

Conclusions

Ultimately local people's behaviors, as opposed to attitudes, are what impacts conservation. However, monitoring people's behaviors is difficult given the illegal nature of natural resource consumption and given the resources required to monitor wildlife populations. For these reasons many conservationists have relied on attitudes as a proxy for behavior despite the fact that attitudes do not affect conservation. Incorporating knowledge, benefits, and costs, with attitudinal studies provides a more complete assessment of conservation than attitudinal data alone. By first identifying those knowledgeable of protected areas, socioeconomic relationships with benefits, costs, and attitudes emerge that may have otherwise been obscured in data that was not filtered by knowledge. Furthermore, attitudinal data itself cannot explain why certain people have more positive attitudes, but the examination of benefits highlights groups that are not recognizing benefit streams. The revelation that local people do realize there is a cost to

bushmeat hunting, but that this cost is lower than the benefits could only be determined with attitudinal *and* cost data.

Along with yielding a more complete assessment of conservation; evaluating knowledge, benefits, and costs provides conservationists insights into policy changes that can affect behaviors and thus directly impact conservation. The low levels of knowledge of protected areas show that benefits from community-based conservation and costs from antipoaching patrols are not influencing the behaviors of the majority of people around the ecosystem. Furthermore, people are lumping conservation areas together rather than distinguishing between the various conservation areas. Conservationists need to more clearly delineate these protected areas so that the benefits and costs of each area can accurately affect local people's behaviors. Local people are linking benefits from wildlife and benefits from Serengeti National Park, which is important for changing poaching behaviors, but certain groups of people are less likely to report benefits and thus may be less inclined to engage in conservation minded behaviors. Local people consider arrests for illegal bushmeat hunting a cost, but the benefits from hunting are great, likely leading to the observed positive attitudes toward the national park on the part of bushmeat hunters. However, given these costs and benefits, current antipoaching efforts are not sufficient to effectively curtail bushmeat hunting behaviors.

Evaluating attitudes is important, but the complexity of conservation in the Serengeti ecosystem and elsewhere is not captured in attitudinal data alone. The costs and benefits of conservation also affect the behaviors of local people. Furthermore, the impact on behaviors of cost/benefit and attitudinal data may conflict. Attitudes may be negative, but conservation may improve because antipoaching has driven up the costs of bushmeat hunting. Only by incorporating analysis on other facets of conservation, namely knowledge, benefits and costs, can conservationists untangle the variables affecting local people's behaviors and improve conservation policies.

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Appendices

Appendix I: Household Questionnaire

Household Socioeconomic Survey **Questionnaire No._____**
Date _____ Village_____ Sub Village_____
Ward _____Division _____
District_____
Region_____
Name of interviewer_____
Name of interviewee_____
Marital Status: 01 Married (spouse lives here) _____ 02 Married (spouse lives elsewhere) ____ 03 Widowed _____ 04 Divorced/ Separated _____ 05 Single _____
Position in the household: 01 Husband ____ 02 Wife ____ 03 Other _____
GPS Location – UTM Zone: _____ Easting:_____
Northing:_____
Checked by:_____
Interview start time: _____ End time: _____
Level of cooperation: 1 2 3 4 5 (low to high)
Level of understanding: 1 2 3 4 5
Comments:

Section A: Demographic Information

1. Gender : 00 Male _____ 01 Female _____
2. Age: _____
3. Tribe:_____
4. Number of people living in the household:_____
5. Number of wives: _____

Sex	Age (yrs)	Current level of education	Education attained	If in secondary school	
				What school is the child attending (government / private)	Who pays the school fees?

(Primary (standard 1-7), Secondary/high school (form 1-6), Diploma, Vocational, University)

6. Main occupation of household head:_____
7. Are you a member of the village government or on a village committee? 00 No_____ 01 Yes _____
8. Place of birth: 01 This village ___ 02 This ward ___ 03 This district ___ 04 This region ___ 99 Other (specify if different country) _____
9. If not this village why did you move here (***Do not prompt***):
   01 Marriage ___ 02 Employment ___ 03 Grazing ___ 04 Cultivation ___ 05 Natural resources (specify) _____ 06 Villagization ___ 99 Other (specify) _____
10. Religion of respondent: 01 Christian _____ 02 Muslim_____ 03 None _____ 99 Other (specify) _____

Section B: Economic profile

11. How many household members are earning income through employment such as employment, small businesses, causal workers? _____
12. Do you own a farm? 00 No _____ 01 Yes _____ 02 Rent _____

    a. If yes or rent, how many acres did you cultivate in the last twelve months?
    b. How much did you harvest within the last twelve months (***Prompt appropriately***)?

	Crops	**Tick if harvested**	**No. of units harvest (specify units)**
1	Maize		
2	Beans		
3	Cassava		
4	Paddy		
5	Sunflower		
6	Onions		
7	Millet		

8	Simsim		
9	Groundnuts		
10	Cashews		
11	Tobacco		
12	Sweat potatoes		
13	Tomatoes		
14	Vegetables (specify)		
15	Coffee		
16	Tea		
17	Cotton		
18	Coconut		
19	Bananas		
20	Mangos		
21	Papaya		
22	Fruit (specify)		
23	Sorghum		
99	Other (specify)		

13. Do you own any of the following?

	Animals	**Number**	**How many animals did you sell last year?**
01	Cattle		
02	Sheep		
03	Goats		
04	Pigs		
05	Chickens		
06	Chicks		
07	Donkeys		
08	Duck		
09	Dogs		
10	Cats		
99	Others (specify)		

14. What times of the year do you most often sell chickens?

01 Jan	02 Feb	03 Mar	04 Apr	05 May	06 June	07 July	08 Aug	09 Sept	10 Oct	11 Nov	12 Dec

13 do not sell ___, 14 anytime ____

15. Where do you sell your chickens? 01 Larger area market (mnada) ___ 02 Within the village ___ 99 Other (specify)_____

16. What times of the year do you most often buy chickens?

01 Jan	02 Feb	03 Mar	04 Apr	05 May	06 June	07 July	08 Aug	09 Sept	10 Oct	11 Nov	12 Dec

13 do not buy ___, 14 anytime ____

17. Where do you get your chickens? 01 Larger area market (mnada) ___ 02 Within the village ___ 03 Given as gift ___ 04 Hatch them ___ 05 Do not buy ___ 99 Other (specify) _____

18. How much of the following products do you produce in a week?

Livestock product	**# Units / week**	**# Units Sold**	**# Units Hatched**	**# Units Eaten / # Units Drunk**
01 Eggs				
02 Milk				
03 Honey				
99 Other (specify)				

19. How much income is earned by the household through the following activities in the last twelve months (***Interviewer should estimate 01, 02, and 03***):

Amount per year	farming (01)	livestock (02)	Natural resources (03)	Other activities (04)	Other income (05)	Remittance (06)
00 Zero						
01 Below 20,000						
02 Between 20,001 and 40,000						
03 Between 40,001 and 60,000						
04 Between 60,001 and 100,000						
05 Between 100,001 and 150,000						
06 Between						

150,001 and 200,000						
07 Between 200,001 and 300,000						
08 Between 300,001 and 500,000						
09 above 500,000						

01. Farming activities
02. From sale of livestock or livestock products (on a household level not large-scale trade)
03. From natural resource activities (business based on honey, timber, charcoal, grass, fish, meat, etc),
04. From other forms of work (salaried, casual labor, working in a bar, non-natural resource based business, etc)
05. From other forms of income (own business, rental property, sales of property, rental of equipment, etc.)
06. From remittance (gifts or assistance from your children or others)

20. Which of the following assets do you own?

	Assets	**Number**
01	House	
02	Cart	
03	Hoes	
04	Motorcycle	
05	Boat	
06	Bicycle	
07	Plough	
08	Tractor	
09	Sewing machine	
10	Total farm land cultivated and fallow (acres)	
11	Refrigerator	
12	Generator	
13	Wheel barrel	
14	Kerosene Stove	
15	Radio	
16	Water tank	

17	Improved charcoal stove	
18	Gun	
19	Car	
20	Cell phone	
21	Chicken coop	
22	Solar panel	
23	Solar panel battery	
99	Others (specify)	

21. What type of stove do you use for cooking? (*Tick all that apply*)
    01 Fuel wood stove ___ 02 Kerosene stove ___ 03 Charcoal stove ___ 04 Electric hot plate or cooker ___ 05 Biogas Stove___ 99 Other (specify) __

Section C: Natural Resource Use

22. Which types of the following natural resources do you use (both from harvesting or purchasing)?

Resource Use	**Frequency (i.e. daily, weekly, monthly, yearly, etc.)**	**Species used**	**Which of these species do you prefer? 00 Not preferred 01 Preferred**	**Are there other species you prefer that are no longer available?**
01 Firewood for cooking food				
02 Firewood for cooking local brews				
03 Grasses for roofing				
04 Medicinal plants				
05 Wood for bricks burning				
06 Grass for grazing				
07 Building equipment				

08 Game meat				
09 Beehives				
10 Timber				
11 Charcoal				
99 Other (specify)				

Section D: Livestock

23. How much livestock did you lose to the following factors in the last twelve months? (*Write total number under each animal*)

Factors	**01 Cows**	**02 Sheep/Goats**	**03 Donkeys**	**04 Chickens/Chicks**	**05 Pigs**	**06 Dogs**
01 Diseases (specify)						
02 Drought						
03 Theft						
04 Wild animals and/or dogs (specify)						
99 Other (specify)						

24. Is there Newcastle disease in this village? 00 No ___ 01 Yes ___

25. (a) What time of the year is Newcastle disease worse?

01 Jan	02 Feb	03 Mar	04 Apr	05 May	06 June	07 July	08 Aug	09 Sept	10 Oct	11 Nov	12 Dec

14 anytime ____

(b) Why? _____

26. Do you vaccinate your chickens? 00 No ___01 Yes___
    a. If yes, against which disease(s) _____

27. What is done with a chicken after it dies from disease (***Do not prompt***)? 01 Burn it ____ 02 Throw it away ____ 03 Feed it to dog ___ 04 Eat it ___ 05 Sell it ____ 99 Other (specify) ____

Section E: Human wildlife interactions

28. What benefits do you get from wild animals (***Do not prompt***)? 01 Cash from tourism ___ 02 Cash from game meat ___ 03 Environmental conservation project ___ 04 Cultural ___ 05 Gift of game meat from friend or relatives ___ 99 Other (specify) _____

29. What problems do you face related to wild animals (***Do not prompt***)?
    01 Livestock diseases ___ 02 People injured ___ 03 Crop destruction ___ 04 Livestock injured ___ 99 Other (specify) _____

30. At what season of the year do you face problems with wild animals? For the past five years have the problems increased or decreased?

Conflict Type	**Season**	**Change**	**Why**	**What animals**	**How do you address the problems?**
01 Crops	01 Wet	01 Increased			
	02 Dry	02 Decreased			
	03 Both	03 No change			
	04 Neither	04 Do not know			
02 Livestock (include dogs)	01 Wet	01 Increased			
	02 Dry	02 Decreased			
	03 Both	03 No change			
	04 Neither	04 Do not know			
03 Chickens	01 Wet	01 Increased			
	02 Dry	02 Decreased			

	03 Both	03 No change			
	04 Neither	04 Do not know			
04 Human beings	01 Wet	01 Increased			
	02 Dry	02 Decreased			
	03 Both	03 No change			
	04 Neither	04 Do not know			

Section F: Attitudes and Knowledge about Protected Areas

31. Are there any areas in or near your village where the use of natural resources is restricted? (***Do not prompt***. *If none are mentioned skip to section G).*

Code	Protected Area	Management organization
PA01		
PA02		
PA03		
PA04		

32. Have any of the protected area managers ever done any of the following (***Prompt***)?

01 Passed through
02 Stopped to purchase supplies
03 Stopped for a drink
04 Greeted the village leaders
05 Posted Fliers
06 Hosted a village meeting

PA Management	Activity	# of times in the last 12 months	Initial year of contact
PA01			
PA02			
PA03			
PA04			

33. From (*list each previously mentioned protected area*), what benefits have you received? What problems have you had with the area? (***Do not prompt***)

Protected Area	Benefit (*if monetary how much and what was done with the money*)	Problem
PA01		
PA02		
PA03		
PA04		
PA99 unknown source		

34. Which groups of people have benefited most from protected area management support?

    01 Mostly the poor ___ 02 Mostly the rich ___ 03 Everyone in the village ___ 04 A few select individuals ___ 05 No one ___

35. How can the protected area managers help you or the village? _____

    _____

    _____

36. How would you feel if (*list each previously mentioned protected area*) was degazetted (***Prompt***)? Why?

Protected Area	Feeling	Why
PA01	01 Happy	
	02 Sad	
	03 Indifferent	
	00 Not answered	

PA02	01 Happy	
	02 Sad	
	03 Indifferent	
	00 Not answered	
PA03	01 Happy	
	02 Sad	
	03 Indifferent	
	00 Not answered	
PA04	01 Happy	
	02 Sad	
	03 Indifferent	
	00 Not answered	

Section G: Attitudes and Knowledge about Hunting

Hunting Companies

37. What hunting companies operate in and near this village? In which hunting block is the company located? (***Do not prompt****. If none are mentioned, skip to question 43*).

Code	**Hunting Block (Area)**	**Hunting Company (Manager)**
HC01		
HC02		
HC03		
HC04		

38. Have any of the hunting companies ever done any of the following (***Prompt***)?

    01 Passed through
    02 Stopped to purchase supplies
    03 Stopped for a drink
    04 Greeted the village leaders
    05 Posted Fliers
    06 Hosted a village meeting

Company	**Activity**	**# of times in the last 12 months**	**Initial year of contact**
HC01			
HC02			

HC03			
HC04			

39. From (*list each previously mentioned hunting company*), what benefits have you received? What problems have you had with the company? (***Do not prompt***)

Hunting Company	Benefit (*if monetary how much and what was done with the money*)	Problem
HC01		
HC02		
HC03		
HC04		
HC99 unknown source		

40. Which groups of people have benefited most from hunting company support?
    01 Mostly the poor ___ 02 Mostly the rich ___ 03 Everyone in the village ___
    04 A few select individuals ___ 05 No one ___

41. How can the hunting companies help you or the village?_____
    _____

42. How would you feel if (*list each previously mentioned hunting block*) was removed (***Prompt***)? Why?

Hunting Block	Feeling	Why
HC01	01 Happy	

	02 Sad	
	03 Indifferent	
	00 Not answered	
HC02	01 Happy	
	02 Sad	
	03 Indifferent	
	00 Not answered	
HC03	01 Happy	
	02 Sad	
	03 Indifferent	
	00 Not answered	
HC04	01 Happy	
	02 Sad	
	03 Indifferent	
	00 Not answered	

Illegal hunting

43. Does poaching happen on your village land? 00 No __ 01 Yes__

44. Does poaching happen in areas surrounding your village lands? 00 No__ 01 Yes__

45. Where are the poachers coming from? 01 This village ___ 02 Neighboring villages ___ 03 Larger towns (specify)_____ 99 Other (specify) _____

46. Is poaching an important activity for people in the village? 00 No ___01 Yes ___

47. Which animals do poachers most commonly hunt?
_____

48. According to your knowledge, in the past 5 years, has poaching from your village: 00 No poaching ___ 01 Increased ___ 02 Stayed the same ___ 03 Decreased ___ 04 Do not know ___

49. If it has increased or decreased, what do you think is the primary reason for the change? _____
_____

Section H: Attitudes and Knowledge about Photographic Tourism

50. What photographic safari companies or camps operate in or near this village? Specify if it is a company or a camp. (***Do not prompt****. If none mentioned skip to section I.*)

Code	Photographic safari company	Photographic safari campsite	*Tick if do not know if company or camp*
PS01			
PS02			
PS03			
PS04			

51. Have any of the photographic companies ever done any of the following (***Prompt***)?

    01 Passed through
    02 Stopped to purchase supplies
    03 Stopped for a drink
    04 Greeted the village leaders
    05 Posted Fliers
    06 Hosted a village meeting

Company	**Activity**	**# of times in last 12 months**	**Initial year of contact**
PS01			
PS02			
PS03			
PS04			

52. From (*list each previously mentioned photographic company and/or camp*), what benefits have you received? What problems have you had with the company/camp? (***Do not prompt***)

Photographic Company/Camp	Benefit (*if monetary how much and what was done with the money*)	Problem
PS01		

PS02		
PS03		
PS04		
PS99 unknown source		

53. Which groups of people have benefited most from the photographic safari companies?
    01 Mostly the poor ___ 02 Mostly the rich ___ 03 Everyone in the village ___
    04 A few select individuals ___ 05 No one _____

54. How can photographic safari companies help you or the village? _____
    _____
    _____

55. How would you feel if (*list each previously mentioned photographic safari company*) was removed (***Prompt***)? Why?

Photographic Safari Company	Feeling	Why
PS01	01 Happy	
	02 Sad	
	03 Indifferent	
	00 Not answered	
PS02	01 Happy	
	02 Sad	
	03 Indifferent	
	00 Not answered	
PS03	01 Happy	
	02 Sad	

	03 Indifferent	
	00 Not answered	
PS04	01 Happy	
	02 Sad	
	03 Indifferent	
	00 Not answered	

Section I: Houses

56. (*Use observation for houses and toilets located at your location. Check only one primary material for walls, floors and roof. For houses/toilets at another location, ask respondent:* What material(s) were used to build your other house(s)? Do you have a toilet at your other house? If so, is it pit or flush?)

Materials	**House 1**	**House 2**	**House 3**	**House 4**	**House 5**
Walls					
01 Cement blocks					
02 Burnt bricks					
03 Mud and poles					
04 Sheet metal					
05 Wood					
06 Thatch					
07 Mud bricks					
08 Lime and stone					
99 Other (specify)					
Floor					
01 Cement and sand					
02 Earth / Clay					
99 Other (specify)					
Roof					
01 Thatching grass / palm thatch					
02 Mud poles and grass					
03 Mud and dry leaves (banana tree bark, coconut leaves, etc.)					
04 Corrugated iron sheets					

(aluminum)					
05 Tiles					
06 Thatch grass and poles					
99 Other (specify)					

Type	**Toilet 1**	**Toilet 2**	**Toilet 3**
01 Pit			
02 Flush			
00 None			

Appendix II: Village Leader Questionnaire

Village Leadership Questions **Questionnaire No. _____**

Date _____
Village_____
Ward_____ Division _____
District _____ Region _____
Name of Enumerator _____
GPS Location UTM Zone:____ Easting:_____ Northing:_____
Checked by: _____
Interview start time:_____ End time:_____
Name/Title of Interviewees

Name	Title	Time serving in village government

Section A: Demography

1. Population size of the following categories and source (*i.e. 2002 census, district profile, etc.*)

Category	**Number**	**Source**
Total Population		
Total Males (all ages)		
Total Females (all ages)		
Total Number of Households		

2. What is the total area of your village lands? _____

3. Are people (including relatives and friends) moving permanently into the village?
   01 Yes ___ 02 No ___

4. If yes, why? _____
   _____

5. Do you allow immigration (including relatives and friends) into the village?
   01 Yes_____ 02 No_____

6. Is there seasonal immigration (including relatives and friends) into the village? 01 Yes _____ 02 No _____
7. How does the village regulate immigration (including relatives and friends)?

   _____

   _____

8. List the main ethnic groups in the village

Names of main ethnic groups
1.
2.
3.
4.
5.
6.

Section B: Livelihoods

9. List the most common forms of livelihood strategies in this village and then rank them in order of importance (***Prompt*** *- tick those respondent mentions*)

Livelihoods	**Tick**	**Rank**
01 Cash Crops		
02 Subsistence farming		
03 Small Business		
04 Wage Employment		
05 Livestock		
99 Other (specify)		
99 Other (specify)		

10. What are the sources of cash for people in your village? (**Prompt** - tick *ones that apply and rank the sources of cash mentioned by the respondent with one being the most important source of cash.*)

Sources of Cash	**Tick**	**Rank**
01 Charcoal		
02 Game meat		
03 Medicinal plants		
04 Timber		
05 Building poles		
06 Thatching grass		
07 Firewood		
08 Bee hives		
09 Alcohol		

Section C: Institutions

11. Do you have the following? (*Tick all that apply*)

Category	**Tick**
01 Natural resources committee	

02 Education committee	
03 Water committee	
04 Agricultural and livestock committee	
05 Elder’s committee	
06 Woman’s committee	
07 Land Committee	
08 Hazards Committee	
99 Other (specify)	
99 Other (specify)	
99 Other (specify)	

12. What types of organizations work in the villages and what activities do they do?

Gov = Governmental *Envi = Environmental*
NGO = Non-governmental *Dev = Development*
Int = International *Rel = Religious*
Nat = National *D K = Do not Know*
Loc = Local

Organization	**Type (*Prompt*)**		**Activities**
	01 Gov ___ 02 NGO ___ 03 D K ___ 01 Int ____ 02 Nat ____ 03 Loc ____ 04 D K ____	01 Envi ____ 02 Dev ____ 03 Rel ____ 04 D K ____ 99 Other ____ (specify) _______________	
	01 Gov ___ 02 NGO ___ 03 D K ___ 01 Int ____ 02 Nat ____ 03 Loc ____ 04 D K ____	01 Envi ____ 02 Dev ____ 03 Rel ____ 04 D K ____ 99 Other ____ (specify) _______________	
	01 Gov ___ 02 NGO ___ 03 D K ___ 01 Int ____ 02 Nat ____ 03 Loc ____ 04 D K ____	01 Envi ____ 02 Dev ____ 03 Rel ____ 04 D K ____ 99 Other ____ (specify) _______________	
	01 Gov ___ 02 NGO ___ 03 D K ___	01 Envi ____ 02 Dev ____ 03 Rel ____	

	01 Int ____ 02 Nat ____ 03 Loc ____ 04 D K ____	04 D K ____ 99 Other ____ (specify) _____	
	01 Gov ___ 02 NGO ___ 03 D K ___ 01 Int ____ 02 Nat ____ 03 Loc ____ 04 D K ____	01 Envi ____ 02 Dev ____ 03 Rel ____ 04 D K ____ 99 Other ____ (specify) _____	
	01 Gov ___ 02 NGO ___ 03 D K ___ 01 Int ____ 02 Nat ____ 03 Loc ____ 04 D K ____	01 Envi ____ 02 Dev ____ 03 Rel ____ 04 D K ____ 99 Other ____ (specify) _____	

Section D: Relation to Protected Areas

13. Are there any areas in or near your village where the use of natural resources is restricted? (***Do not prompt.*** *If none are mentioned, skip to Section E*).

Code	Protected Area	Management organization
PA01		
PA02		
PA03		
PA04		

14. Have any of the protected area managers ever done any of the following (***Prompt***)?

01 Passed through
02 Stopped to purchase supplies
03 Stopped for a drink
04 Greeted the village head
05 Posted Fliers
06 Hosted a village meeting

PA Management	Activity	# of times in the last 12 months	Initial year of contact
PA01			
PA02			

PA03			
PA04			

15. From (*list each previously mentioned protected area*), what benefits has your village received? What problems has your village had with the area? (***Do not prompt***)

Protected Area	Benefit (*if monetary how much and what was done with the money*)	Problem
PA01		
PA02		
PA03		
PA04		
PA99 unknown source		

16. What, if anything does the village earn from each protected area in a year and what is done with the earnings? (*Repeat each previously mentioned protected area.*)

Protected Area	Earnings (Tsh/yr)	What done with earnings?
PA01		
PA02		
PA03		

17. Which groups of people have benefited most from protected area management support? 01 Mostly the poor ___ 02 Mostly the rich ___ 03 Everyone in the village ___ 04 A few select individuals ___ 05 No one ___

18. What if any suggestions do you have for protected area management to help them work more effectively with your village?_____
_____
_____

19. How would you rate the relationship between the protected area (*list each previously mentioned*) and your village on a scale from 1 to 5, with 1 being very poor and 5 being very good? Why? (*Get a group consensus on the rating.*)

Protected Area	Rate	Why?
PA01	1 2 3 4 5 n/a	
PA02	1 2 3 4 5 n/a	
PA03	1 2 3 4 5 n/a	
PA04	1 2 3 4 5 n/a	

Section D: Attitudes and Knowledge about Hunting

Hunting Companies

20.What hunting companies operate in and near this village? In which hunting block is the company located? (***Do not prompt****. If none are mentioned, skip to question 24.)*

Code	**Hunting Block (Area)**	**Hunting Company (Manager)**
HC01		
HC02		
HC03		
HC04		

21. Have any of the hunting companies ever done any of the following (***Prompt***)?
    01 Passed through
    02 Stopped to purchase supplies
    03 Stopped for a drink
    04 Greeted the village head
    05 Posted Fliers
    06 Hosted a village meeting

Company	**Activity**	**# of times in the last 12 months**	**Initial year of contact**
HC01			
HC02			
HC03			
HC04			

22. From (*list each previously mentioned hunting company*), what benefits has your village received? What problems has your village had with the company? (***Do not prompt***)

Hunting Company	Benefit (*if monetary how much and what was done with the money*)	Problem
HC01		
HC02		
HC03		
HC04		

HC99 unknown source		

23. What, if anything does the village earn from each hunting company in a year and what is done with the earnings? (*Repeat each previously mentioned hunting company*.)

Company	Earnings (Tsh/yr)	What done with earnings?

24. Which groups of people have benefited most from hunting company support? 01 Mostly the poor ___ 02 Mostly the rich ___ 03 Everyone in the village ___ 04 A few select individuals ___ 05 No one ___

25. What if any suggestions do you have for hunting companies to help them work more effectively with your village? _____
_____
_____

26. How would you rate the relationship between the hunting company (*list each previously mentioned*) and your village on a scale from 1 to 5, with 1 being very poor and 5 being very good? Why? (*Get a group consensus on the rating.*)

Hunting company	Rate	Why?
HC01	1 2 3 4 5 n/a	
HC02	1 2 3 4 5 n/a	
HC03	1 2 3 4 5 n/a	
HC04	1 2 3 4 5 n/a	

Legal Hunting

27. About how many resident hunters hunt in this area during the hunting season?

# of resident hunters	Tick
0	

1-10	
11-20	
21-30	
More than 30	

28. What, if any, benefits does the village receive from resident hunting?
    _____

29. What, if anything, did the village earn from resident hunting in the last twelve months? _____Tsh

30. What did the village do with these earnings?_____
    _____

31. What, if any, problems has your village had with resident hunters? _____
    _____

32. Which animals are most commonly hunted by resident hunters? _____
    _____

33. What can be done to improve how resident hunting is managed on village land?_____

Illegal Hunting

34. Does poaching happen on your village land? 01Yes ___ 02 No ___

35. Does poaching happen in areas surrounding you village lands? 01Yes ___ 02 No ___

36. Where are the poachers coming from? 01 This village ___ 02 Neighboring villages ___ 03 Larger towns (specify)_____99 Other (specify) _____

37. Is poaching an important activity for people in the village? 01Yes ___ 02 No ___

38. Why do your villagers need to poach? (***Do not prompt****, Tick all that apply*)

Reason	**Tick all that apply**
01 For food for the household	
02 To get trophies for sale	
03 To barter meat for other items	
04 To obtain meat to sell (commercial)	
05 Raise cash to pay taxes/contribution	

06 Raise cash to meet basic domestic needs	
07 Peer pressure / traditional / habitual	
08 Occupation during spare time	
99 Other (specify)	

39. Which animals are most commonly hunted? _____
_____

40. Where would you say most of the game meat is used (***Prompt***)? 01 Eaten in the village ___ 02 Sold to neighboring communities ___ 03 Sold outside the area ___

41. If sold outside the area, where? _____

42. What tools are commonly used for poaching? 01 guns ___ 02 bow & arrow ___ 03 pit falls ___ 04 dogs ___ 05 snares ___ 06 poison ___

43. What do you think could stop people from poaching? (***Do not prompt***. *After list is complete, ask respondent to rank their responses in order of most likely to stop poaching, with one being the most likely.*)

Responses	Tick	Rank
01 More livestock kept by the household		
02 Increased cultivation of food crops		
03 Increased cultivation of cash crops		
04 Improved access to markets to sell farm produce		
05 Marketing schemes for other produce, e.g. honey		
06 Greater opportunities for employment and trade		
07 Increased prices for locally produced goods		
08 Improved health facilities		
09 Alternative sources of game meat		
10 Improved veterinary facilities		
11 Improved availability of livestock meat		
12 Heavy penalties for arrested hunters		
13 Improved transport		
14 Nothing		
99 Other (specify)		
99 Other (specify)		

Section F: Relation to Photographic Tourism

44. What photographic safari companies or camps operate in or near this village? Specify if it is a company or a camp. (***Do not prompt.*** *If none are mentioned, skip to Section G.*)

Code	Photographic safari company	Photographic safari campsite	*Tick if do not know if company or camp*
PS01			
PS02			
PS03			
PS04			

45. Have any of the photographic companies ever done any of the following (***Prompt***)?

01 Passed through
02 Stopped to purchase supplies
03 Stopped for a drink
04 Greeted the village head
05 Posted Fliers
06 Hosted a village meeting

Company	**Activity**	**# of times/year**	**Initial year of contact**
PS01			
PS02			
PS03			
PS04			

46. From (*list each previously mentioned photographic company and/or camp*), what benefits has your village received? What problems has your village had with the company/camp? (***Do not prompt***)

Photographic Company/Camp	Benefit (*if monetary how much and what was done with the money*)	Problem
PS01		

PS02		
PS03		
PS04		
PS99 unknown source		

47. What, if anything does the village earn from each photographic safari company in a year and what is done with the earnings? (*Repeat each previously mentioned photographic safari company/camp*)

Company/Camp	Earnings (Tsh/yr)	What done with earnings?

48. Which groups of people have benefited most from the photographic safari companies? 01 Mostly the poor ___ 02 Mostly the rich ___ 03 Everyone in the village ___
04 A few select individuals ___ 05 No one ___

49. What, if any, suggestions do you have for photographic safari companies to help them work more effectively with your village?_____
_____

50. How would you rate the relationship between the photographic safari company (*list each previously mentioned*) and your village on a scale from 1 to 5, with 1 being very poor and 5 being very good? Why? (*Get a group consensus on the rating.*)

Photographic Company/Camp	Rate	Why?
PS01	1 2 3 4 5 n/a	

PS02	1 2 3 4 5 n/a	
PS03	1 2 3 4 5 n/a	
PS04	1 2 3 4 5 n/a	

Section G: Village Problems

51. What are the three major problems facing this community?
    Problem 1._____
    Problem 2._____
    Problem 3._____

52. How does the village address these problems?
    Problem 1._____
    _____
    Problem 2._____
    _____
    Problem 3._____
    _____

Section H: Human-Wildlife Conflict

53. At what season of the year do you face problems with wild animals? For the past five years have the problems increased or decreased?

Conflict Type	Season	Change	Why?	What animals?	What were the circumstances surrounding the conflict?	How do you address the problems?
01 Crops	01 Wet	01 Increased				
	02 Dry	02 Decreased				
	03 Both	03 No change				
	04 Neither	04 Do not know				
02 Livestock	01 Wet	01 Increased				
	02 Dry	02 Decreased				
	03 Both	03 No change				
	04	04 Do not				

	Neither	know				
03 Chickens	01 Wet	01 Increased				
	02 Dry	02 Decreased				
	03 Both	03 No change				
	04 Neither	04 Do not know				
04 Human beings	01 Wet	01 Increased				
	02 Dry	02 Decreased				
	03 Both	03 No change				
	04 Neither	04 Do not know				

Appendix III: Village Resource Questionnaire

Village Resources Questions **Questionnaire No. _____**

Date _____ Village_____
Ward_____ Division _____
District _____ Region _____
Name of Enumerator _____
GPS Location UTM Zone:____ Easting:_____ Northing:_____
Checked by: _____
Interview start time:_____ End time:_____
Name/Title of Interviewees

Name	Title	Time lived in village

Section A: Infrastructure and Services

Using a map to help with distances answer the following.

1. How far is the village from the following?

Category	**Approximate Distance (*Range Km*)**	**Walking Distance (*Range hrs*)**
01 Main road (*tarmac, all Weather*)		
02 Game reserve boundary (*specify name, if possible*)		
03 National park boundary (*specify name, if possible)*		
04 Hunting block boundary (*specify name, if possible*)		
05 Traveling market (*Mnada*)		
06 Village market		
07 Dispensary/health center		
08 Hospital (specify where)_____		
09 Private clinic		
10 Primary school		

11 Secondary school (specify where)_____		

2. Where are the nearest places to buy and sell the following?

	01 Nearest place to buy		**02 Nearest place to sell**	
	Place	Approximate Distance (*km*)	Place	Approximate Distance (*km*)
01 Maize				
02 Livestock Meat				
03 Wildlife Meat				
04 Vegetables				

Section B: Natural Resources

3. Does your village have a land use plan? 00 No___ 01 Yes___

4. If yes, when did you begin implementing it? _____

5. Where does the village get its water? (***Prompt)***

Type of source	Approximate distance from village (range km and hrs)	Quality of water (*01=clean, 02=muddy, 03=salty, 99=other (specify)*)	Used for how many months? (*range*)	Accessible to how many households?
01 Permanent River				01 All 02 Most 03 Half 04 Few
02 Seasonal River				01 All 02 Most 03 Half 04 Few
03 Bore-hole				01 All 02 Most 03 Half 04 Few
04 Shallow Well				01 All 02 Most 03 Half 04 Few
05 Water pan / Dam				01 All 02 Most 03 Half 04 Few

06 Water Pipeline				01 All 02 Most 03 Half 04 Few
07 Lake				01 All 02 Most 03 Half 04 Few
99 Others (specify)				01 All 02 Most 03 Half 04 Few

6. Where do you get the following resources:

Resource	How far? (*range km and range hrs*)	Why there?
01 Fuelwood		
02 Grazing lands		
99 Other (specify)		

7. List the most commonly used mode of disposing refuse from this village? (***Do not prompt*** *- check all that apply and rank top 3*.)

Mode	**Tick**	**Rank**
01 Dumping in your neighborhood		
02 Burning in your compound		
03 Burying in your compound		
04 Indiscriminate disposal		
05 Local collection system		
06 Organized community collection system		
99 Other (specify)		

8. What are the most common problems addressed by village courts? (***Do not prompt****. After list is completed, ask respondent to rank them in order of most common, with 1 as the most common.*)

Problem	**Tick**	**Rank**
01 Cattle grazing conflict		
02 Cattle rustling		
03 Timber harvest		
04 Charcoal collection		

05 Land tenure issues		
06 Illegal hunting		
99 Other (specify)		
99 Other (specify)		

9. Please rate how often the following activities are done by people coming from outside the village – is the activity done very often, somewhat often, seldom, or never? (***Prompt***)

Activity	**03 Very often**	**02 Somewhat often**	**01 Seldom**	**00 Never**
01 Fuelwood harvesting				
02 Timber harvesting (furniture)				
03 Timber harvesting (building materials)				
04 Cash crop growing (list which crops)				
05 Cattle grazing				
06 Poaching				
07 Fishing				
08 Charcoal collection				
09 Grass collection				
10 Water collection				
99 Other (specify)				

Section C: Human-wildlife conflict

10. What activities are done to reduce human wildlife conflict? Please rate the success of each activity in dealing with the conflict on a 1 – 5 scale, with one being not at all successful and 5 being very successful. (*Get consensus on rating*)

Activities	Type of conflict	Rate of success
	01 Crop Damage	
	02 Depredation	
	03 Human	
	01 Crop Damage	
	02 Depredation	
	03 Human	
	01 Crop Damage	
	02 Depredation	
	03 Human	
	01 Crop Damage	
	02 Depredation	
	03 Human	
	01 Crop Damage	

	02 Depredation	
	03 Human	
	01 Crop Damage	
	02 Depredation	
	03 Human	

Section D: Livelihoods

11. List the most important cash crops grown in the village. (***Do not prompt***)

Crop	**Rank them in order of most commonly grown (*1 being most common*).**	**Who is growing the crops? (*01=local villagers, 02=outsiders, or 03=commercial operations, 99=other (specify)*)**	**Price range per unit (*note unit*)**

12. List additional subsistence crops grown in the village. (***Do not prompt***)

Crop	**Rank them in order of most commonly grown (*1 being most common*).**

Section E: Prices

13. What is the price range per unit (specify unit) of the following crops?

	Crops	**Price per unit (*range*)**
01	Maize	
02	Beans	
03	Cassava	
04	Paddy	
05	Sunflower	
06	Onions	
07	Millet	

08	Simsim	
09	Groundnuts	
10	Cashews	
11	Tobacco	
12	Sweet potatoes	
13	Tomatoes	
14	Vegetables (specify)_____	
15	Coffee	
16	Tea	
17	Cotton	
18	Coconut	
19	Bananas	
20	Mangos	
21	Papaya	
22	Fruit (specify)_____	
23	Sorghum	
99	Others (specify)_____	

14. What is the price range per one animal of the following animals?

	Animals	**What is the price for one animal (*range*)?**
01	Cattle	
02	Sheep	
03	Goats	
04	Pigs	
05	Chickens	
06	Chicks	
07	Donkeys	
08	Duck	
09	Dogs	
10	Cats	
99	Others (specify)	

15. What is the price range per unit (specify unit) of the following products?

	Product	**Price per unit (*range*)**
01	Cow Milk	
02	Goat Milk	
03	Eggs (local)	
04	Honey	
99	Other (specify)	

Appendix IV: Head Teacher Questionnaire

Date _____ Village_____ Sub-Village_____
Ward_____ Division _____District _____
Region _____ Name of interviewer_____
Name of interviewee _____
Location of the primary school by GPS (UTM): Zone ____ Easting____ Northing _____
Checked by:_____
Starting time:_____ Finishing time:_____

Questions

1. How long have they been teaching at that school? _____ *(if less than one year, ask if there is another teacher who can join you to help answer some of the questions)*

2. How many schools does the village have? _____Primary _____Secondary

Questions for primary schools only

Questions	**Primary school #1**	**Primary school #2**
3. How many pupils attend to school?		
4. What is the average percentage of pupils that attend?		
5. How many classrooms (physical classrooms) does the school have?		
6. How many teachers?		
7. There how many teachers house/s?		
8. How many latrines are there for males?		
9. How many latrines are there for females?		

10. For primary school #1:

Questions	**Who built?**	**How many?**	**When?**	**Why?**
Classrooms				
Teachers houses				

11. How much does a household contribute per year?

For school fees	Tsh
For uniform	Tsh
For other contributions such as ,desks, building e.t.c.	Tsh
Total	Tsh

Appendix V: Price Data

To recalculate income data I used price data provided from the Natural Resource Questionnaire. However, not all village resource groups gave prices for all crops, livestock, and livestock products. Furthermore, not all prices were in the same units as the units reported by the households (this was especially true for the agricultural products). To convert prices for different units I used crop unit conversion data gathered by the SFTZ field team in the Arusha market. If a particular village did not give a price for a good, I used the average price for that good from the other villages in the area. The areas are: Northwest (comprised of the villages of: Bonchugu, Bukore, Mariwanda, Misseke, Nata Mbiso, Nyamburi, Robanda, and Singisi), Southwest (comprised of the villages of: Iramba Ndogo, Mbushi, Mwamhongo, Nyanza, Sakasaka, Sapa), and East (comprised of the villages of: Engaresero, Oloirien Magaiduru, Piyaya, Samunge, Soitsambu). We went to one other village in the East, Oldonyosambu, but there is no village resource data for that village. If no village in the area had a price for the good in question, I used the average price for all goods across the study area. If no prices were available for the whole of the study area, I used average applicable district prices from World Bank 2003 data on food crop retail prices for some districts in Tanzania. If price data was still missing I looked at the original household questionnaires where some field team members made a note of the price the household received for their good, or if that was not available, the price given by another household in the village. Finally, if I could not get a price due to a lack of unit conversion factors, but had the price for the required unit from another village resource questionnaire or household I used that given price. The prices varied across villages and areas. Below is a sampling of the average given village resource prices across the three areas.

Prices for agricultural goods (in 2006/2007 Tanzanian Shillings)

Area	Corn (per sack)	Beans (per sack)	Cassava (per can)	Millet (per can)	Sorghum (per can)	Sweet Potatoes (per sack)
Northwest	23,472	59,719	2,414	4,468	3,833	8,688
Southwest	23,896	45,500	0	0	1,460	8,000
East	23,800	67,200	0	6,154	0	0

Note: A zero value means no prices were given by village resource groups in that area.

Prices for one livestock (in 2006/2007 Tanzanian Shillings)

Area	Cow	Sheep	Goat	Chicken	Donkey
Northwest	131,875	15,000	16,250	3,300	55,000
Southwest	130,000	12,917	15,500	2,250	37,500
East	157,000	26,100	33,600	4,563	35,000

Prices for livestock goods (in 2006/2007 Tanzanian Shillings)

Area	Cow Milk (liter)	Egg (one egg)
Northwest	150	105
Southwest	156	67
East	520	163

Appendix VI: Regression Variables

Independent variables tested in study regressions

	Independent variables	Variable type*
1.	Area	Categorical
2.	Kilometers to Serengeti National Park	Continuous
3.	Kilometers to the household's closest protected area	Continuous
4.	Age	Continuous
5.	Gender	Dichotomous (0 – male, 1 – female)
6.	Household head was a farmer	Dichotomous
7.	Household head was a livestock owner	Dichotomous
8.	Household head occupation was something other than farmer or livestock owner	Dichotomous
9.	Immigrant	Dichotomous
10.	Years of education	Continuous
11.	Member of village government	Dichotomous
12.	Ethnic Group	Categorical
13.	Total household income	Continuous
14.	Used bushmeat yearly or more frequently	Dichotomous
15.	Preferred species of firewood are no longer available	Dichotomous
16.	Reported any bushmeat benefits from wildlife	Dichotomous
17.	Reported any benefit from wildlife	Dichotomous
18.	Reported any cost from wildlife	Dichotomous
19.	Belief about human-wildlife conflict	Ordinal (-1 = decreasing, 0 = no change, 1 = increasing)
20.	Belief about crop-wildlife conflict	Ordinal (-1 = decreasing, 0 = no change, 1 = increasing)
21.	Belief about livestock-wildlife conflict	Ordinal (-1 = decreasing, 0 = no change, 1 = increasing)
22.	Farm Size (acres)	Continuous
23.	Livestock lost to wildlife in 12 months prior to survey	Dichotomous

*All dichotomous variables are 0 = No, 1 = Yes unless otherwise specified

	Dependent variable	Variable type[a]
1.	Knew protected area[b]	Dichotomous
2.	Reported a benefit from protected	Dichotomous
3.	Reported a cost from protected areas[d]	Dichotomous
4.	Attitude toward protected areas[e]	Dichotomous (0 = Negative, 1 = Positive)

a – All dichotomous variables are 0 = No, 1 = Yes unless otherwise specified
b – Knew protected area was a also dependent variable for the knowledge regression in that knew Serengeti National Park was a dependent variable for the regression knew closest protected area and vice versa.
c – Reported benefits from protected area was also an independent variable for the costs and attitude regressions.
d – Incurred costs from the protected areas was also an independent variable for the benefit and attitude regressions.
e – Attitude toward protected area was also an independent variable for the benefit and cost regressions.