DISSERTATION

WESTERN SERENGETI PEOPLE SHALL NOT DIE: THE RELATIONSHIP BETWEEN SERENGETI NATIONAL PARK AND RURAL HOUSEHOLD ECONOMIES IN TANZANIA

Submitted by

Eli J. Knapp

Graduate Degree Program in Ecology

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, CO

Fall 2009

COLORADO STATE UNIVERSITY

August 18, 2009

WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY ELI KNAPP ENTITLED WESTERN SERENGETI PEOPLE SHALL NOT DIE: THE EFFECTS OF SERENGETI NATIONAL PARK ON RURAL HOUSEHOLD ECONOMIES IN TANZANIA BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

Committee on Graduate work

Michael Coughenour

Michael Coughenour

Dennis Ojima

Dave Swift

Kathleen Pickering

Kathleen Pickering

Kathleen Galvin

ADVISOR, Kathleen Galvin

N LeRoy Poff

DEPARTMENT HEAD, LeRoy Poff

ABSTRACT OF THESIS

THE RELATIONSHIP BETWEEN SERENGETI NATIONAL PARK AND RURAL HOUSEHOLD ECONOMIES IN TANZANIA

This research examined the relationship between Serengeti National Park and rural household economies living near (within 18 kilometers) its western borders in Tanzania. The study was based upon semi-structured household interviews with a general sample (N = 722), acknowledged poachers (N = 104), households with park-related employment (N = 50) and key informants (N = 15) in three two administrative regions and three districts. Interviews generated information about four primary social-ecological interactions which included crop destruction by wildlife, illegal hunting, park-related employment, and wildlife depredation on livestock. A cost-benefit analysis revealed that the average household generates a net profit of USD $13 from these interactions. Despite this, 84 percent of households were found to be food insecure for maize, the region's primary food crop. Moreover, 78 percent of households were found to be significantly over-budget over the preceding 12 months. These findings suggests that most households next to Serengeti National Park are generally impoverished and are lacking adaptive capacity to deal with severe environmental or socio-ecological changes. The first component of the research provided the context for western Serengeti. Significant findings included the importance of secondary education for increasing income to household economy and showed the level of dependence that households have on local natural resources. Households draw more heavily (often illegally) from the

National Park with the advent of severe crop failures which were found to occur with a ten year periodicity. The second component revealed that neither crop damage nor wildlife depredation on livestock is distributed evenly. Rather, they are heavily localized with few effects on some households and severe effects on others. Although the effects of wildlife on crops and livestock generally decreased with distance from the Park, losses were particularly large for households within three kilometers of a boundary. The third component examined illegal bushmeat hunting and sales. Findings from respondents and extensive court documents suggested that fines and imprisonment had little effect on curbing illegal hunting behavior. The fourth component consisted of a synthesis of the cost-benefit analysis with a focus on food security and its effects on adaptive capacity. Implications of these findings are made for the resilience of the coupled socio-ecological system in western Serengeti.

Eli J. Knapp
Graduate Degree Program in Ecology
Colorado State University
Fort Collins, CO 80523
Fall 2009

Table of Contents

Chapter One

Human interactions with Serengeti National Park: An introduction to household economies in western Serengeti, Tanzania

Part I

1.1.................The current dilemma
1.2.................The greater Serengeti ecosystem
1.3.................Human well-being

Part II

1.4.................The primary sample
1.5.................Subset sample – Poaching
1.6.................Subset sample – Park-related employment
1.7.................Subset sample – Key informants
1.8.................Archival data
1.9.................Household equivalence scale
1.10...............General terminology

Part III

1.11...............Western Serengeti
1.12...............The household
1.13...............Western Serengeti households
1.14...............Ethnicity
1.15...............Poverty
1.16...............Diversification
1.17...............Adaptive capacity & implications for resilience

Part IV

1.18...............Land
1.19...............Agriculture
1.20...............Cassava cultivation
1.21...............Sorghum cultivation
1.22...............Millet cultivation
1.23...............Maize cultivation
1.24...............Potato cultivation
1.25...............Bean cultivation
1.26...............Irrigation-dependent crops
1.27...............Other crops
1.28...............Cotton cultivation
1.29...............Livestock
1.30...............Cattle holdings
1.31...............Goat holdings
1.32...............Sheep holdings
1.33...............Poultry holdings

Part V

1.34...............Rainfall
1.35...............Natural resource use
1.36...............Fuelwood
1.37...............Water

<u>Chapter Two</u>
Effects of crop damage, livestock depredation & park-related employment on households economies

Part I.
2.1.....Introduction
2.2.....Methods
2.3.....Crop raiding
2.4.....Crop raiding in western Serengeti
2.5.....Elephant impacts on crops
2.6.....Wildebeest impacts on crops
2.7.....Impacts of other wildlife species on crops
2.8.....Comparison of biotic and abiotic impacts on crop damage
2.9.....Crop damage by district
2.10...Crop damage by village
2.11...Crop damage by sub-village
2.12...Crop damage by distance from a protected area

Part II.
2.13...Wildlife depredation on livestock
2.14...Losses to cattle
2.15...Losses to goats & sheep
2.16...Losses to poultry
2.17...Livestock loss by district
2.18...Livestock loss by distance from a protected area
2.19...Losses to domestic dogs and cats

Part III.
2.20...Benefits from Serengeti National Park
2.21...Park-related employment
2.22...Park-related employment in western Serengeti
2.23...Park-related employment and the household economy
2.24...Remittances from park-related employment
2.25...Expenditures
2.26...Livelihood indicators
2.27...Protein
2.28...Common obstacles
2.29...Education
2.30...Connections to opportunity
2.31...The Catch-22
2.32...Win-win scenarios

Chapter Three
Illegal hunting in western Serengeti and its effects on household economies

Part I.
3.1.........Introduction
3.2.........Methods
3.3.........History of hunting in western Serengeti
3.4.........Who is poaching?
3.5.........How is poaching occurring?
3.6.........Why is poaching occurring?
3.7..........Income as a driver of poaching
3.8..........Income generated from bushmeat sales
3.9..........Expenditures
3.10.........Protein
3.11.........Traditions

Part II.
3.12.........Costs of poaching
3.13.........Fines, imprisonment, arrest, injury, & opportunity time
3.14.........Fines
3.15.........Imprisonment
3.16.........Contextual examples
3.17.........Court reports
3.18.........Meatu District court records
3.19.........Serengeti District court records
3.20.........Game Reserve versus Serengeti National Park
3.21.........Comparison of court records
3.22.........Failed arrests
3.23.........Other costs of poaching
3.24.........Perceived costs of poaching

Part III.
3.25.........To poach or not to poach
3.26.........Possible steps forward

Chapter Four
Cumulative effects of primary impacts on households with implications for adaptive capacity and resilience

Part I.
4.1.....Introduction
4.2.....Methods
4.3.....Food security
4.4.....Food security in western Serengeti
4.5.....Household income
4.6.....Park-related effects on household income
4.7.....Food security at the district level
4.8.....Household income at the district level
4.9.....Park-related effects on households at the district level
4.10...Food security as assessed by distance from a protected area
4.11...Income earnings and distance from a protected area
4.12...Household food security in-depth
4.13...Household income and food security

Part II.
4.15...In-migration
4.16...In-migration into western Serengeti
4.17...In-migration from non-bordering districts
4.18...Recent in-migration

Part III.
4.19...Implications for adaptive capacity and resilience
4.20...Window of opportunity in western Serengeti
4.21...Possible steps for enhancing adaptive capacity and resilience
4.21 – a...Chapter One
4.21 – b...Chapter Two
4.21 – c...Chapter Three
4.21 – d...Chapter Four

Part I.

Introduction

1.1 – The current dilemma

The Serengeti is envisioned the world over as a place where nature reigns supreme. A place with endless plains and teeming herds untouched by the presence of humans. But in reality, the Serengeti has long been—and continues to be—a profoundly humanized landscape (Shetler 2007). For millennia, people have traversed, lived, hunted, and gathered resources in what is now the very heart of Serengeti National Park (hereafter, SNP). Just three generations ago, in fact, Serengeti was an active zone of interaction for the various people groups comprising the remote northwestern corner of Tanzania. But today, the vast ecosystem which encompasses some 14,000 km^2 is largely off-limits to the local people who find themselves squeezed ever more tightly around the park's borders.

Relatively recent restrictions on land use and access, coupled with a population increase that range from 1.8 – 3.3% per annum in the three districts west of the park (Tanzania Regional Profile 2002),[1] has elevated human-wildlife tensions. As a result, the zone of interaction might more aptly be described as a zone of conflict. Human-wildlife interactions now occur with ever-intensifying consequences and ill-effects are suffered on both sides. Humans annually suffer large-scale crop and livestock losses to wildlife. And just as importantly, the world renowned wildebeest migration—with animals numbering in the millions—is increasingly threatened by cattle grazing, land use change,

[1] According to the most recent census (2002), Serengeti District had a total human population of 176,057 (3.3% intercensal growth rate). Bunda recorded 258,930 (1.8% intercensal growth rate). Meatu was listed at 248,214 (3.2% intercensal growth rate).

and poaching. For wildlife in the park and humans along the park's margins, western Serengeti is an ever-tightening noose of enclosure.

While the Greater Serengeti Ecosystem (hereafter, GSE) was once a porous enclave where humans and wildlife freely entered and left, the system is now resembling an island, with humans pressed against an inner ring of wildlife. As Bernard Grizmek observed in his landmark book, *Serengeti Shall Not Die (1959)*:

> *"Areas, which we knew as wilderness, are now heavily settled and cultivated. Each day the park becomes more of an island, and pressures continue to grow. We must renew our vigilant custodianship, lest we lose this asset for all mankind."*

Pressures have only increased since Grizmek's day. As a result, the outcomes of such conflict are no longer small, insignificant and limited to isolated populations. Now, with greater human population pressure and scarcer resources, human-wildlife interactions that occur in one part of the ecosystem are likely to affect the entire ecosystem (Woodroffe et al. 2005).

On the positive side, increasing human population sizes have led to a growing awareness among the local people for a need for conservation. The realization that natural resources are finite if not used sustainably has taken root. This is not surprising as research has shown that conservationist attitudes often emerge in situations of resource pressure and scarcity (Lu Holt 2005). But unfortunately, just as awareness is developing, local people are being largely cast as enemies of nature and threats to the ecosystem (ibid). Conservation strategies of fences and human settlement relocation have been discussed along with other ideas (Kideghesho and Mtoni 2008).

If fences or forced relocations are carried out, however, local people may lose their window for putting their developing conservation attitudes into practice. In other words, locals may lose their opportunity to adapt. Such competing interests are making it clear that the local people and wildlife of the GSE are at a critical juncture. The need for informed judgment is considerable. Through an in-depth look at household economies, this study allows for better informed decisions by shedding light on several prominent human-wildlife interactions. All such interactions to be examined here have wide-ranging effects on both the human and natural components.

As layers of complexity are added and integrated over the next several chapters, greater emphasis will be put on the idea of resilience (Holling 1973). Within this framework, three larger-scale questions will emerge. One, should the human domain be separated from wild animals through a strict protectionist approach? Two, if people are not separated from protected lands, can they realistically be trusted with conserving nature? And three, should a global good—such as Serengeti National Park—be granted greater priority than local needs? Although these questions are fundamental to this study, they are simply too large for thorough investigation here.

The most important and central question that this study seeks to answer, however, is remarkably simple: Does the average household that is close[2] to Serengeti's protected areas economically benefit or suffer from its primary interactions with the park and its wildlife? This question, which has only been speculated at in the literature, is of pivotal importance for wildlife managers and the multifarious governmental and nongovernmental agencies which seek to stem human-wildlife conflict. More importantly, the question is important for the very survival of the local people

[2] Between 0 – 18km away from Serengeti National Park or one of its affilitated buffer zones.

themselves. If local people financially benefit from living near SNP's borders, for example, then it is plausible—if not likely—that humans will continue to move closer to the park with a resulting increase in human-wildlife conflict. If local people do not materially benefit, however, then other important factors may be at work for escalating human-wildlife conflicts.

Although these two scenarios are overly simplistic, the answer to the question which asks if people benefit—and by how much—is critical for determining how stakeholders will, and should, respond. The answer to such a question, however, demands a comprehensive integration of broad-level questions pertaining to household economies. The danger in such a study, of course, is to include too many variables and lose focus of the question at hand. The concomitant risk, however, is to select too few variables and lose the ability to satisfactorily answer the question.

Despite the many risks entailed, this question was ultimately deemed too important to ignore. After many discussions with locals and stakeholders, I decided to select four primary human-wildlife interactions, and assess the economic impacts that they exert on households (Figure 1.1.1).

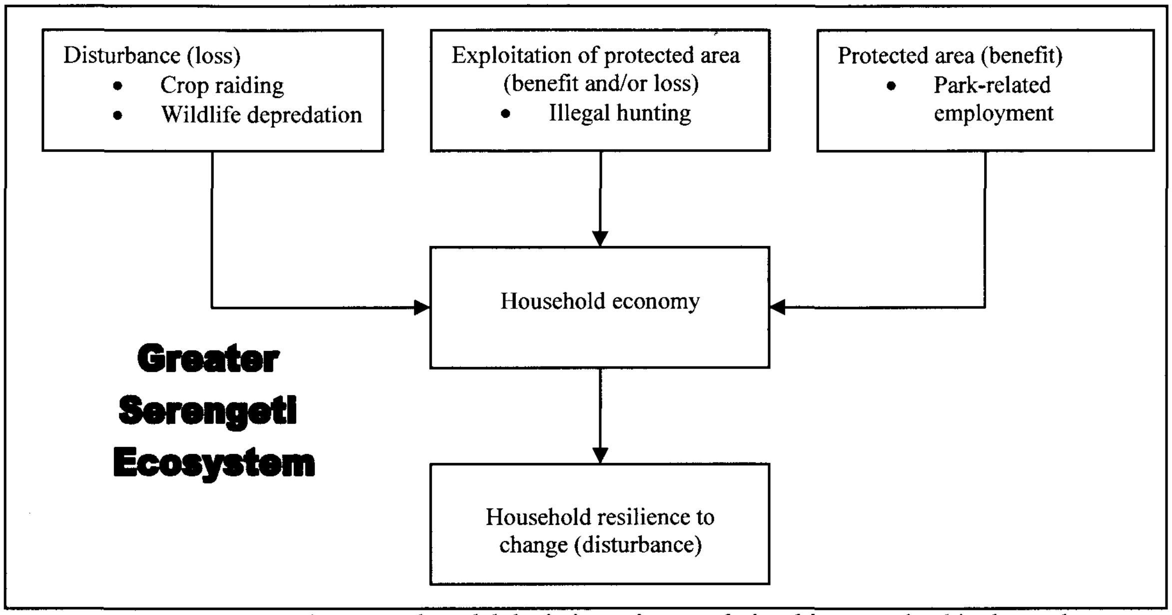

Figure 1.1.1 – Conceptual model depicting primary relationships examined in the study

This set of interactions—crop destruction, wildlife depredation, park-related employment, and poaching—are widely thought to be the most important interactions to household economies. Due to the diverse and sensitive nature of these interactions, however, several varying methodologies were required to obtain usable data. These methodologies are discussed at length in an upcoming section (1.3).

It should be noted, of course, that interactions analyzed over the next several chapters are by no means meant to be considered the only relevant human-wildlife interactions in SNP. At the same time, the current study's timeframe only examines the human-wildlife interactions and livelihood portfolios of households over the span of one year (Section 1.3). Naturally, the outcome of human-wildlife interactions fluctuate temporally and implications from this "snapshot" study must be tempered with that reality. Despite this methodological shortcoming, the results of the current study provide an excellent springboard for further investigations in this field of research.

Determining whether or not people living close to parks benefit or suffer cannot be done by picking the human-wildlife interactions apart, or looking at the parts in isolation. Although some degree of dissection is needed, a disconnected look at human-wildlife interactions prevents a valid answer to the question. Rather, the outcome of local human livelihoods around SNP is an emergent property that only reveals itself at a scale that is beyond its component parts. For this reason, this study systematically examines the aforementioned interaction variables and seeks to aggregate them in Chapter Four. This idea is discussed further in Section 1.8.

The difficulty of assessing human-wildlife interactions and local conservation is amplified by the fact that many of the human inhabitants living around the GSE are impoverished. Poverty confounds the issue because the rural poor often regard conservation as something that can only be attended to when one can afford to do so (Githiru 2007). Furthermore, poverty may cause rural peoples to actively dissent from biodiversity protection if they feel that contact with wildlife—either direct or indirect—is causing them to become poorer (Sitati 2007).

It is unrealistic, however, to assume that both conservation and poverty alleviation can be accomplished simultaneously in every setting. It is equally unrealistic, however, to assume that conservation can occur without attention to poverty or poverty alleviation without conservation. As a result, this study recognizes the need for an integration of these components with special emphases placed upon context and local conditions. In doing so, attention will be paid to current conflicts and incompatibilities between human and wildlife populations. While a greater emphasis may be on conflict, the hope here is that the more subtle thread—the one that rarely makes headlines—of human and wildlife *compatibility* will be equally evident.

One of the central components of the human-ecological system underlying these questions of conflict and incompatibility is one of resource use. As this study will show, the local people of the GSE do not depend on the system's resources equally. The way that people rely on the system, or the livelihood portfolio they hold, is a duel product of their current values and their socioeconomic and cultural histories. Livelihood portfolios examined in this study will reveal how people rely on the system. In the last chapter, the implications of these relationships and dependencies will be discussed for the GSE at large.

Generally speaking, the current context for many living along the margin of SNP is one of decreasing farm yields, limited access to markets, and ever-smaller farm plots per household. Due to increased amounts of land subdivision, sole reliance on agriculture and livestock is no longer widely viewed as a viable livelihood strategy (Himmelfarb 2006). As subsequent chapters will show, one of the primary ways that people living near SNP's boundaries supplement their smaller amounts of land and livestock is by harvesting the park's resources. In particular, chapter three will reveal how many western Serengeti people are heavily dependent on its resources to diversify their livelihoods to help buffer market- and weather-related shocks.

In the chapters to follow, this study will adhere to the concept of resilience (explained fully in Section 1.17) as outlined by the Millenium Ecosystem Assessment (MEA 2005). Although the specific implications of resilience are not the focus of the research, results presented will imply that current household resilience to disturbance will likely weaken along the margins of SNP within the context of the presently increasing population growth (Figures 1.1.2 & 1.1.3) (Campbell et al. 2001).[3]

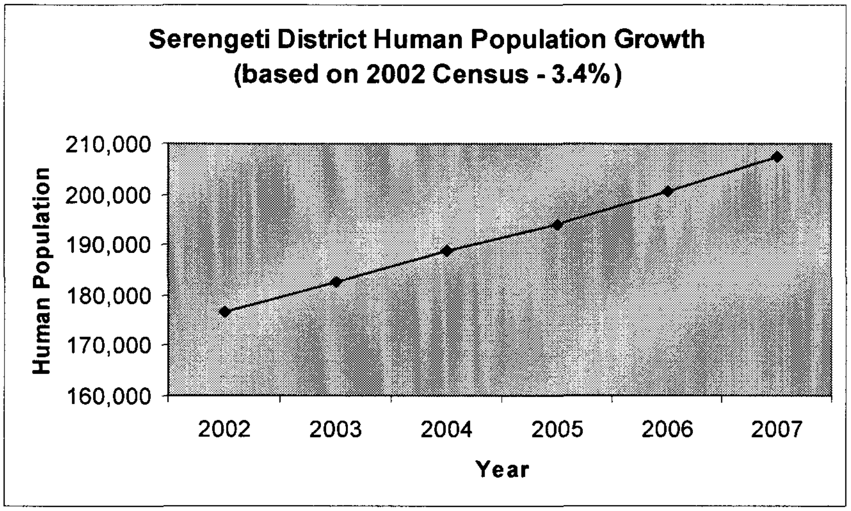

Figure 1.1.2 – Human population size in Serengeti District projected from 2002 Census.

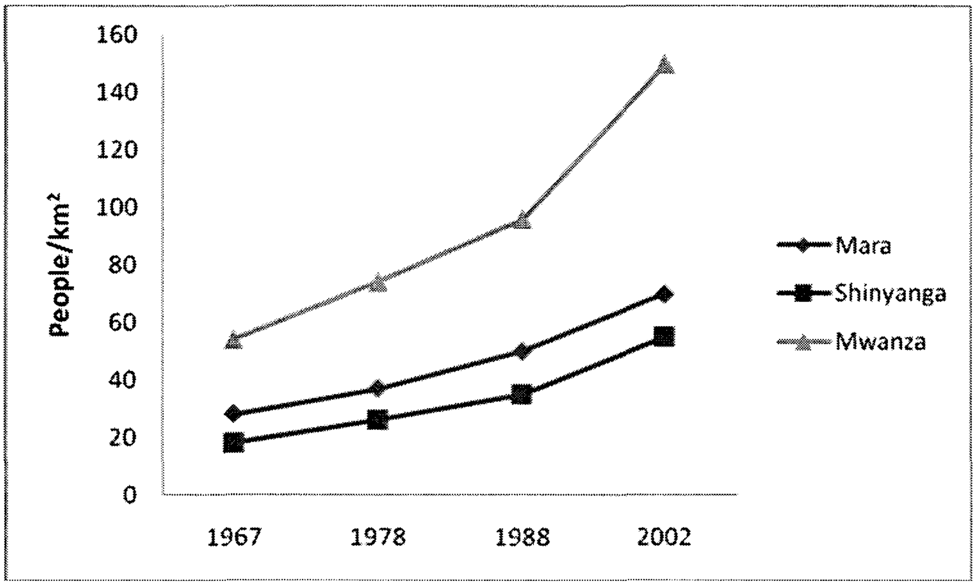

Figure 1.1.3 – Population density in Mara, Shinyanga, and Mwanza Regions over time. This study included households from each of these regions (Section 1.4). Source: Population & Housing Census, Tanzania (2002).

[3] Long-term demographic data shows that human population size has increased steadily over many decades in western Serengeti. While it is likely that the percentage of population growth will fluctuate in the coming years, it is out of the scope of this study to speculate on what these fluctuations might look like.

Due to this underlying assumption, ensuing chapters will argue that off-farm (or, non-farm) employment (Section 1.15) is an essential means of enhancing household resilience of those living along the margins of SNP. Research here will also suggest, however, that non-farm employment is insufficient by itself. Rather, for enhanced resilience and human-wildlife compatibility, local households must depend not just on wildlife's existence, but on its prosperity.

The four chapters of this study will sequentially present evidence to argue this point. The purpose of this first chapter is to provide a framework and context for understanding the coupled human-natural system in western Serengeti. It will do by presenting methods (Part II), context and concepts (Part III), agropastoralism (Part IV) and rainfall and resource collection (Part V).

With context in place, Chapter Two examines three primary interactions between humans, wildlife and the park. Chapter Three also examines a primary human-wildlife interaction, illegal hunting. An entire chapter is devoted to illegal hunting due to its sensitive nature and alleged potential to dismantle the entire system (Sinclair et al. 2007). The fourth chapter synthesizes the study's material in a cost-benefit analysis and explores what implications these findings may have for the adaptive capacity of the household, and the resilience of the Greater Serengeti Ecosystem at large.

1.2 – The Greater Serengeti Ecosystem

The country of Tanzania is often popularly depicted for its large herds of herbivores, healthy populations of attendant carnivores (Sinclair et al. 2007), and various protected areas including the Selous Game Reserve, Ngorongoro Conservation Area, Mount Kilimanjaro, and Serengeti National Park, among others. Tanzania stands out among other African countries in that approximately 25% of the country's one million km^2 is managed for conservation in national parks, game reserves, game-controlled areas, forest reserves, and wildlife management areas (Thirgood et al. 2007). Tanzania's various protected areas include ecosystems under the aegis of several jurisdictions.

The Greater Serengeti Ecosystem—the system of interest here—is a case in point. Serengeti National Park (14,763 km^2) connects with the Maasai Mara Game Reserve to the north in Kenya. On the eastern side, the park is joined by the Ngorongoro Conservation Area (hereafter, NCA), and Loliondo Game Controlled Area. On the western side—the focal point of this study—the park is adjoined by the Maswa Game Reserve (2,200 km^2), Grumeti Game Reserve (1,900 km^2), Ikorongo Game Reserve (563 km^2), and one incipient Wildlife Management Area called the Ikoma Open Area.[4] (Figure 1.2.1)

[4] The assortment of jurisdictions is confounded further by the sporadic support of ephemeral non-governmental organizations and research funding cycles. As a result, restrictions on use have shifted throughout SNP's history and proven difficult to decipher for local peoples.

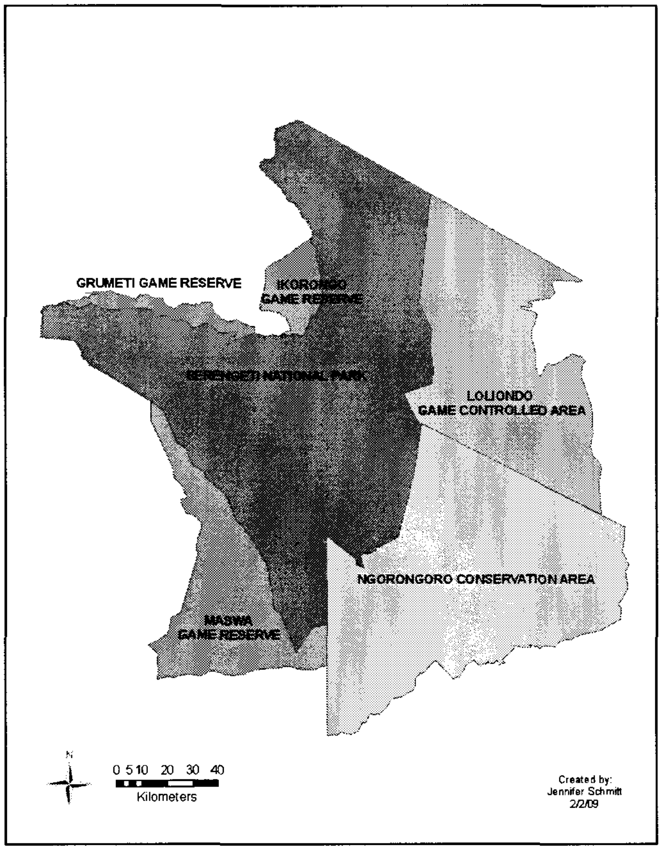

Figure 1.2.1 – Map of Greater Serengeti Ecosystem. Ikoma Open Area is not depicted because boundaries have not been officially demarcated as of the time of this study.

In terms of protection, national parks are the most restrictive among Tanzania's protected areas. Legal uses in SNP are limited to non-consumptive utilization (e.g., game viewing, research, and photographic tourism) (Kideghesho et al. 2007). Access and resource use by local peoples is strictly prohibited and routinely enforced (Hilborn et al. 2006) (Chapter Three). In SNP's adjoining game reserves to the west—those with significant import to the human study population discussed here—licensed hunting is allowed but all other forms of access, cultivation, and livestock grazing are prohibited.[5] Such uses are legal, however in the Loliondo Game Controlled Area on SNP's eastern

[5] These restrictions were established by Wildlife Conservation Act No. 12. (1974)

side.[6] At the time of this research, the Ikoma Open Area was in the process of being established. Restrictions on use for this area are determined and enforced locally.

Together, these areas form a contiguous ecosystem large enough to accommodate an annual migration of approximately 1.3 million wildebeest (*Connochaetes taurinus*) (Boone et al. 2006), 0.2 million zebra (*Equus burchelli*), and 0.7 million Thompson's gazelle (*Gazella thompsoni*) (Norton-Griffiths 1995). It is this migration event that "defines the system" for many as it has been referred to as the foundation of the GSE itself (Sinclair et al. 1995). The multispecies migration often takes the animals in a clockwise fashion through the protected areas. Depending on rainfall, populations may leave protected lands altogether, venturing onto village lands, as was the case during this study's field research. Other large mammals that are also important to the ecosystem's form and function are resident herbivores including elephants (*Loxodonta africana*), Grant's gazelle (*Gazella grantii*), giraffe (*Giraffa camelopardalis*), and hippo (*Hippopotamus amphibious*), among others (ibid).

The rich assemblage of mammalian fauna is largely why SNP stands out among Tanzania's protected areas as the site where wildlife research began and greatly expanded from. Through work instigated by the aforementioned Bernhard Grzimek and his son Michael, the 1950s and 60s saw the creation of the Serengeti Research Institute, where a wide-ranging program of ecological research continues to the present (Sinclair et al. 2007).[7]

---

[6] Game Controlled Areas are Tanzania's least restrictive management category (URT 1974).
[7] Although fieldwork for the present study was concentrated in the surrounding villages, research took advantage of the infrastructure and archival records created by the institute. The Methodology (Section 1.3) discusses this latter point in greater detail.

Initial research at the institute consisted mostly of ecological surveys (Pearsall 1957, Grzimek & Grzimek 1960) and gradually expanded to more intensive studies (Fryxell et al. 2004; McNaughton et al. 1988; Coughenour et al. 1984b). Despite cultural and historical ties to the area now designated as park, local people groups to the west of SNP have been largely ignored by ecologists and anthropologists alike. A suite of factors may have been responsible for this.

First, the early avoidance of ecologists to studying the effects of local peoples may reflect the prevailing paradigm of the fledgling discipline, which saw humans and nature as separate entities. This has changed, however. In the last two decades, novel ecological sub-disciplines such as "human ecology" have reflected the paradigmatic change which views humans as part of the system, or natural systems as "coupled human-natural systems." These important concepts form central tenets in upcoming analyses presented in this study.

The second reason local western Serengeti peoples have gone relatively unnoticed concerns matters of population size. Until the last few decades, human populations surrounding SNP were small enough that local interactions with the resource base were relatively minor and did not "merit" precious research funds. Human populations were low throughout the 1800s and early 1900s. In 1948, for example, the population density in Serengeti district (which borders SNP) amounted to roughly 2 people per km^2. Forty-five years later (1993), the population had grown to just over 10 people per km^2, still the lowest in the Mara region (Shetler 2007). As will be made clear later in Chapter Four (Section 4.16), this is rapidly changing. Now, human populations are now having a major effect on the system and the reality of continued growth and increasing human-wildlife conflicts cannot be avoided.

Third, western Serengeti people have gone unnoticed because the bulk of scientific attention has focused on the Maasai people that inhabit the NCA, Loliondo Game-controlled Area, and other lands to the east of the GSE.[8] The Maasai represent the classic stereotype of the East African pastoralist due to their photogenic appearance and well-documented history as cattle raiders and lion hunters. In addition, the Maasai tendency for living in drought-prone areas and difficult landscapes has resulted in a sizable amount of human-ecological attention (Boone et al. 2006; Galvin et al. 2004; Galvin et al. 2002).

The Maasai have also attracted a considerable share of national attention in the press. They were the only ethnic group, for example, to be granted land-use rights by the government during the 1930s and 1940s when SNP's boundaries were being defined (Shetler 2007). This occurred despite the fact that the Maasai were not the only people living in and around the GSE. Further to the west, myriad ethnic groups had been coexisting with the Maasai for centuries.

Fourth and lastly, western Serengeti people have been geographically isolated. As explained earlier, the western side of the GSE is composed of six districts that fall within three regions. Despite the abundance of natural resources,[9] these regions have historically proven difficult for would-be dwellers due to erratic rainfall and the

[8] Technically, Maasai practices of transhumance and nomadism have led to the creation of settlements throughout the GSE. But the greatest concentration of dwellings is in the ecosystem's eastern reaches, with permanent and semi-permanent dwellings in the NCA and Loliondo Game-controlled Area. During field research, small bands of Maasai were encountered in western Serengeti.

[9] Primary natural resources include wildlife and minerals (e.g., gold, salt).

abundance of the tsetse fly.[10] To the north, Kenya's periodic border closures have made travel to and from western Serengeti arduous due to excessive levels of documentation and permissions required at border crossing points. Difficult river crossings and failure to maintain roadways have also acted as effective geographic barriers. Together, these factors have made western Serengeti people groups relatively inaccessible and sparsely researched.

1.3 – Human well-being

The broad-level focus of this study, although often referred to obliquely, is the idea of human well-being. Human well-being is a dynamic livelihood attribute that largely depends on choices that people make from one day to the next or, from one season to the next. According to the Millenium Ecoystem Assessment (2005), human well-being entails the basic material for a good life which includes secure and adequate livelihoods, enough food at all times, shelter, clothing, and access to goods (MEA 2005). Unfortunately, this definition is fraught with ambiguous words such as "good" life and "adequate" livelihoods. Because the study here attempts to apply this definition to human-wildlife interactions, the words "good" and "adequate" in this dissertation will be defined by livelihoods that can carry on from year to year without undermining the natural resource base.

Nestled within human well-being is the notion of poverty. Here, poverty will be examined in the context of its tendency for causing local people to overharvest wildlife and degrade natural resources. Due to poverty's multidimensional and multi-faceted nature, it will here be narrowed down to a livelihood characterized by the pronounced

[10] Tsetse fly has historically beleaguered human and livestock populations with sleeping sickness.

deprivation of well-being. As with several concepts that have been raised in this section, it bears mentioning again that well-being and poverty are context-dependent and reflect a suite of local physical, social, and personal factors, as well as geography, environment, age, gender, and culture, to name a few (MEA 2003).

Here, poverty and well-being will be linked to ecosystems and natural resources. The link is made due to the pivotal role that ecosystems and natural resources play pivotal roles in the provisioning, regulating, and supporting services they provide to human livelihoods. When natural resources are degraded, people often fall into poverty. The relationship has been likened to a downward spiral, with poverty causing environmental degradation which, in turn, causes greater poverty (Gjertsen 2005). Due to this common cause-and-effect scenario in and around protected areas, this study views poverty and conservation as intrinsically connected. If separated, this study portends, neither poverty alleviation nor conservation in coupled human-natural systems can sustainably proceed (Brockington & Schmidt-Soltau 2004).

In the Durban Accord of 2003, the international conservation community at the World Parks Congress (WPC) expressed the concern "that many costs of protected areas are borne locally—particularly by poor communities—while the benefits accrue globally" (Brosius 2004). The WPC went a step further, too, declaring that all protected area managements will strive "to reduce, and in no way, exacerbate, poverty" (ibid). While the WPC's acknowledgement of locally-borne costs is correct, its declaration for conservation and poverty reduction runs the risk of oversimplification. Without a comprehensive awareness of local contexts, such broad objectives which seek program-generated improvements in well-being often miss the mark. Also ineffective are vague objectives that seek local investment in resource management with concurrent short-term poverty alleviation.

To avoid such common pitfalls, the study here will describe western Serengeti's unique context by exposing the locally-borne costs (Chapter Two) that come with living close to SNP. The study will also point to ways that the resource base might be managed more judiciously (Chapter Four). Once the context is laid out, a case will be made that conservation and poverty alleviation are compatible *only* if there are alternative livelihoods that can readily be pursued. As mentioned, the most effective livelihood for enhancing the adaptive capacity of households is non-farm, park-related employment.

Part II

Methods

1.4 – The primary sample

Methods for the study utilized semi-structured household interviews from the primary sample (N = 722). Interviews were conducted in Kiswahili and administered in two regions, Mara and Shinyanga,[11] and three districts: Serengeti, Bunda, and Meatu, which were selected through nonprobability judgment sampling (Bernard 2006). These districts were selected to obtain a significant level of spatial coverage and ethnic representation of people groups living along the margin of Serengeti National Park. Within these districts, 15 villages were also intentionally selected through nonprobability judgment sampling (ibid). Village selection was based on proximity to the park and the

[11] Mara Region (30,150 km^2) is located at 1 degree, 30' south latitude and 34 degrees, 32' east longitude. Shinyanga Region (50,780 km^2) is located at 3 degrees, 45' south latitude and 33 degrees east longitude.

presence of significant human-wildlife interactions. Regarding proximity, each village was located within 18 kilometers of one of SNP's western boundaries or protected area boundaries (Figure 1.4.1).

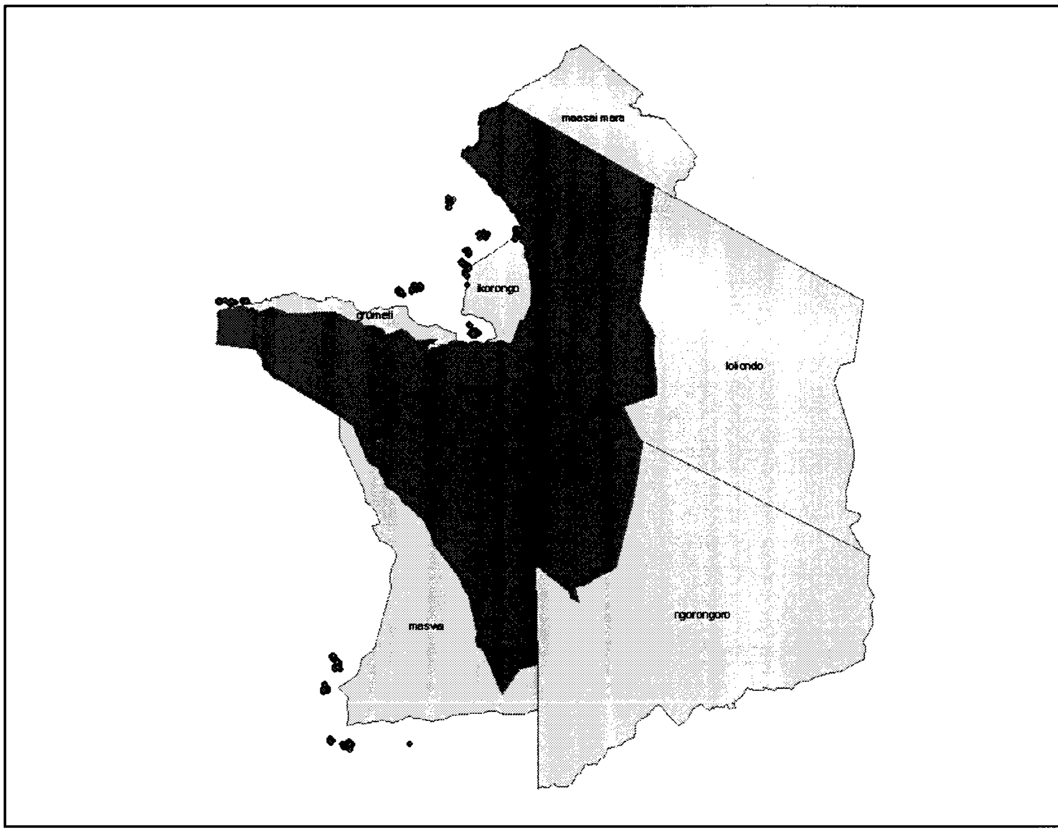

Figure 1.4.1 – Map of Greater Serengeti Ecosystem. Dots on western side reveal village locations, depicted as clusters of households.

The presence of human-wildlife interactions were obtained through archival district reports and open-ended structured interviews with district officials.[12] Interviews were conducted with the purposes of corroborating district reports and recording top-level values on relevant human-wildlife issues.

In Tanzania, villages are subdivided by the government into sub-villages. The methodology here took advantage of this structure with the intent of increasing the spatial

[12] Archival reports were inconsistent and incomplete. As a result, specific levels of human-wildlife conflict were not obtainable. This reinforced the overarching purpose of this study to determine what variables are most important in matters of conflict and coexistence.

heterogeneity within the selected villages.[13] One to three sub-villages were selected from each village and 20-25% of selected sub-villages were sampled.[14] Due to logistical constraints (e.g., inaccessible roads, excessive rain), research was not feasible in several sub-villages within selected villages. A total of 46 sub-villages were selected across the 15 villages.

Within the 46 sub-villages, a total of 722 households were chosen in a stratified-random format.[15] As stated previously, each selected household was located within 18 km of Serengeti National Park, or the Ikoma, Grumeti, or Maswa game reserves. In all cases a local guide from the respective village was assigned by the village chairman to accompany the researchers to each household. Prior to each interview, the assigned guide explained the purpose of the interview. Each household respondent was correctly informed that the interviews were being conducted to better understand human-wildlife conflicts and the impacts that human-wildlife interactions have on household economies. These introductions helped to dispel fear among respondents thereby increasing the accuracy of their answers.[16]

It was explicitly stated before each interview that any and all information would not be used in any format to incriminate respondents. To ensure this, respondents remained anonymous unless they desired otherwise. Due to rural Tanzania's patriarchal

---

[13] Greater spatial heterogeneity at the sub-village level allowed for a more extensive sampling representation of households surrounded by varying vegetation levels, soil types, and/or microclimates.

[14] Two exceptions with sub-village selection occurred in Nyakitono and Robanda village. In Nyakitono, data collection was limited to one sub-village due to the relatively large size ($N = 48$) of the randomly selected sub-village. In Robanda, all sub-villages were selected for the purposes of completing an exhaustive assessment of crop destruction and wildlife depredation on livestock (Chapter Two).

[15] In one sub-village in Kisangura village, it was later realized that the village guide had intentionally selected an equal number of households that he categorized as "poor," "middle class," or "rich." Since this selection process was the intent of the stratified random format, these households are included in the study's results.

[16] Respondent fear, discussed in Chapter Three, spawns from the specter of sanctions relating to admitted guilt in illegal activities such as poaching.

cultural system, household interviews were administered with the male head of the household.[17] This was done to keep in line with current cultural mores and also for possibly uncovering sensitive information pertaining to illegal park activities. If unavailable, interviews were carried out with the household head's spouse.[18] All respondents were 18-years-old or older.[19]

Interviews for the primary sample included 15 interrelated sections often requiring approximately two hours for completion. Relevant sections included socio-demographics, education, income, expenditures, livelihood indicators of wealth, agriculture, livestock, water, firewood, protein intake, 24-hour dietary recall, hunting, wildlife interactions, attitudes toward protected areas, and religion.

1.5 – Subset sample – Poaching

Interviews with the primary sample were integrated with a subset sample obtained during the same timeframe of the primary sample. The subset sample consisted of in-depth structured interviews conducted with 104 acknowledged poachers in western Serengeti. Since poaching is a sensitive issue that carries penalties if arrested (Chapter Three), respondents were selected with "snowball sampling" techniques (Bernard 2006). Interviews were organized with the help of trust-based relationships developed with three key informants, one each from Serengeti, Bunda, and Meatu districts. Respondents

---

[17] Interviews selected males because it is culturally inappropriate to discuss household affairs with women if the men are available. Since males were often unavailable, a greater percentage of interviews were carried out with women.
[18] In several cases, interviews were conducted with a coalition of respondents of respondents who corporately demonstrated knowledge of household affairs.
[19] One interview included a female who was 15-years-old. Due to the unexplained absence of both parents, she was the acting head of the household.

remained anonymous and interviews were conducted in remote areas to ensure full confidentiality.

For comparison with households from the primary sample, topics covered in the poacher subset interviews included many of the same questions administered in the primary sample. Additional topics relating to specific techniques, strategies, and procedures were addressed to extend knowledge of illegal hunting practices and develop a qualitative context. Since an adequate sample size of acknowledged poachers was acquired and feature representatives from all three districts, quantitative comparisons were conducted between the poacher subset sample and primary sample (Chapter Three).

Lastly, an additional four interviews were conducted with individuals arrested for illegal production of charcoal in a protected area. Due to the small sample size of charcoal collectors, results from these interviews are discussed separately from the poacher subset and included in the discussion regarding firewood collection.

1.6 – Subset sample – Park-related employment

An additional subset sample dealing primarily with park-related employment was conducted concurrently with the primary sample and poacher subset. Much like the poacher subset, this methodology included structured in-depth interviews with 50 individuals who had obtained—and were currently involved in—some capacity of park-related employment. For added feasibility, respondents were likewise chosen using trust-based relationships and snowball sampling techniques (Bernard 2006).

This subset also entailed sensitive information yet that of a very different nature than illegal hunting. In addition to topics covered by the primary and poacher subset, the park-related employment subset included more detailed questions pertaining to income. Questions included salary levels for all years worked for, or with, SNP. Due to a general reluctance to answer such questions, interviews were conducted with individuals with whom the author had previously developed a trust-based relationship. Other respondents were selected through recommendations given by friends of the author. For this reason, quantitative comparisons drawn between this employment subset and the primary sample are of limited utility. On the other hand, this methodology enabled an important qualitative context by which to assess an important component of people-park relationships. It also provides an important baseline by which recommendations are made in Chapter Four.

1.7 – Subset sample – Key informants

This subset sample of interviews was conducted solely for the purposes of nesting the much larger primary sample within a more informed context. The premise behind this methodology is that pertinent information is differentially known by respondents at various scales of hierarchy. Key informant respondents were selected non-randomly based upon the position held and a high demonstrated knowledge of issues of interest. This subset included elected and/or nationally appointed officials from seven villages and two districts.

In contrast to the primary sample, interviews were semi-structured, with built in open-ended portions. This was done to uncover information unknown in a priori questionnaire construction. Relevant leads were actively followed up by the interviewer and included topics concerning: taxation, human population demographics, planting and harvesting schedules, cattle raiding, livestock care, land allocation, labor allocation, local government, crime and deviance, wildlife cropping programs, debt, and importance of ancestral ties.

Attempts were made to interview officials from each village represented in the primary sample. Due to unavailability of these higher level respondents, however, just seven of the total 15 villages were represented. Key informant interviews included seven sub-village chairmen, two village executive officers, one head village chairman, one district livestock officer, one district agricultural officer, one zone commander of anti-poaching rangers, and one Italian non-governmental worker. For greater consistency, all interviews in this subset sample were conducted by the author in the same timeframe as the primary sample. Information gathered from this subset methodology provides much of the context for this introduction and the chapters to follow.

1.8 – Archival data

The final component of data collection included archival reports. Archival information was collected opportunistically and depended heavily on existence and availability of relevant documents. In many cases, requests made at village and district offices were unable to be fulfilled due to poor record keeping and/or unknown location of key documents. In several instances, archival data was personally collated by the author from fragmented reports.

Archival data included incomplete records concerning crop destruction, wildlife predation on livestock, rainfall levels, human population demographics, illegal hunting, non-governmental initiatives and programs, HIV AIDS, prison records, and court reports for illegal hunting. Sources for these records included Serengeti, Bunda, and Meatu district agriculture and livestock offices, Grumeti Community and Wildlife Conservation Fund, Community Based Health Promotion Program, two Serengeti district prisons, and Serengeti and Meatu district courts.

Due to its more complete account of a little known topic, court reports provided by Serengeti and Meatu districts are used extensively in Chapter Three's (Part II, Sections 3.12-3.22) analysis of the outcome of persons arrested for illegal hunting. Also drawn upon in Chapter Three are data collected at two prisons in Serengeti District (Section 3.15).[20] In Serengeti District, court records were available for years 2000-2006 but were incomplete for unexplained reasons.[21] In Meatu, records were complete and successfully obtained for the years 2000-2006.

Aside from court reports, other archival information is referenced throughout this study to supplement quantitative analyses within the samples and to provide a more thorough qualitative context by which to base all inferences and conclusions.

1.9 – Household equivalence scale

Although not fully incorporated until Chapter Four, the explanation and utility of a household equivalence scale is worth mentioning here. Household equivalence scales are based on the simple idea that the needs of a household grow disproportionally with each additional member. Implicit in this idea is the notion that household members are not equal. The two factors critical in such scales are the size of the household and the age of each member. While these factors are straightforward, the assignment of values is

[20] Attempts to obtain court data in Bunda District were not successful.
[21] Court officials were ostensibly unable to locate all relevant court documents.

somewhat arbitrary and depends upon value judgments as to the relative "capability" and needs of various aged household members.

After a comprehensive review of existing scales, this study has selected Martin's scale of adult equivalence (Martin 1985). Martin's scale seems most appropriate as its level of detail matches the detail of the survey data and was specifically designed for rural countries. The scale assigns a value of 1 for all household adults over the age of 15. Children ages 6-15 receive a value of 0.6, and children ages 2-5 receive a value of 0.3. Newborns and babies receive a value of 0.1, because their capabilities are few and their needs are comparatively insignificant.

Survey data for the present study included overall household size in addition to the ages of all of the children born to the mother(s) of the household. Absent from the data—and from Martin's scale—are ages (and corresponding smaller equivalence values) of the elderly (e.g., grandmothers living in the household). While the elderly and infirm should arguably receive smaller values due to their diminished abilities, such data proved too difficult to procure due to the majority of older respondents not knowing the specific year of their birth. An unfortunate shortcoming of the dataset is the unknown ages of all of the household permanent guests, or live-ins. Such peoples often included uncles, aunts, nephews, friends, etc. In each case, these persons were assumed to be adults and assigned values of 1.0.

Unlike other equivalence scales which assign males higher capability values, Martin's scale, as stated, assigns male and female adults a value of 1.0. Although males may physically be able to lift more, carry more, or do more vigorous work than females in Tanzania, the reality—as revealed by interviews with key informants—is that they rarely do. In my study site, as in many sub-Saharan African countries, females shouldered much of the day-to-day workload. For this reason, it was deemed unrealistic to assign females lower values than males.

Another notable caveat is that several of the respondents (usually males) were unable to recollect the years that their children were born. In all of these instances, such children were assumed to be over the age of 15 and treated as an adult. For this reason, and the fact that the elderly and infirm were treated as fully capable persons, my household equivalence values might be slightly higher than others found in the literature.

The primary reason for using an equivalence scale is to foster a better understanding of a household's impact on SNP and concomitant ability to buffer impacts from SNP. While categorization is crude and riddled with exceptions, it is useful for approximating which households are the neediest and which, therefore, might be the most likely to exploit SNP.[22]

As an example, one project done in another part of rural part of Tanzania placed households into wealth categories that consisted of: low, medium, and high (Temu & Due 2000). Households falling in the low category were perceived by the authors as incapable of adopting expensive conservation-oriented agricultural techniques and incapable of adjusting their resource-dependent lifestyles. Such households faced periodic times of food insecurity. In the study here, "lower" households will be referred to as "poor" and dubbed as lacking capability to diversify (Section 1.15). These

---

22 Despite its drawbacks, categorization of household wealth has proven a useful tool because it allows for the neediest households to be identified. Theory predicts that the neediest households would be those that bear the largest costs of living next to SNP (e.g., wildlife-caused crop destruction). With such large annual monetary losses, members of these cost-ridden households may more likely to "strike back" at the park through illegal hunting, grazing, or resource collection.

households are thought to lack choices which ultimately affect their resilience to change (Section 1.16).

Households characterized as "medium" by Temu & Due (2000) were those which were better agricultural producers, less prone to food insecurity, and capable of incorporating some degree of natural resource management interventions. In the study here, such households are "middle class" and are considered to be able to cope with all but the most severe livelihood shocks or perturbations.

Households falling in the "high" category in Temu and Due (2000) consisted principally of agricultural producers with additional inputs from other sources of income. The trend for wealthier households to engage primarily in cash cropping has been documented in other parts of Tanzania as well (Van Campenhout 2006). In the current study, the wealthiest portion of the population is referred to as "rich" (determined by income). This infers a high degree of resilience and ability to diversify livelihood strategies.

Research here will operate under the assumption that the poorest households are most heavily involved in unsustainable park interactions. However, as will be shown in subsequent chapters, the richest part of the western Serengeti population may be equally responsible for exploitation, but in a more indirect—and less visible—manner (Knapp 2007). With the luxury of money and time, it is quite possible that the rich are effectively steering the hand of the poor by creating a demand for illegally harvested goods.

1.10 – General terminology

Throughout the pages to follow, the various interview samples are identified for purposes of convenience as the primary sample (N = 722), the poacher subset (N = 104), the employment subset (N = 50), and the key informant subset (N = 15). Sample sizes are given as footnotes for all statistics if the number differs from those just listed.

As stated, mixed methodologies were needed due to the sensitive nature of the interview topics. Although such an assortment of sample strategies limits extensive comparative quantitative analyses, it does enable a more comprehensive understanding of the complex nature of human-natural interactions that occurred—and continue to occur—in western Serengeti. Without such an assortment, the scope and ultimate utility of this study would be severely constrained.

In this study, the historically-used term "tribe" is replaced with "ethnicity," "ethnic group," and "people group". This is done solely to avoid the pejorative connotations that have been associated with "tribe" in recent years. Similarly, the term "resident" is used for all individuals (and their household) who were born in the same village—or a village in the same district—as their current residence. Households that have moved into the study area from another district are referred to "immigrants", or "in-migrants". For purposes here, the latter two terms are considered synonymous.

In regards to agriculture (comprising Chapter One & Two), frequent mention is made of "sacks produced" or "sacks destroyed" of various crops. Sacks are used here in reference to the standard burlap receptacle used by rural households for storage and transport of crops. Sacks typically weighed between 20kg (peanuts) and 120kg (tomatoes). Staple crops (e.g., maize) tended to weigh 90kg per sack.

Other needed clarifications involve the terms "poaching" and "park-related employment", that comprise the second and third chapters. For the purposes of this study "poaching" refers to all hunting done inside or outside Serengeti National Park or one of the four aforementioned protected area buffer zones.[23] Without a purchased permit, all hunting is illegal in Tanzania. Similarly, park-related employment includes all forms of employment that are in some way connected to, or dependent upon, Serengeti National Park or one the protected area buffer zones.

Other terms needing clarity are nonfarm and off-farm income. The literature on rural income sources has tended to treat nonfarm and off-farm income as synonymous, while also equating the terms with "nonagricultural" and "nontraditional" income. To simplify, the terms in Chapter Two will be teased apart somewhat. Here, off-farm income will be referred to as any money generated by agriculturally-related labor that generates wages. This includes wages earned for planting, harvesting, or weeding. It does not include crop sales. Nonfarm income, on the other hand, will be referred to as money generated in any activity that is not agriculturally based. This can include seasonal or year-round employment, trade, or self-employment in activities ranging from basket weaving to accounting.

Lastly, at the time that this study was conducted, one thousand Tanzanian Shillings (hereafter, "TZS") was equivalent to approximately one U.S. dollar. In the analyses to follow, all percentages are rounded to the nearest whole number with several exceptions indicated in the text. Analysis of Variance tests are shortened to ANOVA.

---

[23] Protected areas referred to here include: Ikoma, Grumeti, and Maswa game reserves, and the Ikoma Open Area.

Part III.

Context & Concepts

1.11 – Western Serengeti

Although the area known as "western Serengeti" may more commonly refer to all of the land west of the park extending to Lake Victoria, here—and for matters of simplicity—the term will be used in a narrower sense, to define all households lying within 18 km of a protected area boundary. This is done solely for convenience and should not be confused with the larger area of land west of Serengeti that may appear in the literature (Kaltenborn 2008).

Similarly, in all summaries and analyses to follow, respondents of this study will be collectively referred to as "western Serengeti peoples," unless otherwise specified. The general implication here is that the majority of respondents are East Nyanza, Bantu-speaking agropastoralists occupying the Mara and Shinyanga regions of Tanzania. Just like this study's more narrow use of "western Serengeti," western Serengeti peoples are limited to ethnic groups living from zero to 18 km of the park. As stated previously, this distance range was chosen specifically to capture households that experienced a significant degree of direct or indirect interactions with SNP and its adjoining protected areas.[24] It also successfully captures interactions and interdependencies that these people groups had on the GSE.

[24] Human-wildlife interactions were shown to markedly decrease at distances greater than 10 km from a protected area boundary.

1.12 – The household

All of the interactions and interdependencies that people have with SNP will be discussed in terms of the household. Although the household as a unit of analysis may fail to capture important attributes of key individuals, it remains the unit of choice for empirical investigation dealing with rural socioeconomics (Ellis 1998). In many African societies, the household acts as an indigenous model which includes the critical utility of kinship relations (Kuper 1982). A western Serengeti household is defined in this study as a social group that is coordinated in space and time, shares meals, and makes collective decisions about income, expenditures, and resource allocation.

In addition to its practical utility, the decision to focus on the household is historically well established. Research done by Shetler (2007) on western Serengeti households reveals that while household members are usually biologically related, friends (and even acquaintances) are routinely incorporated into the unit. Once incorporated, unrelated persons all contribute to the domestic economy (Shetler 2007). In the past, non-biological household members were often accorded high status and sometimes honored as great and powerful ancestors (ibid). While such high status for extra-familial members has ebbed in recent decades, western Serengeti households continue to incorporate friends and acquaintances into the unit and may harbor such persons for indefinite amounts of time. For these reasons, a household rather than a nuclear or extended family unit was chosen as the unit of analysis. To focus solely on family units would miss important contributions that non-biological outsiders contribute to western Serengeti households.

The presence of non-biologically related outsiders, temporary guests, and relatives, however, can create uneven power relations and unequal levels of wellbeing among household members (Glewwe & Van Der Gaag 1990). As a result, it is unlikely that intra-household distribution of resources or consumption of goods is evenly spread among household members. While undoubtedly true in western Serengeti, this study's emphasis on broader level interactions renders such inequalities outside the scope of the larger-scale purposes here.

Regarding terminology, "household" will be used interchangeably with "homestead" and "compound." Similarly, the term "livelihood" will be equated with "household economy" to include the general strategies that households use to persist.

1.13 – Western Serengeti households

According to results from the primary sample, the typical western Serengeti household included approximately eight people. It was not uncommon, however, for households to exceed 20 members.[25] Large households were partly a result of polygamous relationships, too. For those that had married, 30% of respondents[26] practiced polygamy.[27]

Just 3% of the sample's respondents had never married. This implies that marriage remains a common cultural practice in western Serengeti. Pragmatically, attainment of multiple wives may be done to help households persist through economic hardships (e.g., crop failure, livestock disease). The study revealed, for example, that in

[25] The largest household included 47 members.
[26] N = 453
[27] In the total sample, 23% of respondents were involved in polygamous relationships.

some cases individual wives of a husband lived far apart, intentionally.[28] As one male respondent explained, having wives in separate locales allowed the collective household to take advantage of widely distributed resources. While one village afforded better grazing opportunities (due to reduced competition), for example, the other had richer soils for growing crops. Although not fully captured by research here, it is likely that such livelihood strategies which take advantage of heterogeneous environments are widely practiced among households with a means to do so.

In general, results suggested that greater resource requirements needed by larger families were offset by an excess of available labor. Theory suggests that more labor, for example, allows for a greater degree of diversification and specialization. As will be shown in Chapter Two (Section 2.2), diversification can be critical for households trying to attain non-farm related income.

Another advantage of larger households concerns care for the elderly and infirm. In countries such as Tanzania, where institutionalized care for the elderly does not exist or is unaffordable, parents often depend on offspring for healthcare and economic support. Information gathered from key informants confirmed this notion, asserting that large families are important because children are a form of insurance for the elderly.

Such straightforward explanations may account for why there were few single person households in the sample. Where single person households did occur, however, they usually consisted of unusual circumstances involving mental illness, substance abuse, or older, widowed women whose children had married, left the household, and moved to more developed areas of Tanzania.

[28] In several cases, wives lived in separate villages. In one case, they lived in separate districts.

The effects that household size exerts on wealth are uncertain and widely debated. Some argue that larger household sizes impose handicaps in times of stress and are more often associated with downward economic mobility (Krishna 2004). This is controversial, however, because larger households are often correlated with greater per capita wealth. While smaller households have been associated with greater capacities for upward mobility, their relatively smaller labor force may also make them more susceptible to disturbances such as prolonged illnesses, death, or emigration of one or two key members.

At present, there is little consensus in the literature concerning the effects on—and effects of—variously sized households. As shown, much of the difficulty lies in the fact that household size varies enigmatically with wealth factors. If per capita consumption is used as a proxy, for example, larger households tend to be designated as poor (Glewwe & Van Der Gaag 1990). If total household consumption is used, on the other hand, then smaller households often appear poorer (ibid). Similarly, one study found a positive relationship between household size and wealth (Scoones 1995) while another found household size to correlate negatively with per capita income (Van Campenhout 2006).

The study here found a stronger correlation between household size and total expenditures (Pearson $R = .426$, $p < .001$) than household size and total income (Pearson $R = .133$, $p < .001$). Although conjecture, this may imply that larger households spend more money but do not necessarily earn more income. This makes sense given the aforementioned nuanced relationship that appears to accompany household size and wealth. Fittingly, there was a negative correlation between household size and per capita expenditures (Pearson $R = -.201$, $p < .001$).

As Chapter Three will reveal more clearly, there was no relationship between the size of actively poaching households and nonpoaching households. Nor was there any relationship between the amounts of crop damage and household size.

Essentially, what all these statistics show is that household size lacks utility as a variable. This may largely be due to the presence of multiple and complex factors that are often concealed beneath household size (Krishna 2004) and which interact nonlinearly. Undoubtedly, household size has important effects on livelihood strategies, human-wildlife interactions, and household resilience. As this study and several others show, however, its innate complexity may render it to be of limited utility in the understanding of human-wildlife interactions.

1.14 – Ethnicity

Like household size, the effects of ethnicity on human-wildlife interactions are innately complex. In 722 total household interviews, 29 ethnicities were recorded for the head-of-the-household[29]. When the household head's wife (or, wives) was factored in, the number of ethnicities climbed to 37. In terms of actual people groups, the Sukuma comprised the majority (40%) followed by the Ikoma (24%), Kuria (16%), and Natta (8%). The percentage of respondents in the remaining 25 ethnic groups were 2% or lower (Figure 1.14.1).[30]

---

[29] When the head-of-the household was not present, a "stand-in" was used, provided that he/she demonstrated adequate knowledge of the household affairs.

[30] Ethnic groups represented by 1% or fewer of total respondents were aggregated into the category labeled "Other" in Figure 1.6.1 to make the figure more readable. See Appendix A for total list of ethnic groups.

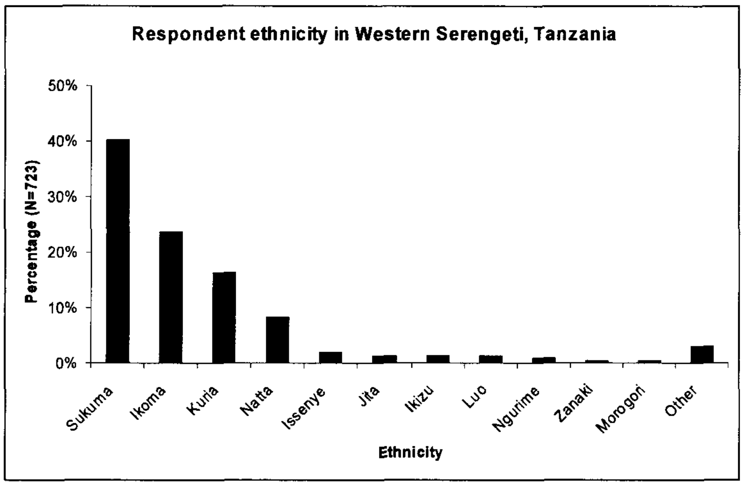

Figure 1.14.1 Ethnic composition of total sample

While the number of ethnic groups bordering the GSE's western side is considerable in such a relatively small area, the actual livelihood differences between the groups are not. In contrast to the Maasai on the park's eastern side, for example, all of the sampled groups to the west practiced agropastoralism as their primary livelihood strategy.

According to historian Jan Bender Shetler, the emergence of many small ethnicities with a high degree of intermarriage and "neighborliness" is of little surprise considering western Serengeti peoples' historical context. Early bands of people, she states, forged close relationships with the land (Shetler 2007). Out of land-based identities, fledgling small-scale ethnicities emerged in the early 1800s which became recognized and codified a century later during German and British colonialism in the early 1900s.

In addition to stemming out of a strong relationship with the land, western Serengeti ethnic groups formed in relation to each other and neighboring ethnicities. Cross-regional awareness and associations were pivotal because it allowed each group to better cope with weather irregularities and ongoing changes in colonialism and government.

Associations between western Serengeti peoples also arose due to external pressures applied by the Maasai during a prolonged period of regional domination in the 1800s. After a series of Maasai raids, western Serengeti peoples were forced to band together in loose coalitions and communities. To prevent greater losses in the event of a Maasai raid, for example, western Serengeti fathers often placed sons in varying locations to prevent the death of an entire household (Shetler 2007).

Similarly, warrior "age-sets" (cohorts of similarly aged males) of various western Serengeti ethnic groups cooperated to repel Maasai advances. As a result, age-sets took precedence over ethnic identities and specific ethnic descent decreased in importance. By the end of the Maasai domination, mixed-settlements had sprung up and a general spirit of inclusiveness enveloped the region. In her exhaustive ethnographic work of the region, "Imagining Serengeti," Shetler recounts how western Serengeti elders can readily list their exact lineage genealogies back to four generations. At the same time, however, they have considerable difficulty describing how their genealogy relates to other ethnic members and to their founder.

More broadly, the importance of lineage may have usurped ethnicity due to long-standing anthropological principles of reciprocity, especially in the arenas of bridewealth and paternal inheritance. According to E. Evans Prichard, personal obligations, such as those seen in father-son relationships, define lineage whereas ethnicity is more concerned with structural relations between collectivities (Shetler 2007). With a mixed ethnic heritage due to factors just discussed, lineage and inheritance likely took precedence over ethnicity in defining communities.

Western Serengeti's pervasive spirit of inclusiveness and its historical cross-ethnic relations may account for the relative similarities (or, lack of significant differences) that the various groups share in their interactions with SNP. None of the human-wildlife interaction variables which were analyzed using ANOVA techniques, for example, revealed significant relationships, or, even hinted at possible relationships.[31] Like household size, the utility of ethnicity was limited and may be less important in understanding the way that western Serengeti people are currently interacting with the GSE.

Further corroborating these results was the high degree of intermarriage (29%)[32] observed in the primary sample. This suggests that marital alliances in western Serengeti are not dictated by ethnic background alone. Although this study downplays ethnic importance in human relationships with SNP, it should not be discounted completely. Results from the key informant subset, for example, suggested that ethnic legacies of some groups (e.g., Ikoma) are more tightly linked with natural resource exploitation than other groups. Due to its potential importance in management options for the GSE, this point will be reexamined in Chapter Three. While ethnic origin undoubtedly plays a role in human-SNP relations, several other variables that affect human-wildlife interactions more significantly will be focused on instead.

---

[31] For clarity, one example of the human-wildlife interaction variables tested was the number of wildebeest consumed in the past 12 months by households representing the various ethnic groups.
[32] N = 472

1.15 – Poverty

Since poverty is referred to throughout the study, it will be discussed only briefly here. Most importantly, households in poverty rarely sit idle, waiting for growth (or program benefits) to suddenly appear (Krishna 2004). Having grown accustomed to weather irregularities and large-scale livestock die-offs, most households in rural east Africa adopt livelihood strategies that actively cope with current hardship and the prospect of future calamity. For two of this study's districts (Serengeti and Bunda) that fall in Mara Region, the pressure created by poverty is especially great. Among Tanzania's 21 administrative mainland region, Mara ranked as the 6th most impoverished. As of the most recent census in 2002, regional per capita annual income amounted to TAS (Tanzania Shilling) 118,591, or US$119 (URT 2002).

Poverty is also a factor in Shinyanga Region, in which Meatu District resides. A Household Budget Survey (2000/01) found that 42% of households suffered from basic needs poverty, which was over the national average of 36%.[33] The same study found that 22% of households had food poverty, whereas the national average was 19%.[34] The important point here is that a greater percentage of households were in poverty in Shinyanga than in many other administrative regions of Tanzania.

How local western Serengeti people feel about poverty, however, is arguably more important than national statistics. Regardless of their actual income, assets, or livelihood portfolios, households that feel poor may be more inclined to exploit protected resources than those that do not. This is significant for western Serengeti as over half (55%) of households felt they were "poor" when allowed to classify themselves. In

---

[33] 46% of households in Mara Region suffered from basic needs poverty (Household Budget Survey 2000/01).

[34] 36% of households in Mara Region suffered from food poverty (Household Budget Survey 2000/01).

contrast, just 4% claimed to be "rich", while 41% referred to themselves as "middle class".[35]

Although the poverty figures to be discussed in subsequent chapters are largely income- and asset-related, poverty in western Serengeti has many other facets (not covered by this research). These include: physical weakness, isolation, powerlessness, limited access to health facilities, and degenerate household structures among others (Chambers 1987, Adams et al. 1997). Such characteristics are important in human-wildlife interactions, but they are exceedingly difficult to measure with household survey techniques over limited timeframes. Likewise, the timeframe of this study was considered too limited for alternative measures of poverty to be used appropriately (Glewwe & Van Der Gaag 1990).

1.16 – Diversification

No study that focuses on the economic outcomes of human-wildlife interactions with implications for resilience can be done without examining the pivotal role played by diversification. Diversification is notable as it has been hailed as the single most important route by which households can escape from poverty (Krishna 2004).

As a concept, diversification can have several antecedents. Here, the focus will be on income diversification as opposed to the broader and more holistic concept of livelihood diversification. Primarily, this is done to avoid overstepping the limits of the dataset. Livelihood diversification includes an active social component that the household surveys did not fully capture. This is somewhat unfortunate because social networks undergird the western Serengeti study population and would undoubtedly act as

[35] N = 718

a more realistic measure for determining the ultimate resilience of the GSE (Section 1.16). On the other hand, it is exceedingly difficult—and subjective—to accurately discern (and apply a value to) the active and heavily nuanced social dimensions of human livelihoods.

Income diversification, on the other hand, readily lends itself to survey work as it refers to the composition of household incomes at a given instant in time (Ellis 1998). For this reason, it will be treated as the best available proxy for the broader concept of livelihood diversification.[36]

An examination of income diversification is essential due to the reality that very few households in rural areas collect all of their income from any one source. Rather, a household's income often derives from a mosaic of sources which are a product of the seasonality of agriculture, uneven market forces, fluctuating employment opportunities, and the variegated composition that most households entail. For the sake of discussion, income sources may be divided into three primary categories which include farm income, off-farm income, and nonfarm income (Reardon et al. 2000).

As mentioned earlier, this study will argue that the only realistic way for park exploitation to fall (if all other forces remain equal, of course) is for greater opportunities for households to diversify into nonfarm income sources. As Chapter Four will show, nonfarm income is the only way to effectively decouple households from the vagaries of weather, thereby smoothing income generation throughout the year. Other studies that

---

[36] As the "permanent income hypothesis" (Friedman 1957) suggests, many households in rural parts of developing countries have variable incomes due to the preponderance of unpredictable harvest yields and seasonal labor markets. The reality of impermanent or inconsistent income causes many people to save in abundant years and subsist on past savings in lean years. This is problematic for "snapshot" survey data due to the difficulty of ascertaining if income data came from a "good" year or a "bad" one.

have assessed the merit of various agricultural growth programs implemented in Africa have largely agreed that such programs are not a viable solution to rural poverty (Krishna 2004; Bahiigwa et al. 2005).

There are two often cited factors that drive diversification. One is a "pull-factor" by which commercial agricultural growth or the proximity of urban centers create opportunities for income diversification (Barrett et al. 2001). Western Serengeti's relatively remote location and the relative absence of commercial companies make this an unlikely driver of current diversification. More probable is that western Serengeti households have diversified as a result of the "push-factor", which often occurs in the absence of strong financial systems and by the limited risk-bearing capacity of households to system-wide perturbations. Theory suggests that climatic uncertainty, coupled with limited land and labor markets, drive households to select the widest possible portfolio of activities to buffer shocks and stabilize income flows (Barrett et al. 2001).

A "push-factor" highlights the fact that income diversification can have negative consequences for the local resource base. Whether stemming from a deliberate household strategy or an involuntary response to a crisis, diversification can harm the natural system when households turn to illegal harvesting—or exploitation—of park resources in efforts to generate, or stabilize, income flows. In this way, the presence of protected areas can serve as a safety valve for the rural poor but ultimately weaken the resilience of the coupled human-natural system.

Another possible ill-effect of diversification is when it acts to further accentuate rural inequality and increase the gap between the poorest and richest households (Ellis

1998). Diversification can do this by acting as a means of accumulation for the rural rich. This idea will be returned to in Chapter Three's discussion of the varying impacts of households on SNP.

1.17 – Adaptive capacity & implications for resilience

Until now, the terms "adaptive capacity" and "resilience" have been used frequently and loosely with various references to human-wildlife interactions and the human-natural system. In this section, narrower—and clearer—definitions will augment their utility in the working framework of this study's thesis.

When households diversify—either by choice or necessity—they are often responding to local, national, or even global changes. Like most human-natural systems, various levels of social, political, economic, and environmental changes are continually occurring in western Serengeti. One current high-impact change affecting the system is human in-migration which is resulting in population growth, land subdivision, and a growing scarcity of natural resources.

The reality of change in Serengeti has been noted in the literature, too. In a recent paper outlining the results of long-term monitoring, Sinclair et al. (2007) stated that the "always changing" characteristic of the GSE is one of its most important lessons to be learned. The difficulty comes, the authors conclude, in distinguishing natural change from human-induced change (ibid). Rather than focusing on the changes themselves, the present study seeks to examine the responses of households to change. More specifically, it will seek to examine changes that occurred in the household's previous 12 months. Perhaps the most productive way to do this is via the concepts of adaptive capacity and resilience. Due to their close relationship (Gallopin 2006), the terms will be discussed in tandem.

As stated, the decision to use resilience as the central framework is due to its underlying tenet that human-natural systems are not static. A resilience framework highlights the dynamic interaction that exists between humans and their surrounding ecosystems. Human livelihoods exert changes on surrounding ecosystems (Chapter Three) and vice-versa, as components of the surrounding ecosystems exert a response—either adaptive or maladaptive—to human livelihoods (Chapter Two). Such interactions can be direct, indirect, and have immediate and/or delayed effects (Figure 1.17.1).

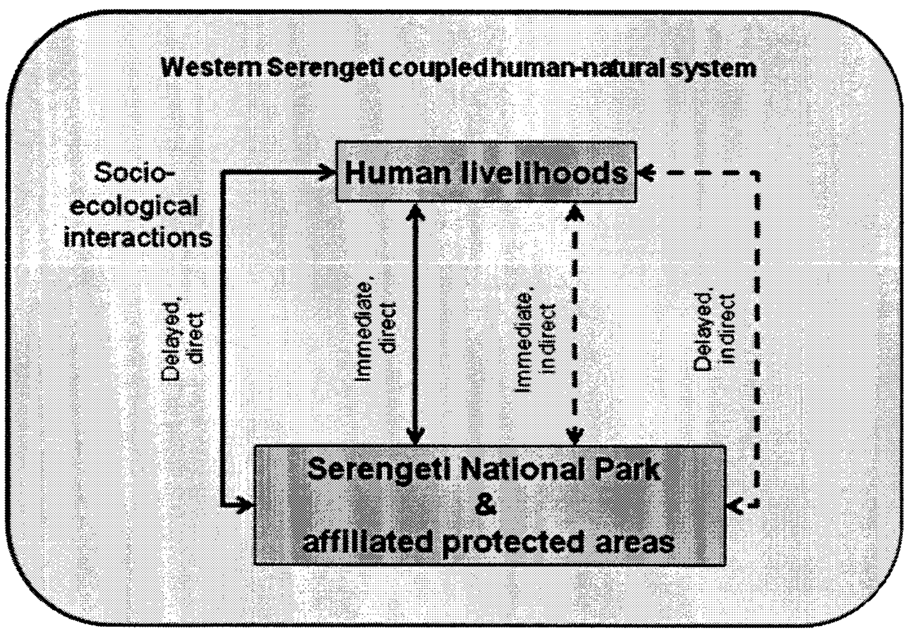

Figure 1.17.1 – Conceptual Model depicting attributes of socio-ecological interactions that humans have with SNP, and vice-versa. Interactions may be direct (indicated by solid line), indirect (indicated by dashed line), and have immediate effects (indicated by shorter lines), or delayed effects (indicated by longer lines). The interactions investigated in this study were primarily direct and immediate. But these interactions also likely have delayed and indirect effects (that were not assessed).

Spatial and temporal interplay that results from these interactions underscores the biocomplexity of the system with both small- and large-scale ramifications on human well-being (Section 1.3) (MEA 2005).

For the purposes of this study, resilience will be simply defined as the ability of a household to buffer disturbance, or shocks. Since specific household responses to disturbance were not measured, however, the study's findings do not directly assess resilience per se, but rather have implications for resilience. Instead, attention is paid to adaptive capacity as a component of resilience. Adaptive capacity is concerned with social learning, flexibility to experiment, openness to novel solutions, and development of generalized responses to challenges (Walker et al. 2002). Also useful is that studies of adaptive capacity often include resources and assets that represent a base from which adaptations can be made (Adger and Vincent 2004). Such ideas are extensively discussed in the second and fourth chapters of this study. In essence, adaptive capacity provides the basis for social-ecological systems to become more resilient to a range of disturbances (Walker et al. 2002). That question is the primary aim of this study.

While the focus is on the human component, the underlying implication is that the resilience of the natural system is compromised similarly—if not more so—whenever the adaptive capacity of a household decreases. This relationship stems from a perspective that people are integral parts of ecosystems and therefore, that human-natural systems are innately coupled.

The ability of a household to buffer disturbance is largely dependent on its income flows. Not surprisingly, households that live closer to the margin of poverty can buffer fewer shocks (Krishna 2004). Without alternative incomes, degradation to the natural system and a subsequent loss of ecosystem services are borne disproportionately by the poor due to their greater dependency on the resource base. As was mentioned in

Section 1.14, this may result in greater inequalities among rural inhabitants, create atmospheres of social conflict (MEA 2005), and ensnare households in poverty traps.

Thus far, resilience has been referred to as a positive attribute—or even an implicit goal—of a human-natural system. But it should be pointed out that resilience can be harmful, too. For example, a severely degraded system can be highly resilient and maintain its degraded state if behavioral changes or interventions do not occur. Because of these potentially negative connotations, the resilience-enhancing initiatives that this thesis discusses are those that allow households to buffer shocks without undermining the resource base of the GSE. A resilient human-natural system, therefore, is one that may exist indefinitely while retaining an ability to reorganize and learn while undergoing change (Berkes & Turner 2006).

Historian Jan Shetler has described the general Serengeti environment as one that has proven incredibly resilient over the course of time (Shetler 2007). From the perspective of the often marginalized western Serengeti people, this has definitely been the case. From the earliest records, it is clear that they have persisted in the face of severe droughts (Section 1.34), disease[37], famine, Maasai raiding, and colonial upheavals (ibid). The various western Serengeti ethnic groups have buffered the shocks by learning, adapting, and reorganizing themselves and their livelihood strategies. These adaptations—Western Serengeti people's adaptive capacity—have largely taken the form of local migrations (to avoid disease or better access resources), and by varying their agricultural, livestock, and/or hunting practices.

[37] Widespread disease has swept through western Serengeti human and livestock populations in the primary forms of African sleeping sickness (*Trypanosoma brucei rhodesience*), malaria, smallpox, rinderpest, and pleuropneumonia (Shetler 2007; Cleaveland et al. 2005; Cleaveland et al. 2001).

Some of the resilience that Shetler describes can be attributed to an abundance of natural resources with correspondingly low human and livestock population densities. Historically, people groups surviving in resource-abundant areas with simple technologies and subsistence economies have been viewed as conservation-friendly (Lu Holt 2005) and sometimes even been protected by the state. This had been the case for the Maasai peoples located to the east of SNP. The combination of a low population density and resource abundance has been dubbed "epiphenomenal conservation" in that it often results from an inability, or lack of incentives, to incur significant use pressures on an area's natural resources (ibid).

Because this was largely the case in the early decades following the creation of Serengeti National Park, the effects that people were having on the western side were largely ignored. Instead, as mentioned earlier (Section 1.2), research and funding tended to focus on wildlife and "pristine" ecological studies devoid of human influence. As populations and park pressures have increased in the west, however, attention has abruptly shifted to the human component. But unlike the more ecologically friendly reception that the Maasai have received to the east, western Serengeti peoples have been viewed as generally incompatible with biodiversity conservation.

While it is true that epiphenomenal conservation cannot proceed in the face of high demographic, economic, and technological growth (Lu Holt 2005), what has largely been missing from the discussion has been an acknowledgement that human populations are "cushioned" from their natural environments by cultural and organizational systems. Such intermediate systems, often called institutions, change and adapt as resource availabilities fluctuate or grow scarce (Berkes and Folke 1998). The existence of flexible institutions and strong kinship networks function as a household's adaptive capacity (Smit and Wandel 2006). Ultimately they allow households to buffer shocks in the system.

Theory suggests that population pressure and resource depletion may act to gradually reduce a system's adaptive capacity (Smit and Wandel 2006). While this is likely true, institutions play an important intermediary role that can thwart management plans which are overly simplistic and straightforward (Clay et al. 1994). In short, the implementation of Malthusian and Boserupian natural resource models in social-ecological systems has not proven successful.

Although institutions are outside the scope of this study, attention will be directed at several often overlooked intermediate linkages that exist between people and the resource base. For example, instead of focusing solely on human population as the ultimate problem, intermediate linkages such as in-migration, out-migration, and household composition dynamics will be examined.

In addition to its emphasis on institutions, the resilience framework encourages a fundamental change in the way the western Serengeti study population—and those like it—are viewed. In short, the framework casts the GSE as a socially produced system in which the 29 ethnic groups (Section 1.14) relate to the natural world in a very different way than wildlife managers, outside agencies, and academics of European-derived backgrounds. In the western world, there is a tendency to set humans apart from nature. Moreover, nature and culture are regularly viewed as static entities (West 2006).

This little acknowledged paradigm subtly—and wrongly—negates the complex ways that people groups interact with the natural system that they rely on for food, shelter, economic, social and sometimes even spiritual needs (West 2006). A resilience framework successfully obviates this common pitfall. It does so by advocating a nuanced set of relationships that humans have with the natural system and one that is complex, interconnected, and undergoing perpetual change.

Perhaps the most difficult aspect of using a resilience framework is taking it from "metaphor to measurement" (Carpenter et al. 2001). To do this effectively, one must contextualize both adaptive capacity and resilience as site-specific measures (Smit and Wandel 2006; Carpenter et al. 2001) and balance the need between specific (targeted) resilience and general resilience (Walker et al. 2009). For added understanding, both general and specific resilience will be used in this study. When the term is used without reference to a distinct component of the system, then general resilience is assumed. General resilience refers to the GSE system at large and its capacity to cope with unidentified shocks. In other parts of this study, specific—or, specified—resilience is used. This is done to contextualize the theory and identify its key variables (Carpenter et al. 2001). Here, specific resilience denotes the capacity of households to change as the GSE changes, while still maintaining their functionality. More clearly, it's the ability of a household to change somewhat (adapt) without causing that household to cross a threshold into a different regime, or, alternative stable state (Scheffer et al. 2001; Walker and Salt 2006; Garmestani et al. 2009). While this may appear pedantic or trivial, a household's ability to retain essentially the same function and structure within the Greater Serengeti Ecosystem after undergoing disturbance can determine the very survival of the household. At the very least, it will determine how—and to what extent—households interact with the Park.

If a drought occurs, for example, a household may demonstrate its adaptive capacity in several ways. Some households may earn extra income through noncontract wage labor (Chapter Two). Others may draw resources from contacts outside the system (Chapter Two). Or others may turn to poaching wildlife (Chapter Three). In the case of poaching, if too many households choose to poach, then wildlife populations could potentially decline to such an extent that the GSE crosses a threshold. Poaching's effects on the wildebeest migration, in fact, has been identified as one of the key relationships undergirding the functioning of the entire GSE (Sinclair 1995). Other key thresholds that could push the system into a different regime include land degradation and land fragmentation. At the household level, regime changes could involve households having to move closer to the park boundary (for more efficient access of resources), or selling off of livestock, which are valuable in difficult circumstances.

In this way, resilience is applied to two very different components of the coupled system. General resilience of the GSE is a natural outgrowth of a large body of studies on ecological resilience done on lakes, coral reefs, oceans, and forests (Scheffer et al. 2001). While the general resilience of the GSE is mentioned here, it is done so loosely and speculatively. An analysis of the full suite of variables (e.g, climate change, nutrient stocks, human values) underlying this highly complex system extends beyond the scope of this study. A more thorough examination, however, will focus on the resilience of western Serengeti households. Compared to its wider use with economic systems (Rosser 2003) and urban systems (Garmestani et al. 2007), its application to the household is much narrower. The household is a logical choice because it functions as a specific and micro economic system. Although the general and specific emphases of resilience are different, they are considered inherently linked in this study. The general resilience of the GSE depends on the specific resilience of households to change, and vice-versa. As the resilience of either component declines, it will take progressively smaller disturbances to push the system into a different regime (Scheffer and Carpenter 2003) in which the structure and function at either level may be substantially different. An example of a loss of resilience at the household level may be a loss of opportunity or more constrained options among households to earn adequate income. Or, it might be the inability of the GSE to offer needed ecosystem services (e.g., fuelwood, water, etc.).

A complicating aspect of the relationship that western Serengeti households have with Serengeti National Park is that resilience in and of itself is not necessarily desirable. To extend the example used previously, a resilient household might be one that persists through a disturbance by increasing poaching efforts. In such a scenario, actions of resilient households may undermine the general resilience of the GSE. This concept of desirability is fundamental to resilience. According to Walker and Salt (2006), a resilient social-ecological system in a desirable state may be one that can support a quality of life while being subjected to a variety of shocks. This same definition will be loosely applied to this study, but with an important caveat. Here, households are considered resilient to change if they can support a quality of life that doesn't undermine the GSE on which they depend. Stated as such, households in this study are considered to be lacking resilience if they poach wildlife, sell firewood, or utilize SNP's rivers for watering livestock. While all of these actions are short-term optimizations, they have the capacity to make the GSE cross a threshold into a different system regime over the long-term. The fact that resilience can be desirable or undesirable underscores this study's use of adaptive capacity, which is only viewed as a desirable characteristic in the coupled system.

Crossing over into a different system regime is considered here to be undesirable largely because new regimes are inherently unpredictable, or emergent properties of complex systems. If poaching efforts increase substantially, for example, then poaching may eventually stop but the wildebeest population may not recover. This would be an undesirable regime shift that could threaten the GSE at large. Other alternative stable states—some desirable and some undesirable—are also possible (Walker et al. 2009). Since new regimes cannot be predicted with any accuracy, western Serengeti's current system regime is considered *most* favorable. Other unfavorable stable states, for example, might feature lower wildlife populations and/or more widespread poverty among local households. As subsequent chapters will discuss, a household's ability to buffer disturbance without undermining the resource base—specific resilience—is essential for the general resilience of the Greater Serengeti Ecosystem.

Change is nothing new to western Serengeti. The interplay of natural processes and the decisions of human inhabitants has been both a disruptive and renewing force at various times in the region's history. What is new to the system, however, is the increased human migration into the area accompanied by constant population growth. As this study will show, this has led to more land subdivision and increases in agricultural intensification. While the problems (potential regime shifts) in this trajectory are recognized (Sinclair et al. 2007), it remains unclear as to how to address them. Using resilience as a framework, this study aims to shed light on these questions.

As a final note, the distinction between the general resilience of the GSE and the specific resilience of the household to change is based upon a hierarchy of nested relationships. This idea, called a panarchy, is defined by a nested set of adaptive cycles operating at discrete scales (Gunderson and Holling 2001). In this study, the household acts as the discrete unit of analysis—a smaller scale system—operating within the larger scale GSE system. This distinction does not, however, separate the household from the GSE. To reemphasize, humans (and households) are considered a part *of* the GSE rather than constituting a separate entity, as has historically been the perspective of western-based approaches. Since households are considered one of many influential components of the system, the resilience of a household is necessarily intertwined with that of the GSE. Due to this, the current study is designed as a cost-benefit analysis with implications for both household resilience, and the resilience of the GSE.

As Carpenter et al. (2001) stated, resilience is most helpful when viewed in a site-specific context. To give the concept footing for later chapters, the rest of this chapter will be devoted to developing a more specific agropastoral context in which western Serengeti households currently live.

Part IV.

Agropastoralism

1.18 – Land

Land is arguably the most critical determinant of resilience in western Serengeti. In Tanzania, every piece of land is designated by one of four categories which include:

private land, conservation land, village land, and common land (the latter two categories often overlap). The first sense one gets when walking through a western Serengeti village is that rural lands in Tanzania are a mosaic of many individual properties. Despite a lack of fences, boundaries, signs, and often inhabitants, ownership and current status of each parcel is widely known—and usually respected—by other villagers. Negligent households that allow their livestock to wander onto neighboring lands with resulting damage often face sanctions levied by a locally elected village land committee.

Out of convenience, this study refers to the amount of land "owned" by a household. Technically, however, this is incorrect. All land in Tanzania is under the current President's control and is the property of the nation, governed through the Department of Land (Shetler 2007). With the exception of protected areas, household and village land is held in a communal type of tenure, locally known as the "deemed right of occupancy" (Kideghesho et al. 2006).

Land features prominently due to its importance in livelihood diversification (Section 1.16) and its increasingly limited availability.[38] Land availability has changed swiftly. Just a generation ago, contiguous acres were readily available to local residents who wished to increase their holdings and to village immigrants who requested it via a letter/application to the elected village council.[39] After cursory background checks by village officials, relatively large tracts were historically parceled out indefinitely and

[38] The information given in this section is largely derived from interviews done with village officials in western Serengeti.

[39] Land tenure laws have been implemented sporadically in the seven villages represented here. In three of the villages (Nata Mbisso, Robanda, and Bwitengi), laws were installed in 1974-75, as a part of "Operation Kijiji" or "Ujamaa". Land laws were installed in Rung'abure in 1999 and in Kisangura in 2003. Laws have yet to be installed in Park Nyigoti and Bonchugu. While conclusions must be hesitantly drawn from this small sample, it does reveal that no uniform land policies have been exacted in western Serengeti.

without charge.[40] This process continues today in the sampled villages[41] but with several exceptions. The village reserves the right to reclaim land in situations in which: the occupants leave the area or desist in using their land, are unable to pay a fine for an unrelated infraction (e.g., arrested for illegal hunting), are arrested for severe misconduct and found guilty[42], or land is required for a village project ("mradi wa jamii").[43] Depending upon the village, use of privately owned land is monitored by the village chairman, the village executive officer, or a village land committee.[44]

There also exists varying amounts of communally held land in Tanzania that accompanies individual holdings. In western Serengeti, communal lands ranged from 50-100 acres and always adjoined a river or watershed tributary. The primary purpose of communally held lands is to provide free grazing for livestock, water access, and firewood collection. As will be discussed shortly, these communal lands have been heavily used and may lead to diminishing returns.

As mentioned, however, there is little—if any—land left to be distributed. Most land that is still available is now of poor quality for livestock or agriculture. In key informant interviews with village officials representing seven different villages, only three of the villages still had land available to immigrants. As an example of the amount of uninhabited land that is still available to newcomers, Robanda village had over 1,000

---

[40] One informant revealed that a "tip" made to the land committee aids in land acquisition.
[41] Nata Mbisso village charges the equivalent of one day's labor (TZS 2,500) for one acre of land to residents. This land is then the property of the buyers until they stop using it. Immigrants, however, are charged TZS 10,000 per acre on a yearly basis for every acre they purchase. The effect that this policy is having on human in-migration into this particular village would be an informative and useful spin-off study.
[42] Misconduct can have many forms in western Serengeti. According to key informants, however, the usual forms include theft and assault.
[43] Examples of village projects have included irrigation schemes, wells, and cattle dips (to prevent cattle from tick-borne diseases).
[44] Land use was not monitored by any designated persons or committees in Kisangura village.

acres while Park Nyigoti had approximately 400 acres left. If current population growth continues unabated in the study region, it is not difficult to project a complete elimination of available land within one, or possibly two, generations (Chapter Three).

Traditionally in rural Tanzania, land has been passed down paternal lines. While this practice continues today, interviewed fathers expressed having an inadequate amount of land to pass on to male heirs. As a result, many male respondents reported having been forced to subdivide their land holdings into ever smaller amounts. Ongoing subdivision has several social and ecological drawbacks. In general it causes or allows: higher levels of land fragmentation, fewer fallow periods for land to recover, greater agricultural intensification, overuse of communally held lands, and closer encroachment to protected area boundaries. Ultimately, it may be the primary reason that many western Serengeti residents are relying more greatly on park resources to make up subsistence shortfalls.

Current households owned an average of 8.9 acres while their parent's households owned 43.6 acres.[45] In just one generation, therefore, land ownership has decreased by a factor of four. Despite this rapid decrease, the amount of land owned per household along Serengeti's western border still ranks higher than other areas of rural Tanzania where average household ownership amounts to 3.8 acres (Bahiigwa et al. 2005). The fact that western Serengeti households owned more than double the amount of land than households in other parts of Tanzania may serve to attract outsiders into the study area. It may imply a continual encroachment on SNP's boundaries.

The amount of land under private ownership affects western Serengeti residents in profound but sometimes unintuitive ways. Not surprisingly, larger landholders have

[45] N = 274

greater flexibility for letting fields lie fallow and renew their productivities. As a result, such landholders are more likely to achieve greater agricultural yields. Households with more land also have the capacity to convert excess acreage to non-food uses such as pasture for livestock, woodlots for firewood, and other forms of diversification (Clay et al. 1994).

Households in the study largely followed this pattern.[46] Those that owned more land devoted more acreage to subsistence ($R^2 = .558, p < .001, N = 630$) than did households with less land. They also devoted more land to cash cropping ($R^2 = .488, p < .001, N = 631$), and pasture for livestock ($R^2 = .444, p < .001, N = 631$). Although not directly related to the subject at hand, it should be noted that larger landholders had more people living within the household ($R^2 = .256, p < .001, N = 701$).[47]

Western Serengeti households devoted 3.3 acres (67%) of 8.9 total acres to growing subsistence crops, 1.7 acres (34%) to cash crops, and 0.7 acres (14%) for livestock grazing.[48] These results demonstrate that the majority of locally owned land in the study area is needed for households merely to sustain themselves. The importance of subsistence crops illustrates that the human-natural system is dependent upon rainfall and adumbrates a lack of resilience for households whose primary earnings are subject to the vagaries of weather. It is also clear from this that households devote little of their own landholdings for grazing livestock. Households that *did* use their lands for pasture were households that owned lots of land, upwards of 50 acres or more.

[46] Results presented here are derived from Pearson Bivariate Correlations.

[47] Regarding landholdings and household size, it is unclear what the causal mechanism for this relationship is. Due to its implications for natural resource use, this relationship merits further study.

[48] The total percentage adds up to greater than 100% because respondents often used land for multiple purposes in the course of a calendar year. Livestock holders, for example, often grazed their cattle on their crop lands after a harvest.

It is of little surprise that land-poor households could not afford to graze livestock on their limited holdings. What is less intuitive, however, is that the majority of the middle-tier landholders actively chose not to use their own land for regular livestock grazing. Optimistically, this implies that middle-tier households have been able to find sufficient suitable pasture in communally held lands. More realistically, however, current practices may foreshadow a tragedy of the commons scenario where communal land is degraded to a point of limited, or diminishing, returns (Hardin 1968). Coupled with ever finer subdivision and decreasing yields, overuse of the commons may eventually force more households to graze in protected areas if they hope to maintain current livestock numbers (Chapter Three).

Somewhat surprisingly, households actively used only 4.9 acres (55%) of their total holdings over the course of a year. If the year that data were taken was representative (key informants verified it was), then it implies that landholders are allowing approximately 45% of their holdings to lie fallow for soil regeneration. Or, it may be that households do not have an adequate labor force, as previously described by household equivalence (Section 1.9), to work all 8.9 acres. Regardless, these findings suggest that extreme agricultural intensification has not yet taken hold and that in comparison to other regions of Tanzania, western Serengeti households are comparatively land rich.

This idea is corroborated by the fact that just 12%[49] of the sample did not own any land at all. Although this figure may seem high, it is actually lower than findings from other parts of rural Tanzania. Ellis and Mdoe (2003), for example, found that 22% of households in Morogoro Region had zero landholdings.

---

[49] N = 82

Although western Serengeti households may have had more land than other rural regions, the majority (62%)[50] reported that their landholdings were insufficient in meeting their basic needs. As mentioned previously, some respondents explained that they viewed their current holdings as insufficient because it was not enough to divide among their sons. Although their sons would inherit land, the smaller, subdivided plots would not be enough to sustain each respective household.

While 12% of western Serengeti households reported that they did not own land, just 2% claimed not to use any land whatsoever. This suggests an active rental market. Several households that did not own land admitted to using the land of friends or relatives. In some cases, such agreements were free-of-charge. In others, land-poor households could "rent" land in exchange for a fraction of the harvest they obtained in a given growing season. This underscores the importance of strong social networks that feature reciprocity in western Serengeti. Dependence upon land by nearly every household (98%) also demonstrates the pivotal role that agriculture plays in current livelihood strategies. In regards to resilience, it suggests that the vast majority of households are at least partially dependent upon rainfall and weather regimes.

A household's landholdings are obviously important for wellbeing and associated livelihood strategies. What may be equally important—but less obvious—is the distance between a household and its land. Without personal vehicular transport, or money to afford public transport, distance to land may be critical in terms of travel time. Longer travel times may exert a significant time drain on households; time that could be used in other income-generating activities. In other words, the time necessary for commuting to agricultural fields may prevent efforts made to diversify the household.

[50] N = 440

On average, a household's nearest agricultural plot was 1.4 km[51] away. This required an average travel time of 49 minutes[52] one-way. Considering that plots need to be planted, harvested, and frequently weeded requires weekly (and sometimes daily) commutes during the various seasons. Perhaps more importantly, it points out why most households are largely unable to defend their fields from wildlife. In this way the cost of travel may contribute to why households closer to the park were prone to larger losses in potential revenue (Chapter Two).

Before proceeding into specific agricultural strategies (Section 1.19), it is worth mentioning that the stability of land tenure may be of greater importance than land ownership (Clay et al. 1994). The reasoning behind this assertion is straightforward. With secure land tenure, households are more likely to invest in sustainable practices. Since land tenure has been reasonably secure since the colonial regimes ended,[53] it is not considered further in the present study.

Lastly, it should be noted that households with large landholdings are not necessarily the wealthiest. As subsequent findings will show (Chapter Four), some of the wealthiest households are those that earn the majority of their income from nonfarm activities. Moreover, households with high nonfarm income often have a higher net agricultural output they achieve per hectare (Bahiigwa et al. 2005). In other words, households with high levels of nonfarm income are able to do considerably more with

---

[51] N = 220
[52] N = 257
[53] As stated earlier in the section, key informant interviews revealed that all existing land tenure laws were put into place in 1974 or after. Despite this relatively recent occurrence, landholdings have been secure in the study area with notable exceptions. During the period of Tanzanian socialization, several respondents reported having to give up their landholdings and were forcibly evicted at the government's behest. This was done to allow for communal agriculture and easier monitoring by government officials. In exchange, evicted respondents were given equivalent parcels in another village. Since this affected <2% of respondents, it is considered of little import.

less. For these reasons, one must proceed with caution when using measurements of landholdings as a reliable indicator of poverty or household wealth.

1.19 – Agriculture

The previous section mentioned that 98% of households had used land in the last year. Of these, 86% used land for subsistence and/or cash cropping. From this, it is clear that agriculture features prominently in western Serengeti. Agriculture acts as a primary means of income, a form of diversification, and may even serve as a means of measuring household resilience. For purposes of simplification, agriculture is examined here in isolation from other livelihood strategies. It is important to bear in mind, however, that agricultural practices, livestock-raising, wage-earning, and even hunting are interwoven—and sometimes interdependent—livelihood strategies (Shetler 2007). The extent that each strategy is conducted may be predicated on the successes (or failures) of each.

Part of western Serengeti's heavy dependence on agriculture may lie in the fact that it serves as a relatively low-input and risk-averse livelihood strategy (Ayalew et al. 2003). Since its inception in the region, farmers have made rational decisions which have sought to maximize overall benefits from the natural resource base. But a key distinction should be made here. While the decision to farm may be risk-averse, undue reliance on farming alone in rural Tanzania is associated with greater levels of poverty and vulnerability (Bahiigwa et al. 2005). This distinction will be reexamined in Chapter Four, where it will be argued that farming best serves western Serengeti when it acts as a complement to even more risk-averse livelihood strategies such as nonfarm employment.

Within the resilience framework, agricultural practices—like the other livelihood strategies to be discussed—should not be viewed as a static enterprise. Rather, decisions about land use and crop varieties are a dynamic process which is heavily dependent on local market conditions, weather, available labor, household wealth, and soil conditions. In the case of the western Serengeti study area, of course, decisions are also greatly affected by wildlife patterns (Chapter Two). In general, farmers adapt to extrinsic forces by adopting more suitable practices (Clay et al. 1994), or, by extensification.

Extensification is a process whereby farmers respond to extrinsic forces—and oftentimes, degradation—by moving into ever more fragile environments. It tends to occur in more impoverished regions where farmers lack capital for implementing improved technologies and/or agricultural inputs. As made clear in Sections 1.1 and 1.15, western Serengeti is just such a region. To date, a general lack of wealth and low purchasing power has prevented most households from obtaining the necessary inputs required for higher crop production.

As an example of this, western Serengeti households spent only TZS 11,172 in the past year on fertilizers and seeds. This amounted to only 1.5% of their total annual expenditures (Figure 1.19.1).[54]

[54] But unlike income, expenditures proved easier to administer on the survey and avoids the intractable nature of self-employment. Possibly due to the extreme importance of petty cash for the purchase of monthly household necessities (e.g., matches, kerosene, sugar), respondents demonstrated an uncanny ability to hastily recall the previous week or month's expenses. In several interviews, respondents brought out the past year's receipts and tallied them on the spot. After several pilot surveys, my questionnaire consisted of 11 categories of household expenditure. These included food, regular necessities, medical, clothing, education, housing, transport, entertainment of guests, seeds & fertilizer, flour grinding, and beer.

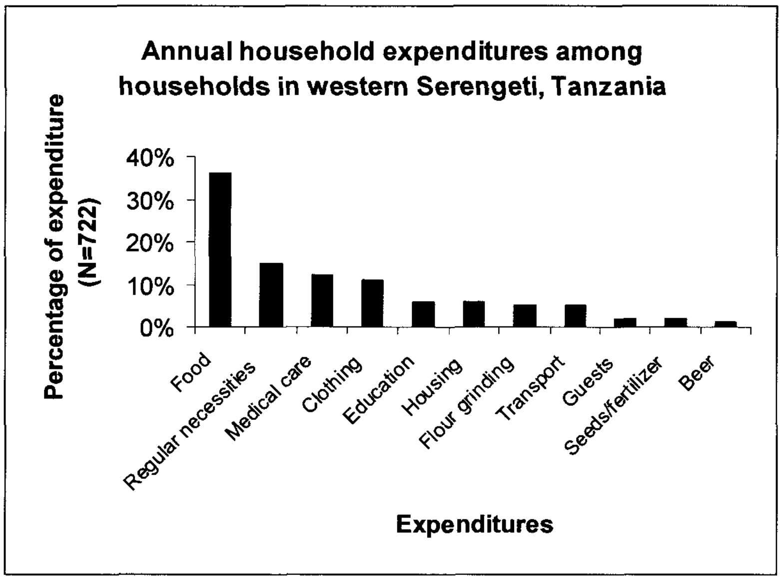

Figure 1.19.1 – Household expenditures as measured over a 12 month period in western Serengeti, Tanzania

Until recent years, it has been more economical for households to extensify their agricultural production rather than intensify their inputs. It is likely that this practice has led to greater encroachment on SNP's boundaries and greater amounts of crop destruction by wildlife (Chapter Two).

1.20 – Cassava cultivation

The crops that farmers chose are well-adapted for the semi-arid conditions of western Serengeti. Perhaps the best suited crop, which is widely grown in the region, is cassava (*Manihot esculenta*). Generally regarded as a famine crop, cassava is little affected by droughts. It is capable of remaining underground for several years relatively unharmed by dry conditions.

Cassava is little affected by locusts, which historically have been quite prevalent in western Serengeti. Other advantages are that it can be easily uprooted during times of hunger and requires fewer labor inputs than other crops. Several respondents stated that cassava was their only viable food crop during bad drought years (Section 1.34). While cassava acts as insurance in lean years, it is not highly sought after during good years. This is because it is comparatively less nutritious and has a taste that some have said resembles "hyena feces" (Shetler 2007).

Cassava's importance is supported by its longstanding role in the region. The crop was first recorded by a German traveler in 1892. Shortly after that, planting of cassava was made compulsory by the German colonial government as an anti-locust measure during the famine of 1929-34 (Shetler 2007). Nearly 20 years after the famine, cassava's primary role as a subsistence crop gave way to its emergence as a significant cash crop. Today, however, cassava's role as a cash crop has been replaced by cotton (Section 1.28) and to a lesser extent, maize (Section 1.23).

At the time of the study, the price per sack for cassava was less than half that of maize and sold by only 4% of households (Figure 1.20.1).

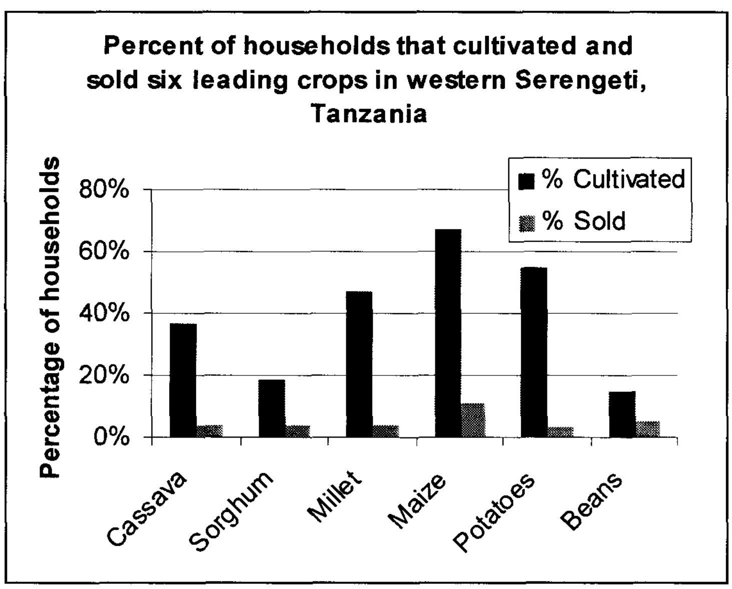

Figure 1.20.1 – Cultivation and sales of six leading crops by households in western Serengeti, Tanzania (N = 722)[55]

[55] Cotton was excluded from figure 1.20.1 because it is cultivated as a cash crop exclusively. 100% of cotton that was cultivated was sold.

This amounted to a household's year income of TZS 1,180 (Figure 1.20.2).

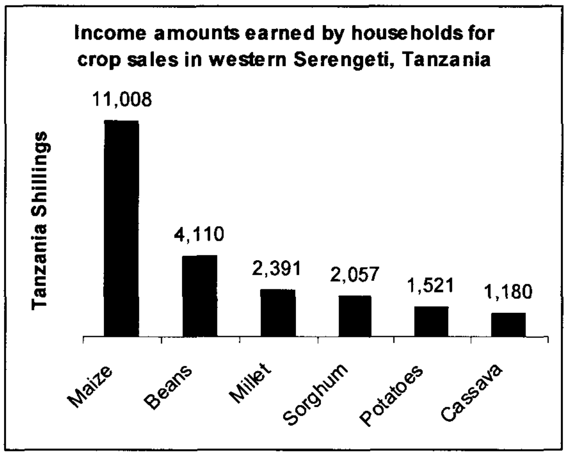

Figure 1.20.2 – Income generated by crop sales for households in western Serengeti, Tanzania (N = 722). Cotton (TZS 109,861) was left out because it is grown entirely as a cash crop.

Even as a subsistence crop, cassava seems to play a smaller role than it historically did as only 37%[56] of households produced it (Figure 1.20.3).

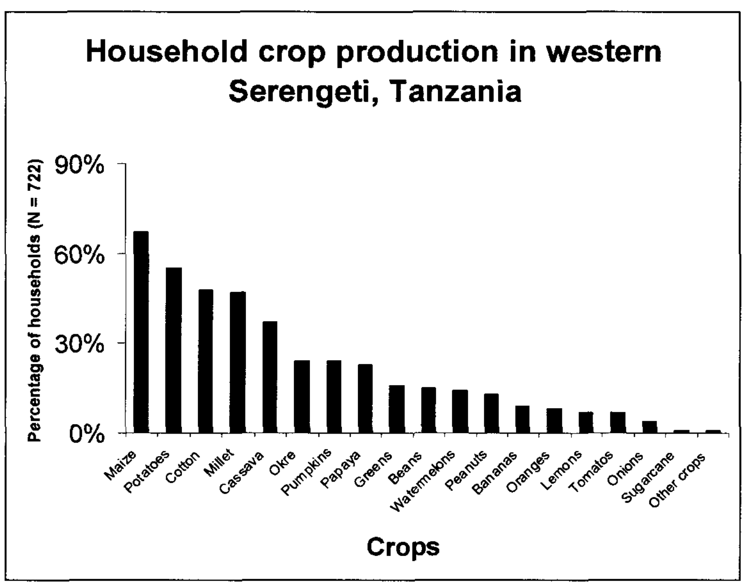

Figure 1.20.3 – Percentage of households that produce 36 crop varieties in western Serengeti, Tanzania. Crops cultivated by less than 2% of households were aggregated into the category "other crops" for simplification.[57]

[56] N = 692

[57] 18 total other crops were cultivated by less than 2% of households. See Appendix A for these crop names.

1.21 – Sorghum cultivation

Another famine crop that is cultivated even less than cassava is sorghum (*Sorghum vulgare, Sorghum bicolor*). Just 19% of households[58] grew sorghum despite the crop's several advantages. Sorghum can reduce its levels of transpiration, for example, by rolling up its leaves during rainfall shortages. Moreover, the roots of the plant resist collapse in dry soil and the plant responds efficiently in ephemeral times of moisture availability. The lack of widespread cultivation of sorghum may be partly due to the relatively low yields it produces in seasons of abundant rainfall. Other factors include its tendency to rot during storage, labor-intensive threshing and winnowing, and high susceptibility to a variety of diseases and pests (Rowland 1985).

Susceptibility to damage was evident in western Serengeti. Households lost an average of TZS 16,245 in sorghum damage as opposed to earning just TZS 2,051 (Figure 1.20.2). Just 4%[59] of households reported selling sorghum in the last year, highlighting its more important role as a subsistence crop.

1.22 – Millet cultivation

In contrast to the two aforementioned crops, a higher percentage (47%)[60] of households grew fingermillet (Figure 1.20.1), here referred to simply as, "millet" (*Eleusine coracana spp*). Millet is similar to sorghum by producing relatively low yields during high rainfall years. But it may be better suited to western Serengeti as the rainfall it requires match western Serengeti's rainfall regime quite closely. To flourish, millet needs sustained rainfall for the first two months. The long and short rains that

[58] N = 721
[59] N = 721
[60] N = 718

characterize western Serengeti often allow for this in October-November and March-April.

Higher interest in millet may also be due to the fact that it is the only cereal grain that is impervious to insect pests during storage and is good in beer brewing (Section 2.25). Although a greater percentage of households grew millet, just 4%[61] sold it for an average per household revenue of TZS 2,391 (Figure 1.20.2).

1.23 – Maize cultivation

The most widely grown—and arguably most important—crop grown in western Serengeti was maize (*Zea mays*). Two-thirds (67%)[62] of all households grew maize (Figure 1.20.1) and roughly one-tenth (11%) sold it as a cash crop. As a result, households earned nearly five times the amount for maize (TZS 11,008) as they did for the other cereal crops of sorghum and millet (Figure 1.20.2).

Maize's popularity in western Serengeti reflects a global trend in which the crop is increasingly grown in semi-arid environments. While maize thrives in rainfall regimes of 300-400 mm per year, it can survive on as little as 175 mm, provided that rainfall is evenly distributed. Maize is favored in western Serengeti for its higher yields in periods of high rainfall and sweeter tastes. Like millet, it is also widely used in brewing beer.

---

[61] N = 718
[62] N = 719

1.24 – Potato cultivation

Somewhat surprisingly, the second most widely grown crop in western Serengeti was potatoes (*Ipomoea balatas spp*). While over half of all households (55%),[63] grew potatoes (Figure 1.20.1), only 3% sold them as a cash crop. The low monetary value that potatoes attain in relation to their weight may account for their small role as cash crop (Andersson 1996). Compared to an equally weighted sack of maize, potatoes generated TZS 11,013 less income at the time of this survey (Figure 1.20.2). Since transport is difficult in western Serengeti, the labor costs of getting potatoes to local or regional markets likely exceeded the profits earned.

Another possible contributing factor to low potato sales is that potato consumption has a negative stigma attached. In some areas of Tanzania, eating potatoes is a "poverty sign" and looked badly upon (Kapinga et al. 2000).[64]

Historically, potatoes were prone to disease, tuber degeneration, pests, and drought. But better, hardier varieties have become available in recent years which offer improved storability and sweetness. Low fiber content coupled with an ability to be used in many ways is likely why potatoes are widely grown in the region.[65]

1.25 – Bean cultivation

Beans (*Phaseolus vulgaris*) were another important crop in the western Serengeti. A total of 96% of households reported having consumed beans in the last month,

---

[63] N = 703

[64] The social status of potato consumption was not investigated for western Serengeti. But there is little reason to assume the study area differs from other regions.

[65] In rural parts of Tanzania, potatoes are boiled, made into 'michembe' (which can be stored indefinitely), roasted, and made into flour for porridge (Kapinga et al. 2000)

constituting an average of 11.6 meals per month.[66] Since just 15% of households reported growing beans (Figure 1.20.1), it implies that beans were one of the primary crops that households buy to supplement their protein intake. At the time of this survey, the going rate for beans was TZS 33,073 per sack. This was TZS 8,573 higher than the next highest selling crop (onions). Prices for beans varied extensively by season and location (TZS 6,000 – 96,000). Such potentially high returns likely contributed to the willingness of households to sell rather than consume the beans they harvested. Of the 15% of households that grew beans, over one-third (35%)[67] that produced beans sold a portion. The portion sold amounted to over half (58%)[68] of their harvest. Over the entire sample, beans contributed TZS 4,110 to total household income.

A study measuring household consumption in urban and rural Tanzania found that beans compose 38% of utilizable protein and 12-16% of daily caloric requirements (Mmbaga et al. 2008). Beans have been recognized as a cheaper source of protein for the poor than maize (ibid). Such characteristics make beans an especially important crop for building resilience in western Serengeti. These ideas will be reexamined in Chapter Four.

1.26 – Irrigation-dependent crops

Despite western Serengeti's semi-arid climate, many households are able to grow fruit trees with the aid of small-scale irrigation techniques. The most important of these were mangos (*Mangifera indica spp.*), which were grown by nearly half of the sampled

---

[66] Both of the statistics in this sentence have sample sizes of 307.
[67] N = 111
[68] N = 39

households (49%)[69] (Figure 1.20.1). Of these, 37%[70] sold mangos. Across the entire sample, this generated more income (TZS 4,461) than beans. Perhaps more importantly, however, not one household reported a loss of mangos to wildlife destruction (Chapter Two).

In contrast, one household reported annual earnings of TZS 100,000 by growing mangos and delivering them to Fort Ikoma for sale to tourist lodges in Serengeti National Park. Such a profitable interaction between local households and tourist lodges along Serengeti's western edge exemplifies the synergistic relationship that this study promotes for building resilience in western Serengeti. Mango cultivation is an effective crop for this because it has a high demand and is relatively impervious to wildlife damage.

Like mangoes, onions (*Allium cepa spp.*) are another crop that might be profitably expanded in western Serengeti. As mentioned earlier, the average price per sack of onions (TZS 24,500) ranked second only to beans. Onions are widely used by tourist lodges and little prone to wildlife damage. The drawback to onion cultivation, like mangos, is its need for an irrigation scheme in a semi-arid region like western Serengeti. This is likely why just (4%)[71] of households sold onions for a profit of TZS 5,487 over the entire sample.[72] If irrigation techniques improve, however, water-dependent crops such as mangos and onions have potential to generate considerable income for local households.

---

[69] N = 68
[70] N = 33
[71] N = 690
[72] N = 690

Papaya (*Carica papaya spp.*) is grown by nearly one-quarter of western Serengeti households (23%)[73] (Figure 1.20.1) for home consumption and sales. Unlike mangos, households lost more income than they earned from papaya trees due to heavy wildlife damage.

While wildlife damage may negate papaya's ability to help the household economy, the crop does feature effectively in fostering social relations in the region. One respondent, for example, mentioned that papaya is one of the principle crops that are shared with guests. During fieldwork, it was evident that the majority of papaya trees are grown around the homestead with produce readily observable to passersby. As has been alluded to previously, social networks are important because resources accrued by some households may be redistributed to others that lack them during difficult circumstances.

But there can be a downside to social networks, too. In rural western Serengeti culture, for example, "haves" are often required to share of their surplus with "have-nots". The very same cultural necessity of sharing, which buffers some households in difficult times, may also hold them back during advantageous seasons. Crops such as papaya that are easily visible are more likely to be shared than crops that can be "concealed" in storage. This cultural phenomenon may deem papaya production as economically unattractive for households seeking to increase income revenue.

In contrast to papaya cultivation, tomatoes are grown primarily for sale. Households that grew tomatoes sold 88%[74] while consuming the remaining 12%. Tomatoes tended to be grown in small gardens called "bustanis" and are tended mostly by women. As has been mentioned with mango and onion, however, the water-intensive

---

[73] N = 720
[74] N = 713

nature of these gardens is a greatly limiting factor for western Serengeti households. The study found that households with profitable gardens were those that were situated along rivers or in valleys with higher water tables. Strategic homestead locations, which take advantage of key resources like water and good soil, are of the utmost importance in rural Tanzania (Van Campenhout 2006). As mentioned in Section 1.18, the most productive sites in western Serengeti have already been claimed and are in the process of being subdivided into ever smaller plots.

As a result of the paucity of year-round water availability, just 7%[75] of households produced tomatoes (Figure 1.20.1) providing an average income of TZS 1,872 across the entire sample. For the few households that did live in strategically located places with year-round water access, however, the potential profits of tomato cultivation were considerable. One household, for example, was able to produce 41.7 sacks of tomatoes and sell them for a profit of TZS 665,157 over the course of one year.

Like several of the crops already mentioned, banana cultivation is limited to greater water availability than the semi-arid western Serengeti climate generally allows. Due to this requirement, just 9%[76] of households produced bananas (Figure 1.20.1) with most (85%)[77] doing so for home consumption. In addition to water limitations, banana crops were susceptible to biotic and abiotic factors.[78] Households lost an average of 16.7 bunches[79] while producing 19.5[80] bunches. As a result, bananas contributed a meager TAS 721 to annual household revenue.

[75] N = 713
[76] N = 686
[77] N = 685
[78] Abiotic factors that adversely affected banana cultivation included wind and drought.
[79] One "bunch" is equivalent to 9 individual bananas.
[80] N = 685

1.27 – Other crops

Final crops to be discussed here are those that contributed to households almost entirely for subsistence purposes. This assortment of crops is aggregated because they featured less prominently in household economies than the aforementioned crops.

Of the remaining crops, pumpkin and okra were cultivated by nearly one-quarter (24%)[81] of the sample. Just 4%[82] of the households sold pumpkins while only 3%[83] sold okra. Pumpkins earned households slightly more revenue (TZS 1,407)[84] compared to TZS 534[85] for okra.

A smaller percentage of households (14%)[86] grew watermelon. Proceeds from watermelon, however, generated higher revenue (TZS 2,461) than pumpkins and okra combined.

Peanuts contributed to the subsistence needs of 13% of the sample. Although peanuts commanded a relatively large price per sack[87] (TZS 20,875), few households (3%) sold them at market.

Roughly equal numbers of households produced oranges[88] (8%)[89] and lemons (7%)[90] (Figure 1.20.1). Neither crop, however, contributed substantially to household revenue.

[81] The sample size for pumpkin cultivation was 542. For okra it was 531.
[82] N = 545
[83] N = 537
[84] N = 544
[85] N = 537
[86] N = 721
[87] 1 sack of peanuts weighs approximately 20 kg

One respondent reported having lost oranges to insect pests due to the failure to spray pesticide on the trees. Failure to use pesticides is more likely economical than cultural, however, as several respondents admitted they lacked sufficient capital for such an endeavor.

Another respondent reported that school children and other passersby frequently pull oranges off of her trees. Socially acceptable practices like this may diminish incentives to increase fruit cultivation.

Unlike oranges, lemons are used primarily in western Serengeti for improving the flavor of the local porridge, or "uji." Households did not generate any wealth from lemon sales.[91] Although lemons are used daily, they are used more as a sweetener than a food source. This may account for why lemon sales did not contribute to the household economy.[92]

The primary source of iron in western Serengeti diets come from two primary green vegetables known locally as "sukuma wiki" and "mchicha", respectively. These crops are typically harvested weekly from small plots within, or just outside, the homestead. Although greens are mostly used for home consumption, 5%[93] of households reported having sold some for approximately TZS 1,690.[94]

---

[88] The number of households that produced oranges and lemons should not be confused with the households that have orange or lemon trees. Immature (nonproducing) trees were not included in the estimate.

[89] N = 542

[90] N = 525

[91] N = 526

[92] On several occasions, the author observed lemons being exchanged free of charge between households. This practice may contribute to strengthening social networks, as was observed for other crops.

[93] N = 718

[94] A total of 73 other respondents also reported growing "kunde", which is a locally cultivated green vegetable. Sales from this crop contributed an average of TZS 3,442 to households. This crop was not officially listed on the questionnaire, however. As a result, the percentage of households that grew it is unknown.

Of the common crops, sugarcane was grown by the fewest households (1%)[95] (Figure 1.20.1). Although sugarcane is a widely sought after commodity, it appears to be heavily prone to wildlife damage. Households lost far more revenue (TZS 12,627) than they earned (TZS 162).[96]

A total of 18 other crops were cultivated in western Serengeti. Of these, none were grown by more than 2% of the population.

1.28 – Cotton cultivation

Cotton is discussed apart from the other crops for two reasons. One, it is not a food crop. And two, it role in western Serengeti may be disproportionately large on household economies. Cotton contributed more revenue (TZS 109,861) per household than all of the other crops combined. This is ironic considering how heavily resisted cotton was when it was first introduced during the colonial era. Much of local resistance was unwillingness to leave more traditional subsistence-based lifestyles in lieu of an inchoate market.

In the early 1900s, the ruling German colonial government attempted to incorporate local western Serengeti people into the market more rapidly by imposing "hut taxes" and "poll taxes". The thinking was that the imposition of taxes would force locals to cultivate cash crops – primarily cotton. But instead planting cash crops, much of the native population paid the taxes via increased sales of livestock and hunting products to the Sukuma people living to the southwest.

[95] N = 686
[96] Both statistics in this sentence have a sample size of 690.

Unsatisfied with the region's flagging cash crop production, the British made cultivation of cotton compulsory following their defeat of the Germans during World War II. While the date of cotton's original introduction into western Serengeti is disputed, its emergence as the dominant cash crop didn't solidify until right before Tanzanian independence in 1961 (Shetler 2007).

Initial resistance to cotton was not borne of general recalcitrance, however. Rather, it was because cotton was not very profitable. A lack of established infrastructure for cotton prevented profits from matching those derived from traditional livestock-keeping and hunting (Shetler 2007). In recent decades, this has changed. At the time of this study, much less land was available for livestock and greater restrictions and enforcement make illegal hunting more difficult.

The increased role of cotton in western Serengeti is plainly evident. Households produced an average of 325.7 kg that sold for TZS 366 /kg. Nearly half (48%)[97] the sample produced cotton (Figure 1.20.1) and only one-tenth[98] reported wildlife or abiotic damage. Cotton's high demand, low wildlife utilization, and adaptation to the semi-arid climate of western Serengeti make it extremely attractive for households to plant.

While cotton has undoubtedly contributed much to household economies and well being, over-reliance may undercut a household's resilience in the long-term. While the crop has proven relatively stable in recent years, exogenous market failures or widespread drought could devastate local populations. If such an event were to happen with cotton crops failing altogether, households might be forced to exploit SNP's

[97] N = 706
[98] N = 712

resources. Continued planting of drought-tolerant subsistence crops and income diversification are more resilience enhancing practices for the long-term.

1.29 – Livestock

From the beginning of recorded history in western Serengeti, livestock have featured prominently in conferring resilience to human populations. Livestock's central importance is epitomized in the traditional household layout in which cattle are kept in the middle of the compound. Men's conversations occur in the surrounding courtyard, reifying the symbol of livestock as male property (Shetler 2007). Despite the growing importance of cash in recent decades, large numbers of livestock continue to signify wealth and status (Fleisher 2000; Nyahongo et al. 2005) in western Serengeti.

Livestock[99] are defined here as including all species of chickens, goats, sheep, and cattle. These animals play a vital part in asset accumulation and are often "traded up" in sequence (e.g., chickens to goats / goats to cattle) (Ellis & Mdoe 2003). Although all households routinely trade up, better-off households tend to maintain adequate numbers of each livestock species. Table 1.29.1 supports this as higher cattle ownership was correlated with higher ownership of goats, sheep, and chickens.

[99] Other recorded livestock in western Serengeti included: donkeys, doves, rabbits, and pigs. The socioeconomic impacts of such species were limited and therefore not included in this discussion.

Table 1.29.1 – Correlation analysis of livestock owned by households

	Cattle	Goats	Sheep	Chickens
Cattle	1.000			
	(.)			
Goats	.328**	1.000		
	(.000)	(.)		
Sheep	.269**	.240**	1.000	
	(.000)	(.000)	(.)	
Chickens	.377**	.264**	.114**	1.000
	(.000)	(.000)	(.002)	(.)

Numbers in parentheses indicate significance levels
**Correlation is significant at 0.01 level (2-tailed)
(.) Correlation cannot be calculated

Maintenance of multi-species herds appears to be norm and is likely done as a response to drought and to diversify assets. Multi-species herds may also better exploit the mixed grassland–shrubland–woodland of the western Serengeti environment (Hella et al. 2001).

Before proceeding, it is important to understand why households in western Serengeti seek to accumulate livestock. It is thought that the accumulation of livestock occurs for four primary reasons.

First, western Serengeti presents few opportunities for households wanting to invest excess income. Without an efficient or reliable banking system,[100] the accumulation of livestock is one of the only viable means.

Second, having cash on hand is problematic for households because of poverty and heavy social obligations that are placed upon wealthier households. As has been mentioned in previous sections, stinginess is a taboo in Tanzania. Although social networks can be beneficial, they can also keep progressive households from getting ahead. Immediate investment in livestock eliminates the socially-induced pressure of

[100] At the time of the study, there were no banks operating in western Serengeti. Even if banks come to the larger district towns in the near future, their presence may not help the more rural population whose transportation costs would prohibit them from taking advantage of their presence.

sharing with those in the network because livestock are seen as indivisible and out of the realm of social obligation (Fleisher 2000).

Third, in times of drought, illness, or some other hardship, livestock may be quickly converted to cash, traded for goods, or slaughtered for food. Such asset flexibility acts as a form of insurance and allows households to buffer system-wide disturbances. Hella et al. (2001) demonstrated this with the observation that farmers sell more livestock when food stocks are at their lowest—October through January—or in years of extreme drought.

Lastly, livestock can reproduce and grow with relatively low input levels. In western Serengeti, water and forage are free and the labor required for herding is readily available in most households.

Not surprisingly, livestock ownership was also strongly correlated with revenue generated from livestock sales. With the exception of chickens, western Serengeti households with more livestock generated more revenue from sales (Table 1.29.2).

Table 1.29.2 – Pearson correlation coefficients between number of livestock and revenue from livestock

	Cattle	Goats	Sheep	Chickens
Cattle	.899**			
	(.000)			
Goats	.291**	.366**		
	(.000)	(.000)		
Sheep	.273**	.054	.412**	
	(.000)	(.151)	(.000)	
Chickens	.346**	.026	.026	.044
	(.000)	(.486)	(.486)	(.239)

Numbers in parentheses show levels of significance
**Correlation is significant at 0.01 level (2-tailed)

While the correlation represented in Table 1.29.2 appears between higher income levels and greater herd sizes may appear straightforward, another key factor may be at work. Research by Ellis and Mdoe (2003) has shown, for example, that nonfarm employment may be primarily responsible for allowing households to increase herd sizes of all livestock species. In other words, nonfarm income may actually be the causal mechanism which allows for more livestock and household wealth. If correct, this idea would support this study's thesis that nonfarm income leads to more livelihood diversification. Ultimately, this might allow households to have less dependence on park resources. Loibooki et al. (2002) found, for example, that higher livestock ownership was correlated with lower levels of participation in illegal hunting (Chapter Three). Such a positive domino effect, however, may be driven by nonfarm income which drives livestock accumulation rather than livestock accumulation driving nonfarm income. Due to its link with many livelihood strategies, nonfarm income will be examined periodically in all subsequent chapters.

Although nonfarm income may indeed be involved, its presence does not negate the fact that more livestock are associated with more household income. Since inputs are largely free and labor for livestock is inexpensive, maintaining larges herds of livestock may be an extremely profitable investment. To accurately gauge this profit-margin, however, requires comparison with other livelihood alternatives. This will be done in Chapter Four.

Although livestock ownership appears to connote wealth, monetary returns on sales may only be a secondary objective of households living in the semi-arid western Serengeti study area. The primary purpose may actually be to stabilize household food security in case of crop failure due to drought (Hella et al. 2001). This important point will be further examined in Section 1.34.

Despite livestock's association with household income and added resilience, increasing herd size is unlikely to be the "solution" for weaning households off of SNP's resources. As land and grazing resources become scarce, households with large herds are likely to be more hard-pressed to find adequate forage. There have already been many reports of individuals arrested in western Serengeti for illegal grazing in a protected area (Claire Lewis pers. comm.). If land continues to be subdivided and cattle herds increase, cattle encroachment on SNP may be inevitable.

1.30 – Cattle holdings

Cattle are a highly sought after asset in western Serengeti. When respondents were posed a hypothetical question which asked what their first purchase would be if they had more money, 22% said cattle (Figure 1.30.1).[101]

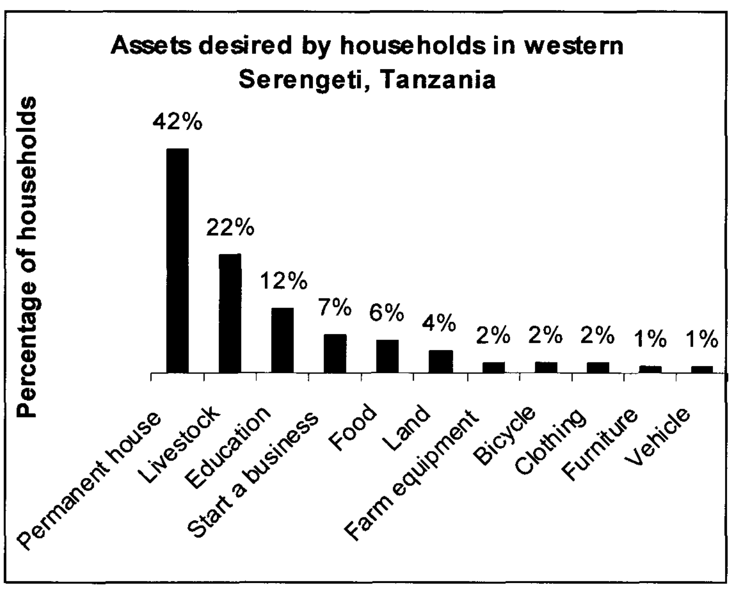

Figure 1.30.1 – Assets desired by households in western Serengeti, Tanzania (N = 722).[102]

---

[101] Cattle were the second most sought after asset in western Serengeti. A permanent house (constructed with cement and tin) ranked first (42%).

In addition to serving as an important marketable asset, cattle also provide households with milk, offspring, manure, traction (e.g., plowing, hauling of timber, water, etc.) and—as already mentioned—meat in difficult times. Moreover, cattle are used in bridewealth transactions, although the study here—and another done in northwestern Serengeti (Fleisher 2000)—show that the practice has declined (Figure 1.30.2).

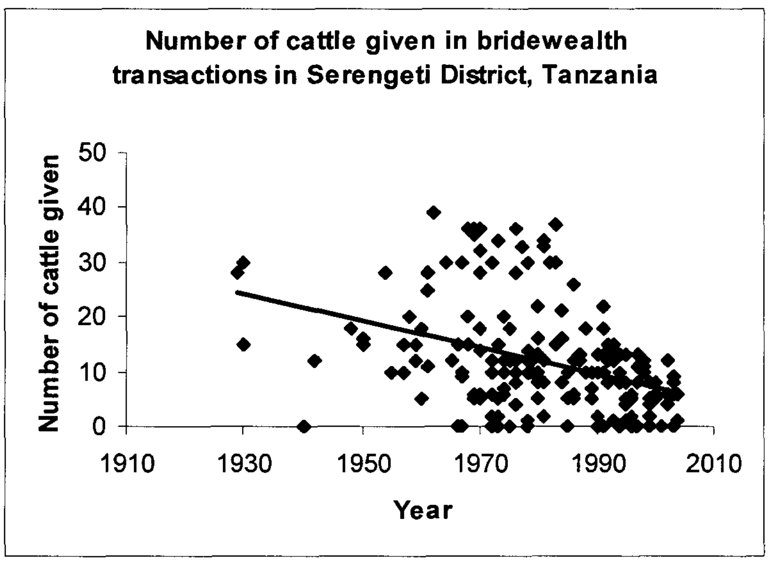

Figure 1.30.2 – Number of cattle given in bridewealth transactions by males in Serengeti District, Tanzania (N = 190)

This may be due to the gradual expansion of the market economy (Fleisher 2000). In the place of cattle, younger males are increasingly paying bridewealth with cash (Figure 1.30.3).

[102] Respondents were asked what the household would hypothetically purchase if excess money was available.

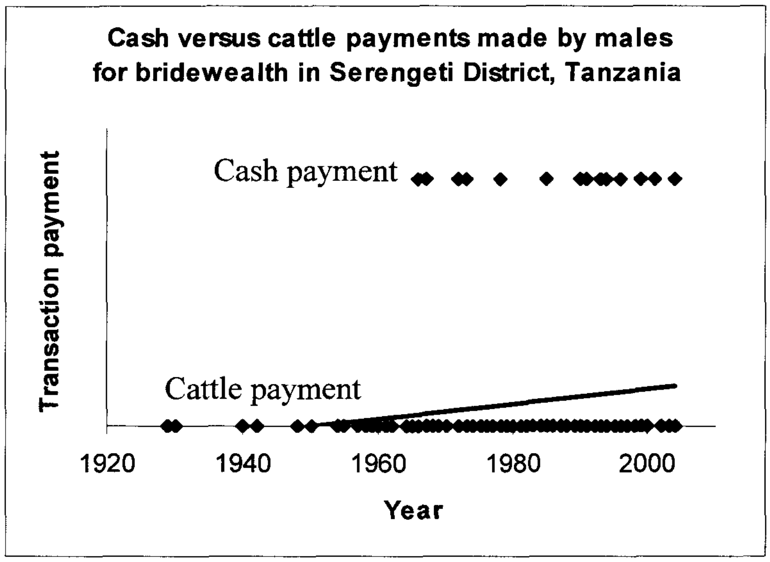

Figure 1.30.3 – A depiction of cash versus cattle payments by males in western Serengeti (N = 190)

There may be several explanations for this. It may be, for example, that cattle are more difficult for households to keep, due to water and grazing constraints. Or, it may be that households in western Serengeti are articulating more fully with the modern economy. Although speculative, the change in bridewealth transactions may hint at the coming of a more fully developed cash-based society. This stands as yet another reason why this study advocates nonfarm income as a workable means of building resilience in the region.

Although transactions are increasingly done in cash, the historical—and even present—importance of cattle in the GSE cannot be overstated. For the last two centuries, the relationship people have had with the natural system has been highly coupled with the well-being of cattle. In the early 1900s, for example, an assortment of Maasai raiding, rinderpest plagues, and drought decimated western Serengeti cattle populations. To recoup pre-1900s numbers, many locals turned to hunting. Products obtained through hunting were sold and traded to Sukuma peoples living to the southwest of Serengeti in exchange for cash and cattle (Shetler 2007). Although trade routes and methods have obviously changed since colonial times, the practice of selling wildlife products to build up herd sizes continues today (Chapter Three).

Cattle's present importance is empirically validated by the fact that many households maintain sizable herds. The average household had an average of 7.1 cattle.[103] When compared to household size, this equals approximately 0.92 cattle per person. In western Serengeti, cattle sales appear to be most important to the household economy.[104] The average household was two-and-a-half times more likely to sell a cow than they were to buy a one. Moreover, they were over five times more likely to sell a cow than slaughter one.

Although households were more likely to buy cattle than slaughter them, the fact that households sold an average of 0.7 cows[105] while buying 0.3[106] suggests that—like goats, sheep, and chickens—cattle primarily enter households through birth. Cattle sales earned households TZS 192,521 in the last year which was 34% of total household income.[107]

Cattle holdings varied significantly among the sample. Many households lacked cattle while one household owned over 800. Just because a household lacked cattle, however, did not mean the household was bereft of cattle benefits. Households with large herds—such as the one owning 800—have difficulty sustaining their holdings

---

[103] N = 721

[104] The fact that households only rarely buy cattle does not imply that beef is infrequently eaten. On the contrary, beef was consumed more often than any other form of livestock, at 2.2 times per month, which equals over 4 meals per month. Rather than buy cattle, households tended to buy beef from local butcher shops with income generated from nonfarm employment and agricultural sales. As mentioned previously, this represents an interdependence of livelihood strategies.

[105] N = 720

[106] N = 300

[107] Total household income was TZS 565,169.

without dividing them up among other households in the social network. In exchange for tending cattle, such households received daily milk for their efforts and some reported they received newborn calves as an additional form of payment.

This practice aided poorer and richer households alike. According to key informants, dividing up cattle between multiple households—and sometimes even multiple districts—helps cattle-rich households buffer losses that may come through disease epidemics. It also helps ensure that households with lots of cattle find adequate forage.

1.31 – Goat holdings

Unlike cattle, goats were slaughtered for home consumption more often than they were sold. This usually occurred when households experienced an agricultural shortfall during the dry season. This is not uncommon. Ayalou et al. (2003) found that two-thirds of the off-take of goats (sales, slaughter, or outward transfer) was done for subsistence purposes. Such high off-take rates do not necessarily reduce a household's herd of goats, however, due to a goat's higher reproductive rate[108] than cattle.

In addition to providing protein, goats offer western Serengeti households a relatively low-cost and inflation-proof savings account. Investment in goats helps a household balance current cash needs against expected and unexpected future needs (Ayalew et al. 2003).

Households owned an average of 4.7 goats[109] and reported having lost 1.0 goats[110] to disease and/or wildlife (Chapter Two). Since goats were slaughtered more often than

---

[108] Sieff (1999) found the annual reproductive rate for goats to be 126%.
[109] N = 721

cattle and sold less frequently, it is of little surprise that their contribution to household income was nearly seven times less at TZS 27,630.

1.32 – Sheep holdings

Household sheep holdings were much less than goats. This was possibly because sheep have higher natural rates of mortality than goats (Sieff 1999). Or it is due to a sheep's greater dietary restrictions. Being primarily grazers, much of the western Serengeti semi-arid landscape, characterized by woody shrubs, is unpalatable. As a result households owned less than one sheep per household and bought[111] as many as they sold (0.1) in a 12-month period. Sheep contributed a negligible amount of income (TZS 948) to households and were consumed in two meals per month.[112]

Due to their meager contributions to the household economy, and for simplification, sheep are hereafter aggregated with goats and collectively referred to as "shoats".

1.33 – Poultry holdings

It can be argued that poultry are of a greater importance than any of the aforementioned livestock animals to western Serengeti households. This is because poultry (defined here as chickens, geese, and ducks) are easier for poorer households to keep and therefore "used" more frequently. The study found, for example, that poultry

---

[110] N = 719
[111] N = 301
[112] Although households consumed sheep infrequently, one household reportedly ate sheep 28 meals per month. Larger sheep flocks and higher sheep consumption most likely reflects differences in available grazing areas between households. Such exceptional cases were common among households for all livestock species in western Serengeti, highlighting the fact that averages must be used cautiously.

species were bought, sold, and slaughtered with more frequency than cattle, sheep, or goats. Households owned 7.1 chickens with income from sales amounting to TZS 5,207. Since chickens vastly outnumbered other poultry species, the terms "poultry" and "chickens" are used here synonymously.

Since chickens are inexpensive and can reproduce quickly, the logical question is why western Serengeti households do not own greater numbers and generate more income. As with most decisions that households make, there appears to be a tradeoff involved. Natural mortality, disease, and wildlife predation accounted for losses in more than half (55%)[113] of a household's average chicken holdings in a 12-month period. Such high losses likely reflect a greater susceptibility chickens have to disease. They may also reflect, however, a lower level of household custodianship. In contrast to cattle and shoats that are rarely left unattended by day, chickens are allowed to roam freely around the homestead. As a result, they are more vulnerable to predation by diurnal predators (e.g., Black kite, Slender mongoose) (Chapter Two).

Increased poultry mortality represented a significant loss to both human diets and household economies. As a protein source, chicken ranked just below beef in monthly serving amounts. Moreover, chicken eggs provided an additional protein source that was utilized by many households. Combined, poultry products were consumed more frequently than any other livestock. Due to its importance as a potential means of mitigating illegal hunting, this idea will be examined further in Chapter Three.

Now equipped with an understanding of the major land, agricultural, and livestock context, the next section examines how these factors relate to rainfall to resource collection.

---

[113] N = 720

Part V.

Rainfall & resource collection

1.34 – Rainfall

Historically, fluctuations in rainfall have posed the largest, most consistent threat to crops, livestock, and the general well-being of western Serengeti households. According to survey results, the average household has experienced a severe crop failure approximately 3.4 times. Viewed another way, just 3%[114] of the interviewed households indicated they have never experienced extreme crop failure. It is likely this small percentage represent households that have not farmed (likely due to significant involvement in nonfarm activities) or have just started farming practices. Even worse, most households (85%)[115] have had the majority of their crops fail more than once. As will be discussed shortly, this has major effects on household resilience and human-wildlife interactions.

The primary reason for repeated crop failures in western Serengeti is the effect of ENSO (El Niño-Southern Oscillation). The phases of ENSO cause inter-annual variability in rainfall across much of East Africa. Variability occurs across a hierarchy of temporal scales. It also acts as the central climatic factor which ultimately governs plant and animal populations as well as human socioeconomic wellbeing (Ogutu et al. 2008; Ogutu et al. 2007).

Despite a high inter-annual variability, a generalized pattern can be deduced for western Serengeti. A "rainy season" tends to occur between November and June

---

[114] N = 690
[115] N = 569

(Norton-Griffiths 1975) followed subsequently by a "dry season" that peaks in August. Inter-annual variability within these generalized seasons mean that rains may start at different times in different years. Within the generalized seasons, rainfall distribution is highly irregular and sometimes characterized by prolonged dry seasons and delayed rainy seasons (Hella et al. 2001).

Although droughts tend to garner more media attention, excess rainfall can be equally damaging to western Serengeti livelihoods. Many respondents noted, for example, a widespread and almost complete destruction of crops during the severe El Niño rains of 1997. Others noted the added difficulty that often occurs during years when prolonged droughts immediately precede—or immediately follow—El Niño years. In the study, Bunda and Serengeti districts lie within a gradient of higher annual rainfall (1200mm) while Meatu receives lower annual amounts (800mm) (Sinclair 1979).

The tightly coupled links between livestock, agriculture, wildlife populations, and human well-being make potential changes in rainfall of special concern for long-term household resilience. According to the IPCC (Intergovernmental Panel on Climate Change), the world's climate continues to change at rates unprecedented in human history (Houghton et al. 2001). Moreover, tropical countries such as Tanzania are expected to be affected disproportionately by such changes.

To date, long-term rainfall trends for the GSE indicate that rainfall amounts have steadily increased.[116] Other trends indicate a 10-year periodicity in which low rainfall years occur (Sinclair et al. 2007). More specifically, research by Sinclair et al. (2007) reveals that the GSE has received two high rainfall episodes (1961-1962 and 1997-1998) and three severe drought years (1960, 1984, and 1993). These years align well with this

[116] Rainfall records are based on data from Musoma, Tanzania from 1901-1991.

study's findings. A question on the survey asked respondents to recall specific years in which the majority of their crops failed[117] (Figure 1.34.1).

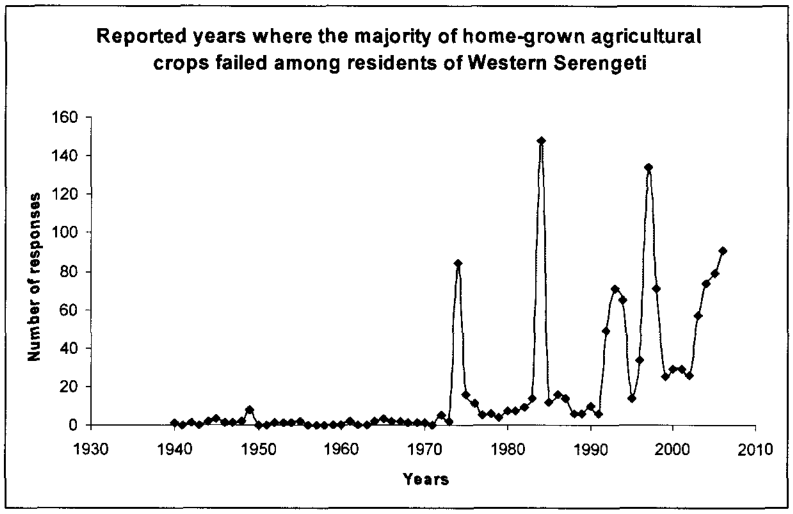

Figure 1.34.1 – Years in which the majority of crops failed as reported by households (N = 722) in western Serengeti, Tanzania.

Analysis of this recall question reveals a discernible periodicity in rainfall. Heavy damage events appear to have occurred on a ten year cycle. Although the number of heavy crop damage years appears to be climbing since 1980, this is most likely a function of the fact that mean sample age was 45 and relatively few respondents had begun farming before this time. Another likely explanation is the tendency for people to recall more recent years due to memory error. Although data in Figure 1.34.1 are skewed toward damage events that occurred in recent decades, the fact that many households reported large crop failures underscores a need for alternative, non-weather related livelihood strategies in the event of another severe agricultural failure.

Households particularly vulnerable to stochastic rainfall distribution in western Serengeti are those that lack adaptive capacity, safety nets, and/or have lower levels of

[117] For this question, respondents were encouraged to recall as many years as possible. As a result, the total N of responses is 1274.

income or wealth to fall back on. As subsequent chapters will show these same households are also more likely to be directly dependent on SNP resources. Making such households more resilient and weaning them off park resources requires a better understanding of the nature and drivers of a household's decision-making (Thornton et al. 2007).

To better understand this, western Serengeti respondents were asked what decisions they made and how they adapted their livelihood strategies during years of heavy crop failure. Approximately 94% of all households reported a definite change in household strategies during difficult years. Of these, exactly half sold livestock (Figure 1.34.2).[118]

[118] The total number of responses in Figure 1.34.2 was 818, despite having 722 respondents. This occurred because many households employed more than one new strategy during a time of heavy crop failure. For example, several households began hunting in addition to selling livestock and firewood as a means of generating adequate food for the household.

Second, not captured in the survey was the fact that many households which did not report one of the changes seen in Figure 1.34.2 underwent other significant changes in diet. Most often, such households shifted to heavy cassava consumption and replaced meats with a variety of locally harvested greens. Many of these households anecdotally reported that they had stored cassava for several years in anticipation of coming droughts.

Third, noticeably absent from Figure 1.34.2 is household mobility during times of crop failure. Just one household reported moving in response to drought. In contrast to the pastoral Maasai in NCA, the lack of local or large-scale migrations in response to climatic disturbances suggests that household resilience is predicated on the immediate environment. Internal or external agencies seeking to enhance resilience should bear this more sedentary aspect of western Serengeti households in mind.

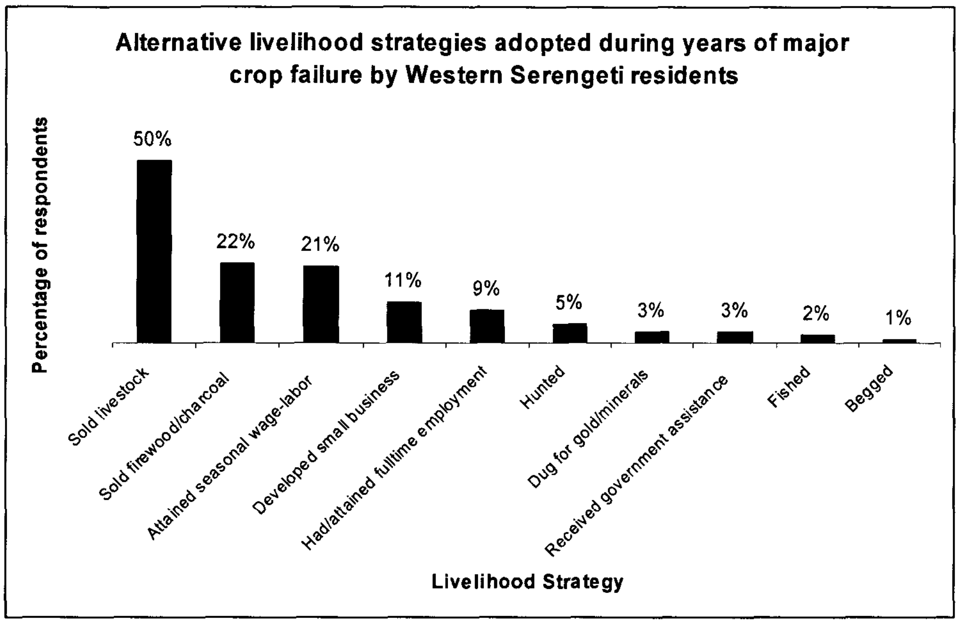

Figure 1.34.2 – Livelihood strategies practiced by households (N = 722) during years of severe crop failure in western Serengeti, Tanzania.

This response demonstrates the importance of livestock as a buffer or fallback option.[119]

Other households decided to collect (to sell) firewood and charcoal. Over one-fifth (22%) of the sample took up this option. The implications of this well-used strategy are potentially dire for the park and its protected areas. Outside Serengeti National Park, fuel wood is growing scarce and households must travel long distances to collect it (Section 1.36). Increasing scarcity of firewood in village communal areas may cause some households to gather it illegally from protected areas. Findings here suggest a link between wood and charcoal collection and times of flooding and drought. Since wood collection appears to increase during aberrant rainfall regimes, logic holds that the park is more vulnerable to resource exploitation during these times. Although seemingly minor,

[119] Although most often sold to acquire money for food crops, three respondents reported that they regularly drank cow's blood during bad drought years. This custom reveals that cows are used flexibly and that traits of nearby pastoral groups (e.g., Maasai) have infused into western Serengeti culture.

this linkage may have import to outside agencies or enforcement strategies hoping to protect the park and increase household resilience (Chapter Three).

Serengeti National Park's fish and wildlife may also be more vulnerable during, or right after, heavy crop failures. Of surveyed households, 7% took up hunting and/or fishing during difficult years. It is important to note that this percentage refers to households that had not illegally harvested wildlife prior to—or after—a crop failure. In other words, these households represented additional hunters to those that routinely harvested wildlife as a part of their livelihood portfolios. This suggests a definite linkage between weather, agricultural success, and hunting. It may also suggest that in addition to suffering from a loss of forage, wildlife populations may be hunted by more people during excessively low—or high—rainfall years.

Nearly one-third (32%) of western Serengeti households coped with crop failures by attaining a form of wage labor or developing a small business. Employment opportunities are critical because they potentially allow households to persist without illegally harvesting resources. Small businesses and activities undertaken by households included: tailoring, beer brewing, animal hide tanning, dagaa[120] sales, basket weaving, stool making, wood selling (from local plantations), spoon making, chair making, bicycle repair, brick making, baked good sales, and salt sales. Of these, beer brewing (and sales) comprised the primary small business alternative.

Another portion of the sample (9%) obtained, or had already obtained, year-round employment at the time of heavy crop failure. While seasonal labor and entrepreneurial opportunities are important, greater availability of full-time employment is imperative for

[120] "Dagaa" is a local name for a small fish that are often obtained in Lake Victoria and sold throughout the western Serengeti region. They are often fried, dried, and eaten whole as a protein accompaniment to flour-based 'ugali' or rice.

long-term household resilience and protection of SNP resources. As will be discussed in Chapter Three, the major shortcoming of seasonal jobs is that its termination often causes households to fall back on illegal exploitation of park resources.

Another livelihood strategy that households adopted during periods of large-scale crop failure was mineral extraction – primarily gold. Upon being discovered near Fort Ikoma in 1902, gold has played a significant role in western Serengeti. It featured most prominently as a livelihood strategy between the years 1930-1942, with 12 of the 24 mines located in Serengeti and Bunda districts (Shelter 2007). Most of the workers (90-95%) came from within Mara region and mined gold in addition to farming and livestock (ibid). Despite closure of the last mine in 1965, households have continued to mine for gold, albeit less intensively. The study here showed that 3% mined gold when crops failed. According to several key informants, the location of several mines within SNP continues to draw individuals. Such persons enter the park illegally and often combine gold mining and prospecting with poaching activities.

A small percentage (4%) of households coped with large crop failures by receiving government aid and/or begging in public areas. Although not as destructive to the natural resource base as some of the aforementioned strategies, government assistance and begging are indicative of a fragile system lacking in sufficient livelihood alternatives.

One other seemingly trivial point merits mention here. Six percent of households reported no appreciable changes in lifestyle during periods of heavy crop failure. In other words, these households were unaffected by drought or flooding. For most, it was because they had already procured year-round employment. As this thesis argues, year-round employment effectively decouples households from the immediate resource base by making income independent of agricultural success (Chapter Two). This lessens the impacts on SNP by potentially increasing household (and protected area) resilience.

1.35 – Natural resource use

Household resilience in western Serengeti is largely determined by the system's natural resources. Wildlife typically receive the most national and international attention for an assortment of reasons. Often overlooked, but equally important, are firewood (also referred to here as "fuelwood") and water. Firewood and water are renewable resources. From a household's perspective, however, both of these resources can become limited depending on the season, the number of users, and/or the resource's location. In addition, both of these resources take time to collect. This is critical for households because time which is devoted to resource collection cannot be devoted to other livelihood strategies such as agriculture or employment.

While water collection is extremely difficult in the dry season, it appears that firewood is the more limiting resource of the two in western Serengeti. Four-fifths[121] of the sample reported that firewood is difficult to obtain compared to just half[122] for water (Figure 1.35.1).

[121] N = 700
[122] N = 700

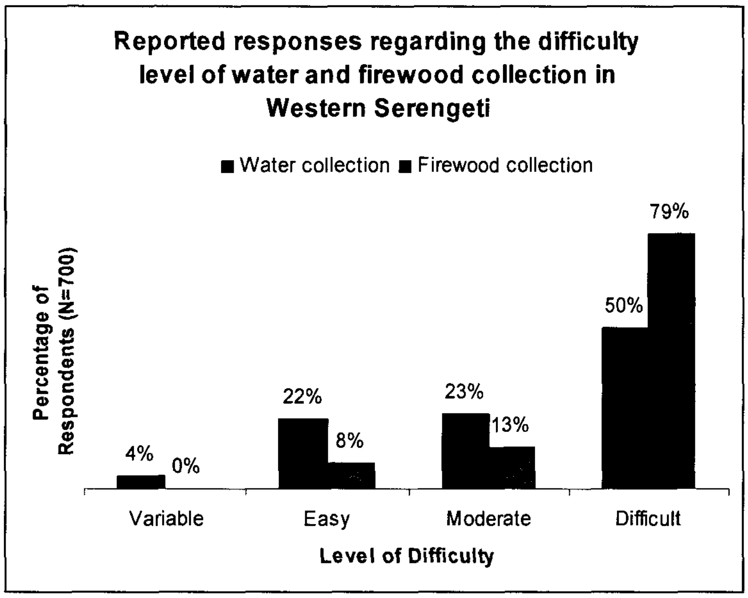

Figure 1.35.1 – Difficulty of water and firewood collection as reported by households (N = 700) in western Serengeti, Tanzania

1.36 – Fuelwood

Fuelwood serves western Serengeti households by acting as the main source of cooking and heating (Kideghesho et al. 2006). It is also, however, one of the three primary contributors to wildlife habitat destruction (ibid).[123] In a study from another part of Tanzania, Luoga et al. (2002) note that present patterns of fuelwood collection and tree harvesting are altering the structure and composition of communal areas and are unsustainable. They also remark that depletion in communal areas will ultimately increase the pressure on parks and reserves (Luoga et al. 2002).

In western Serengeti, pressure is already being felt. When asked why firewood collection is difficult, over one-tenth of respondents (13%)[124] reported that they collect it in protected areas and routinely face the threat of arrest (Figure 1.36.1).

[123] The other two contributors to wildlife habitat destruction are human settlements and demand for agricultural land.
[124] N = 294

Interviews with four respondents who admitted to illegal firewood collection—in the form of charcoal—provide context for the fuelwood situation. Three of the four respondents were women, none younger than 35-years-old. The four individuals had several things in common. One, they had all tried, or were actively doing, various small business ventures. These included sales of grass (for homes), beer, eggs, soda, and water delivery. Two, and most importantly to the study here, all four individuals collected charcoal simply to meet their basic needs.

Charcoal collection, however, is labor-intensive and earns very little money. Reported sales from the four respondents ranged from TZS 2,500 to 21,000 per month. To earn TZS 21,000, however, the respondent needed to spend 21 days in a protected area. One of the four had been arrested (8 times in 13 years) with punishment consisting of mandatory village work. Perhaps the most startling—or troubling—result of these interviews, however, are the recipients of the sales. Two of the four individuals reported that they routinely sold their charcoal to Serengeti wildlife tour camps and even Tanzanian National Parks (TANAPA) authorities. One of the other two respondents regularly sold charcoal to illegal hunters while in SNP. The same respondent also attested to regularly buying bushmeat from hunters. Context here reveals that fuelwood and bushmeat collection are intertwined with ramifications on the ecosystem and household economy.

Households in western Serengeti spend approximately 7 hours per week collecting firewood with some spending as many as 12 hours.[125] To gauge the difficulty of collection effort, respondents were asked to categorize it as "difficult", "moderate", or "easy". Unsurprisingly, respondents who described fuelwood collection as "difficult"

[125] N = 654

needed more hours (3.2) to collect it than households who reported the task as "easy" (2.6) or "moderate" (2.9) ($F = 4.52$; df = 3; $p = .004$). Similarly, respondents who needed more trips per week to collect firewood (2.9) rated the task as "difficult" compared to respondents who labeled it "easy" (2.2) or "moderate" (2.2) ($F = 5.20$; df = 3; $p = .001$).

Fuelwood collection falls mainly on women and children and is affected heavily by household size and structure (Biran et al. 2004).[126] Since time is finite, rural women face a daily dilemma of how to allocate time to firewood collection amid their many other "duties" which often include: planting, harvesting, milking, weeding, cooking, child care, and other household activities. Heavy time demands on daily household tasks often preclude women from partaking in other potentially profitable livelihood alternatives.

The 7 hours per week needed to collect firewood is largely the result of its scarcity. Nearly one-third (33%)[127] of respondents cited scarcity as the primary reason firewood was difficult to collect.

---

[126] Research here, however, found the relationship between household size and firewood collection time to be insignificant (Pearson $R = -.055$, $p = .173$). This might be due to patchiness of firewood resources in western Serengeti.
[127] $N = 294$

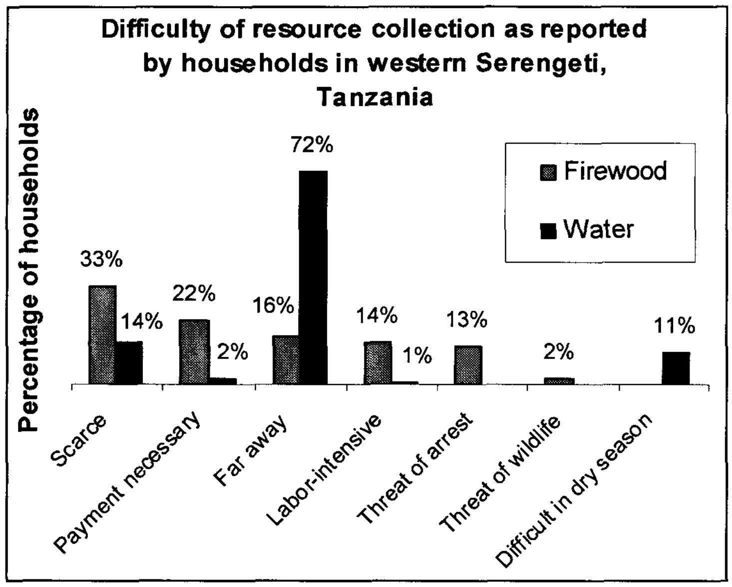

Figure 1.36.1 – Reported responses as to the difficulty of firewood and water collection by households in western Serengeti, Tanzania (N = 722)

The scarcity of wood relegates women and children to travel long distances to find adequate amounts (described as "far away" in Figure 1.36.1). Approximately 16%[128] cited this as the most challenging factor. Luosa et al. (2002) has observed that the demands of longer travel times cause firewood collection to decline with increasing distances from village settlements. As a result, other options for fuel must be found.

Research here found that households have three primary options to obtain fuelwood. One, they can continue to walk long—and increasing—distances. Two, they can, as already mentioned, harvest it illegally from SNP. Or three, they can buy it. Nearly two-thirds (63%) chose legal collection while over one-tenth (13%) chose illegal harvesting. The final fifth (22%) of the sample opted to buy their firewood.[129]

At first glance, it might appear that the percentage of households that illegally harvest firewood is low, and therefore, not likely to harm SNP. This is undoubtedly a

[128] N = 294

[129] All of the statistics in this paragraph had sample sizes of 294.

low estimate, however, as many households that bought firewood likely did so from others that collected it illegally from the Park. Regardless of the exact percentage, pressure on SNP's trees and woody vegetation already exists. Moreover, this pressure is likely to increase with increases in human settlements. It is reasonable to assume that distances to travel for legal collection of firewood will eventually become too time-intensive for households. This might cause demand for fuelwood to increase with a concomitant increase in price. Although speculative, such a scenario encourages the need for alternative fuels.

One possible solution to the growing fuelwood dilemma in western Serengeti would be the installment and availability of electricity in the region. At the time of the study, key informants suggested this was an unrealistic solution for rural households. Even if the necessary infrastructure was in place, the high costs of power would deem it unaffordable to the poorest of the population.

While the provision of widespread, affordable electricity to western Serengeti dwellers remains in doubt, a more viable—and affordable—option is tree farming. At the time of the survey, less than one-tenth (7%)[130] of the study population grew trees exclusively for fuelwood. While tree farming requires adequate land and long-term vision, relatively little labor is required after initial planting. In addition to supplying needed fuel, tree farming could also add supplementary income to a region where daily fuel costs will undoubtedly escalate. Ultimately, of course, household tree planting endeavors would relieve pressure on the park and better maintain wildlife habitats in key buffer areas. Although the merits of tree farming are outside the scope of the study, it is

---

[130] N = 294

mentioned here merely for its potential duel capacity to increase resilience of the household and the system at large.

1.37 – Water

Unlike firewood, water acts as a limiting resource only during the drier months (June – September). Households spent an average of 1.5 hours per bucket of water in the four months of the "dry season" compared to 0.7 hours in the wet. Considering that households use 5-7 buckets per day (one bucket equaled 20 liters), some households may need a total of 11 hours simply to meet their daily water needs. Obviously, 11 hours devoted to water collection would inhibit completion of other necessary tasks.

Households at this extreme overcame this in several ways. One, water collection was divided up among household members.[131] And two, water collection was often done with the aid of a bicycle, donkey, or oxen, which greatly limited the number of trips needed due to greater carrying capacity. Even with the help of these techniques, however, significant time was needed for water collection. Time used for this activity—especially during the critical months of the dry season—can limit livelihood diversification and other wage earning opportunities. Time required for water collection is often heavily dependent upon the source and location of the water. The rest of this discussion will focus on these important factors.

In the eight months[132] of the wet season, 70%[133] of western Serengeti households collect water from wells (Figure 1.37.1).

---

[131] Larger households naturally have more labor available for water collection but necessarily have greater water needs that may cancel out these benefits.

[132] Wet and dry season terminology is used here loosely. For simplification, the wet season refers to the 8 wettest months of a calendar year in Tanzania.

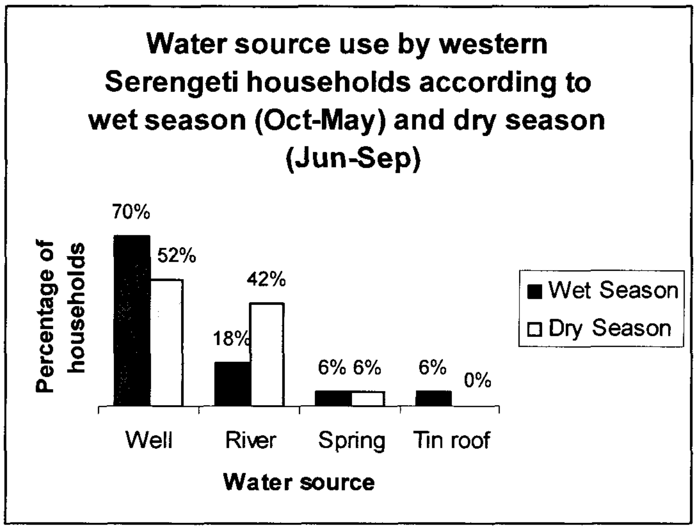

Figure 1.37.1 – Water sources accessed by households (N = 722) during the wet and dry seasons in western Serengeti, Tanzania.

Just 50%[134] of households, however, are able to do so in the dry season. According to several key informants, this pattern occurs because the water table drops considerably during the drier months. Well water can still be obtained in the dry season, but the time required increases considerably because the well takes time to recharge. The significant increase in wait time often causes women and children to queue up between 3-4 a.m. to ensure they obtain sufficient water. Excessive waiting at the wells prompt many households (42%)[135] to draw water from local rivers and creeks compared to 18% that do so during the wet season (18%).[136]

From an ecosystem perspective, dependence on local rivers is problematic in western Serengeti. Many of the rivers (and tributaries) form the borders of the protected areas (e.g., Grumeti, Malulu, Manchira, Rubana rivers). The problems this can create are several. The drawing of water from rivers for household use, for example, may preclude

---

133 N = 689
134 N = 683
135 N = 683
136 N = 689

wildlife from using the same sources. In the driest months of July and August, the rivers of western Serengeti often function as critical reserves for wildebeest and other resident ungulate populations (Sinclair 1995). Fear of humans may inhibit many species from accessing needed water.

Human presence at protected area borders can disrupt wildlife movements and degrade riverine and riparian habitats. One respondent stated that "getting water is difficult because animals come to the river in dry season". The respondent was referring to the tendency for predators such as lions and leopards to congregate at dry season water sources to ambush prey. Three other respondents mentioned that water levels drop so low in some of the tributaries that they are forced to routinely dig in the riverbed to access water.

Stress on local rivers is intensified greatly by livestock. Approximately 81% of livestock-raising households obtained water year-round from river sources. Another 17% derived water from springs and swamps.[137] Daily concentration of livestock at the edges of the protected areas may increase wildlife depredation at these sites (Nyahongo 2007; Patterson et al. 2004) in addition to possibly increasing incidences of disease transmission between wild herbivores and livestock (Cleaveland et al. 2005; Cleaveland et al. 2001) (Chapter Two). Trampling and erosion also result from livestock concentration at water sources (Strauch et al. 2009; Epaphras et al. 2008).

A somewhat more subtle cost associated with livestock river use involves travel time. Just like households needing time to collect water, herding livestock to daily water sources is time-draining as well. The study revealed that this required 7.8 hours[138] round

[137] The sample size for these two statistics was 168.
[138] N = 153

trip. As mentioned earlier, this is time that cannot be devoted to other wage-earning activities.

Perhaps the most intriguing and potentially valuable source for decreasing household dependence on wells and rivers are tin roofs. At the time of this survey, just 6%[139] of the population collected water from a tin roof during the wet season (Figure 1.37.1).[140] This is despite the fact that 35%[141] of households had tin roofs. Respondents from households that did obtain water from a tin roof stated that they stored excess water and used it throughout the dry season. The reluctance of households that had tin roofs but did not take advantage of it may be due to several reasons. One, sufficient water storage requires households to have at least a 2,000-10,000 liter tank. While such tanks are available in the region, they have a prohibitively high cost for most households.[142]

Two, the tendency in western Serengeti for needier households to ask wealthier households (coupled with the cultural taboos about stinginess) may make the investment of water storage not profitable for some households. Three—and more speculatively—wet season water storage may simply not have "caught on" yet. In other words, cultural inertia may be obscuring the tin roof option at present.

Forty-three percent of households reported sufficient year-round water availability. Households that collected water from tin roofs were included in this percent. Others were those that were fortuitously—or strategically—situated near wells and rivers

---

[139] N = 689

[140] Just 0.1% collected water from their tin roof in the dry season (N = 683).

[141] N = 699

[142] At the time of the survey, one 4,000-liter tank was ~USD 2,000.

that had year-round water. Over one-tenth (15%) of households, however, lived near water sources but reported limited water availability in the drier months.[143]

Distance to water sources also factored significantly in western Serengeti livelihoods. ANOVA tests revealed that difficulty ascribed to water collection is a function of the hours needed to collect it during both the dry season ($F = 22.81$, df = 3, $p < .001$) and the wet season ($F = 12.37$. df = 3, $p < .001$). These results suggest that perceptions of water collection shift seasonally based on expectations of water availability. Households expect to spend less time collecting water in the wet season and therefore consider it difficult if it takes less than one hour per bucket. In the dry season, however, households expect to spend more hours collecting water and accordingly consider the same amount of time as "easy." Such shifting expectations may imply that western Serengeti households are long accustomed to—and adapted to—fluctuations in water availability in the semi-arid environment of the GSE. How adapted they are to crop destruction and wildlife depredation will be explored next in Chapter Two.

[143] Sample size for statistics in this paragraph were 291.

Chapter Two

Effects of crop damage, livestock depredation & park-related employment on households economies

2.1 - Introduction

It has become increasingly clear that nearby protected areas affect the livelihoods and household economies of marginalized Africans (Himmelfarb 2006). Some of the most notorious effects result from human-wildlife conflicts that often occur around the boundaries of protected areas. It is thought that larger protected areas, such as Serengeti National Park (hereafter, SNP) for example, are more likely to have an impact on local poverty rates (Upton et al. 2008) due to higher incidences of human-wildlife conflict. Poverty rates are often higher around protected areas because in part rural communities bear the costs of living with wildlife which are rarely offset by material benefits of their presence (Kaswamila et al. 2007).

In addition to increasing poverty, human-wildlife conflict is widely recognized as posing a considerable threat to the success of conservation initiatives (Webber et al. 2007). These initiatives can be undermined by local resistance that often emerges from human-wildlife conflicts. Local resistance can take the form of trespassing and poaching in protected areas, a decreased level of cooperation with conservation programs, and negative attitudes toward wildlife (ibid). In short, the success of conservation efforts and poverty alleviation programs on communal lands and buffer zones hinges upon the relationship that local people have with wildlife (O'Connell-Rodwell et al. 2000). Understanding the nature and complexity of this relationship, therefore, is essential if human-wildlife conflicts are to be successfully resolved.

Serengeti National Park and its affiliated game reserves[144] exert large effects on households living along the borders. Such effects can be positive, negative, or neutral.

---

[144] Ikoma, Grumeti, and Maswa are the major game reserves connected to the western boundary of Serengeti National Park.

They can also be direct or indirect and may include opportunity costs. Direct costs may involve loss of crops, wildlife, and human life, while indirect costs may include time and money that is spent in the prevention of wildlife damage. Opportunity costs often accompany the direct and indirect effects as they involve potential income lost from a suite of other activities due to the presence of wildlife (Norton-Griffiths & Southey 1995).

This chapter focuses on the direct effects that SNP has on households. While all effects are important to livelihoods and household economies, it has proven difficult to accurately quantify indirect and opportunity costs through standard survey techniques. Rather than address the array of direct effects in a cursory fashion, three of the arguably most significant effects will be examined. With regards to negative effects that SNP has on households, the two selected are crop raiding (Part I) and wildlife depredation of livestock (Part II). For positive effects of the park on households, park-related employment will be analyzed (Part III). Each of these facets will be discussed in terms of their effects on livelihoods and household economies. The chapter concludes with implications these interactions pose on household resilience to change.

2.2 – Methods

Methods for the analysis presented in this chapter utilize semi-structured household interviews from the primary sample (N = 722). Interviews from this sample were conducted in the Swahili language and administered in 15 villages selected from Serengeti, Bunda, and Meatu Districts. Households were chosen in a stratified-random format dependent upon their proximity to Serengeti National Park or the Ikoma, Grumeti, or Maswa game reserves. Each household considered was located within 18 km of one of these designated areas. For matters of simplicity, the study area encompassed by these specifications is referred to hereafter as "western Serengeti."

To ensure adequate spatial heterogeneity, one to three sub-villages were selected from each village and 20 to 25% of selected sub-villages were sampled.[145] Due to logistical constraints (e.g., inaccessible roads, excessive walking distances), sub-villages were selected using judgment sampling (Bernard 2006) based upon the feasibility of being able to administer interviews. A total of 46 sub-villages were selected across the 15 villages. Interviews were conducted with the male head of the household. If unavailable, interviews were carried out with the household head's spouse.[146] All respondents were 17-years-old or older.

Interviews with the primary sample were integrated with a subset sample obtained during the same timeframe (Part III). The subset sample consisted of 50 interviews conducted with individuals who were actively employed in year-round jobs that were related to Serengeti National Park, Ikoma Game Reserve, and/or Grumeti Game Reserve. The sample included respondents working for the Tanzanian Wildlife Research Institute (TAWIRI, 18%), Tanzanian National Parks (TANAPA, 18%), lodges or hotels (16%), nongovernmental organizations (14%), private companies (14%), individual entrepreneurships (14%), and foreign research organizations (6%). Interviews for this sample involved sensitive issues dealing with exact amounts of income generated through

[145] Two exceptions with sub-village selection occurred in Nyakitono and Robanda villages. In Nyakitono, data collection was limited to one sub-village due to the relatively large size (N = 48) of the randomly selected sub-village. In Robanda, all sub-villages were selected for the purposes of completing an exhaustive assessment of crop destruction and wildlife depredation on livestock (Section 2.11).
[146] In several cases, interviews were conducted with a group of respondents who corporately demonstrated knowledge of household affairs.

several years of employment. As a result, respondents were chosen with judgment sampling techniques (Bernard 2006) and predicated upon trust-based relationships developed over several years. Park-related employment included all work with lodges, safari companies, research organizations, rangers (TANAPA), staff, and non-governmental organizations.

At the time that this study was conducted, one thousand Tanzanian shillings (hereafter, "TZS") was equivalent to approximately one U.S. dollar. In the analyses to follow, all percentages are rounded to the nearest whole number.[147]

2.3 – Crop raiding

The importance of crop raiding by mammals is underscored by the fact that when coupled with invertebrates, weeds and pathogens, annual crop losses in African subsistence agricultural systems have been as high as one-half of the total crops planted per household (Kaswamila et al. 2007). When weeds and pathogens are removed, losses have remained as high as 40% of crops planted (Nahonyo 2000). Obviously, such losses can result in severe reductions in household income and food security. They often also create incentives for rural peoples to partake in retaliatory killing of wildlife and to further reduce the quantity and quality of wildlife habitats so as to curb future crop raiding events (Kaswamila et al. 2007; Webber et al. 2007).

In the literature, crop raiding has mostly focused on larger mammals (Nahonyo 2000; Mkanda 1994; Ntiamoa-Baidu 1997). This is likely because larger mammals are more visible and their destructive events can be quick and severe. But smaller mammals (and invertebrates) can exact heavy losses too, resulting in considerable economic losses

[147] In Section 2.14, decimals are rounded to the nearest tenth rather than the nearest whole number.

for households (Keesing 2000). Multimammate mice (*Mastomys natalensis*), for example, has been documented as destroying as much as 80-100% of crops throughout sub-Saharan Africa (Leirs 1993). Due to their ability to cause significant and widespread destruction, smaller mammals, birds, and invertebrates will be included in the analysis here (Section 2.7). But, as in most survey research, smaller mammals were reported much less frequently.

Crop raiding is often exacerbated by extreme weather events such as drought that not only destroys crops, but may also increase the incidence of crop raiding events due to losses of forage available to wildlife in other parts of the ecosystem. Although beyond the scope of this study to ascertain the causal links between extreme weather events and crop raiding, possible synergistic effects will be discussed through a comparison of the losses incurred by wildlife with those incurred by drought and/or flooding (Section 2.8).

The crop-raiding analysis to follow occurs in stages, beginning with a general overview (Section 2.4) and ending with a finer-scale examination at the district (Section 2.9), village (2.10), and sub-village levels (2.11). The overview describes crop raiding in western Serengeti and examines problematic species and the susceptibility of the seven most heavily planted crops. In the ensuing section (2.12), crop raiding is analyzed in regards to distance that households are located from protected area boundaries. Part I concludes with a discussion of the links between crop raiding and household wealth.

2.4 – Crop raiding in western Serengeti

Perhaps the most ominous aspect of crop raiding in western Serengeti is the fact that it seems to be increasing. Data obtained from Serengeti District agricultural officials reveals a considerable increase in the number of hectares destroyed for seven of the most heavily planted crops between the years 2002-2006 (Figure 2.4.1).[148]

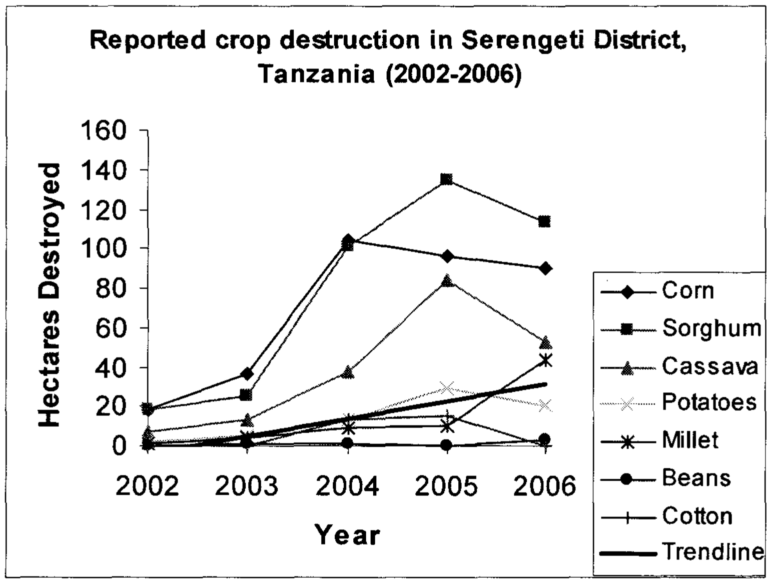

Figure 2.4.1 – Reported crop destruction in Serengeti District between the years 2002-2006.

While these figures are important, what is relevant are the large effects that crop raiding exerts on the household economy. Results from the primary sample—across all households[149]—revealed that a total of 22 different crops were grown in western Serengeti. Annual earnings from all crops combined amounted to TZS 167,751 (Section 4.5). Conversely, annual losses from crop raiding equaled TZS 110,427 (Section 4.6) which was 40% total possible revenue from crop sales. In the context of total income, households lost approximately 22% of potential earnings to crop raiding alone. These

[148] Statistics showing the percentage of households that planted crops are given in Chapter One (Part IV).
[149] The primary sample consisted of 722 households from Serengeti, Bunda, and Meatu districts (Section 2.2).

losses decrease food security by forcing households to purchase more food to make up for their shortfalls (Section 4.4).

Crops that featured greater earnings than losses included cotton (*Gossypium sp.*), onions (*Allium cepa*), tomatoes (*Solanum lycopersicum*), pumpkins (*Cucurbita sp.*), oranges (*Citrus sinensis*), okra (*Abelmoschus esculentus*), lemons (*Citrus limon*), and mangoes (*Mangifera sp.*) (Figure 2.4.2). Of these, cotton was by far the most profitable.[150] The only crop with no reported cases of wildlife destruction was mango. On the flip side, crops that suffered greater losses than earnings included maize (*Zea mays ssp.*), beans (*Phaseolus sp.*), finger millet (*Eleusine coracana*), sorghum (*Sorghum bicolor*), cassava (*Manihot esculenta ssp.*), potatoes (*Solanum tuberosum ssp.*), papaya (*Carica papaya ssp.*), groundnuts (*Arachis hypogaea ssp.*), bananas (*Musa sp.*), sugarcane (*Saccharum sp.*), and black-eyed peas (*Vigna unguiculata ssp*). While sugarcane was technically the least profitable crop, its relative rareness in western Serengeti deems it less vital to households than the heavy losses incurred to staples crops such as cassava, maize, millet, and sorghum.

[150] Reasons for this are explained in Chapter One (Section 1.28).

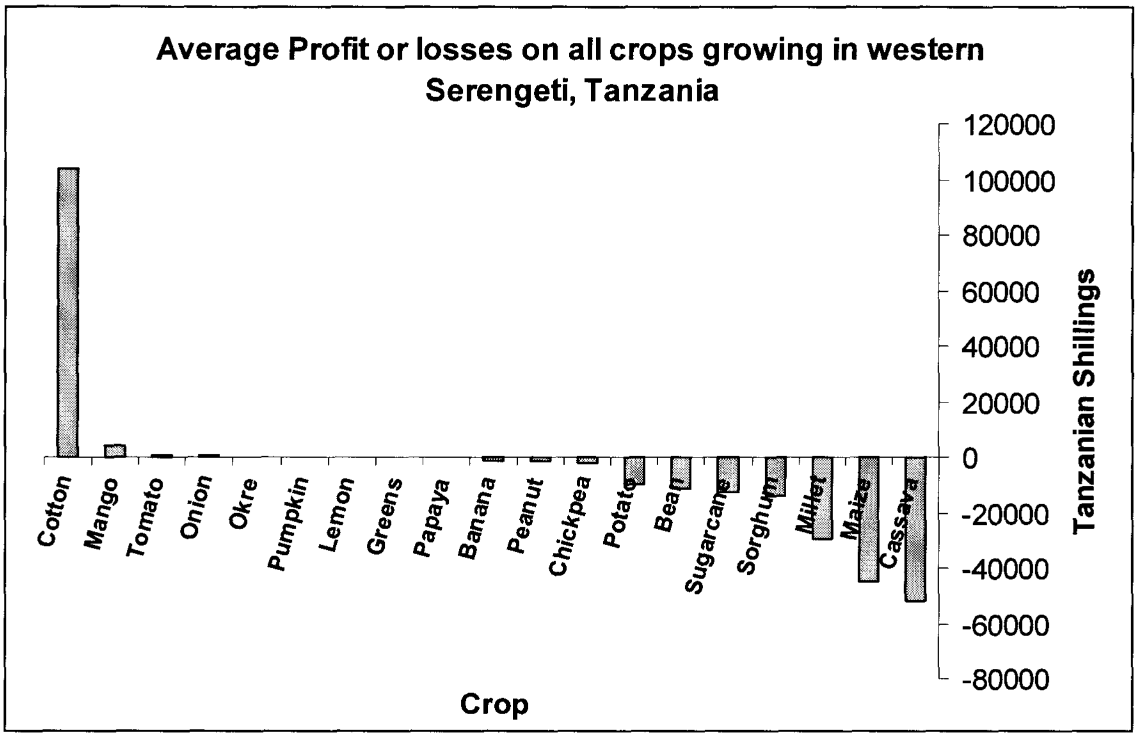

Figure 2.4.2 – Average profits or losses for 19 crops cultivated by households (N = 722) in western Serengeti, Tanzania.

Crop raiding losses in western Serengeti far exceed losses recorded in other parts of Tanzania. A study by Kasmawila et al. (2007) in northeastern Tanzania found that crop losses due to wildlife led to a mere 1.3% loss of household income. The reason for such a higher degree of crop destruction in western Serengeti than other areas of East Africa is most likely due to the presence of elephants (*Loxadonta Africana*) that account for the majority of the region's crop destruction. In most other areas of Africa primates are the major culprits of crop damage (Webber et al. 2007; Hill 2000; Naughton-Treves 1996). A meta-analysis conducted by Naughton-Treves (1999)[151] that ranked wild pests in Africa found that less than 10% of crop losses were blamed on elephants. This is markedly different than western Serengeti. For the 20 crops that respondents listed,

[151] Twenty-five studies were reviewed in this analysis from various parts of sub-Saharan Africa (Naughton-Treves 1999).

elephants were listed as a destructive agent for 19 of them[152] compared to baboons that were cited only once for the destruction of papaya trees (Figure 2.4.3). Moreover, elephants featured as the *primary* destructive agent for 17 of the 20 crops. Due to their disproportional impacts in crop raids, the next section provides a finer-scaled analysis of elephants on the household economy.[153]

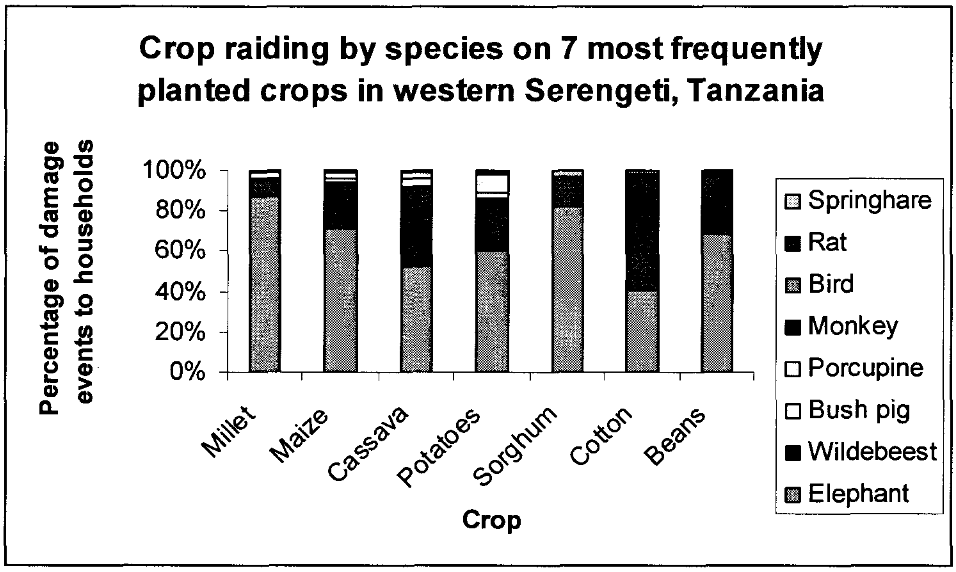

Figure 2.4.3 – Wildlife species reported in the crop raiding events among households (N = 722) in western Serengeti, Tanzania.

2.5 – Elephant impacts on crops

An important fact when examining the impacts of elephants on local livelihoods is that approximately 80% of the world's African elephants range outside of protected areas (Hoare 2000). In other words, elephants are wide-ranging species that are accustomed to living in multiple-use landscapes. In regards to conservation, therefore, if elephants cannot be conserved in human-natural landscapes, it is unlikely they can be conserved at

[152] The only crop that elephants were not reported as a destructive agent for was papaya. Rather, baboons (*Papio anubis*) were the only wildlife species cited in the destruction of papaya.
[153] All listed crops were raided for consumption purposes except cotton, which was trampled by elephants and wildebeest.

all (Woodroffe et al. 2005). But if elephant conservation is to succeed, it must be done with considerable care and innovative ideas. This is because the direct and indirect costs of elephant-caused crop damage make it one of sub-Saharan Africa's greatest causes of human-wildlife conflict (Woodroffe et al. 2005). While the emphasis here is on direct costs, it is important to bear in mind that indirect costs can be equally debilitating to a household. Indirect costs, for example, can include loss of sleep, reduced school attendance, and a heightened exposure to malaria due to the necessity of guarding fields (Kaswamila et al. 2007). Also important are opportunity costs which include all of the income-generating activities (e.g., tree plantations) foregone due to the presence of elephants.

As the district and village-level analysis will show (Sections 2.9 & 2.10), elephant damage is highly localized but catastrophic where it does occur. Research by Naughton-Treves (1998) has shown that it can eliminate up to half of a household's average annual income. Analyses here support this research and clearly illustrate the ostensibly stochastic and severe damage caused by elephants. Sugarcane suffered the greatest losses of potential income by elephants. Average losses for sugarcane growers were TZS 1,244,460 which is 3.1 times the amount of annual household income (Figure 2.5.1). Such high monetary losses, coupled with the fact that all sugarcane cultivators lost some to wildlife, may explain why just 1%[154] of the sample attempted to grow the crop. Heavy losses to sugarcane may be explained by a tendency for fields to be planted in low lying, water saturated areas far away from homesteads and settlement. Such areas are attractive to wildlife and their greater distance makes them difficult to protect from nocturnal foraging events.

[154] Eight households cultivated sugarcane (N = 686)

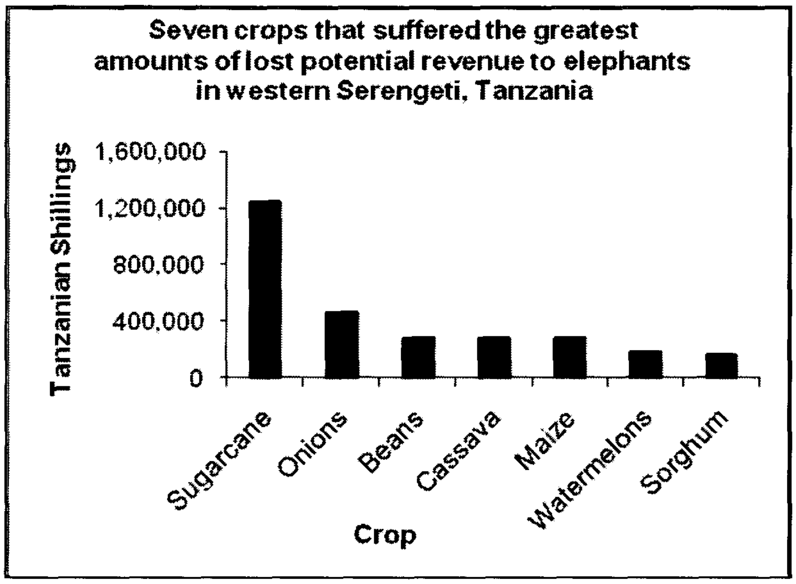

Figure 2.5.1 – Economic losses incurred on the seven most heavily damaged crops by elephants among households (N = 722) in western Serengeti, Tanzania.

Like sugarcane, onions also incurred high monetary losses due to elephants. For households that planted onions, over one-quarter (27%) lost an average of TZS 465,655. Again, such highly localized losses likely indicate why just 4% of the sample may have chosen to grow onions. Although the monetary losses to sugarcane and onions by elephants were severe, the relative rarity of these crops in the region deems them to be of little importance in the larger picture of household well-being. The same is not true for maize, however. Maize was the most widely grown crop in western Serengeti with 67% of households documented as having grown it during the past year (Chapter One – Maize). Of the households that grew maize, 72% of them lost an average of TZS 283,017 to elephants (Figure 2.5.1). Such losses are equivalent to over half the amount of a household's annual earnings.[155] The potentially catastrophic effects of these losses are underscored by the extreme range of potential losses. No household lost less than

[155] A household's total annual earnings from all sources was TZS 396,137.

TZS 18,189 in maize damages while some lost as much as TZS 5,456,700. In other words, some households lost upwards of 13 times the average annual income.

Perhaps the most problematic reality of elephant damage to agriculture is the difficulty of safeguarding crops from them. In a subset questionnaire in which acknowledged poachers[156] were asked to record what they feared most, elephants were listed most frequently (20%), ahead of lions (*Panthera leo*) (18%), anti-poaching rangers (17%), and buffalo (*Syncerus caffer*) (17%) (Section 3.24). During several interviews, several respondents interjected that they regularly saw or heard elephants in their fields at night but lacked adequate courage to scare them off. Perhaps the most problematic aspect of elephants, however, concerns the large quantities of forage they can consume in a short amount of time. As a result, farmers can lose several acres of agricultural crops in a single night. But elephants are not the only species in western Serengeti capable of quickly exacting heavy tolls on crops. Also guilty are wildebeest (*Connochaetes taurinus*). Due to their destructive potential—and their keystone presence in the GSE (Sinclair et al. 2007; Sinclair 1995)—the effects of wildebeest on crop damage are examined next.

2.6 – Wildebeest impacts on crops

As suggested, the impact of wildebeest can be devastating. Although a single wildebeest obviously consumes far less crops than an elephant, there are much more wildebeest (1,300,000) (Boone et al. 2006) than elephants (2,200) (Hilborn et al. 2006). As a result, their collective impacts often are equally destructive. Like elephants,

[156] Subset questionnaire was administered to 104 acknowledged poachers in western Serengeti, Tanzania (Section 3.2)

wildebeest crop destruction tends to be heavily localized yet severe where it occurs. Much of this can be attributed to the annual wildebeest migration. The well-documented Serengeti wildebeest migration (Sinclair et al. 2007) has shown that herds exit the protected areas and pass through village lands as they make their way north to the Maasai Mara National Game Reserve in Kenya.

Wildebeest peregrinations have often coincided with the drier months of June, July, and August. Data obtained with Global Positioning Systems (GPS) on eight collared wildebeest revealed that the animals spent 121 days per year outside of Serengeti National Park and up to 36 days per year within 10km of a village on the western border (Thirgood et al. 2004).[157] It should be noted that although wildebeest regularly travel southwest into the Maswa Game Reserve in particularly dry years, key informants suggested that they rarely exit the protected areas in the southwest and therefore rarely cause significant crop damage to the villages from Meatu District (Section 2.9).

While elephant crop destruction often consists of both trampling and consumption, the damage caused by the migrating wildebeest herds tended to be largely caused to a greater extent by trampling. This tendency is readily observed in damage inflicted to cotton fields. Cotton, for that matter, was the only recorded crop that suffered more damage from wildebeest than elephants. Since neither species particularly favors cotton as a source of forage, trampling may best explain the damage patterns observed for this crop.

As suggested by several studies (Sinclair et al. 2007; Boone et al. 2006; Thirgood et al. 2004), the wildebeest migration is a quite regular phenomenon. The particular

[157] The wildebeest in this study were characteristic of the larger herds that migrate clockwise around the Greater Serengeti Ecosystem.

routes by which the herds have travelled, however, has varied considerably from year to year. For this reason, safeguarding crops from wildebeest has proven problematic for many western Serengeti households. Despite being located in similar geographic settings and at approximately equal distances from the Park, some villages suffered severe crop damage while others suffered hardly any at all (Section 2.10). Such inherent stochasticity is difficult for farmers who have trouble predicting whether or not the wildebeest will migrate through their fields in any given year. As a result, decisions concerning types and quantities of crops to cultivate have been problematic.

In terms of potential household revenue, the crop most heavily affected by wildebeest was cassava. Although elephants damaged cassava more often (52%) than wildebeest (39%), wildebeest cost households an average of TZS 346,533 (Figure 2.6.1) which was more than damage incurred by elephants (TZS 285,884). Two other crops that cost households large amounts of potential revenue included beans and maize. For households that suffered bean damage, wildebeest accounted for nearly 29% of the damage events with average losses of TZS 235,426. These figures were similar for maize with wildebeest causing 23% of the damage events for average losses of TZS 211,218.

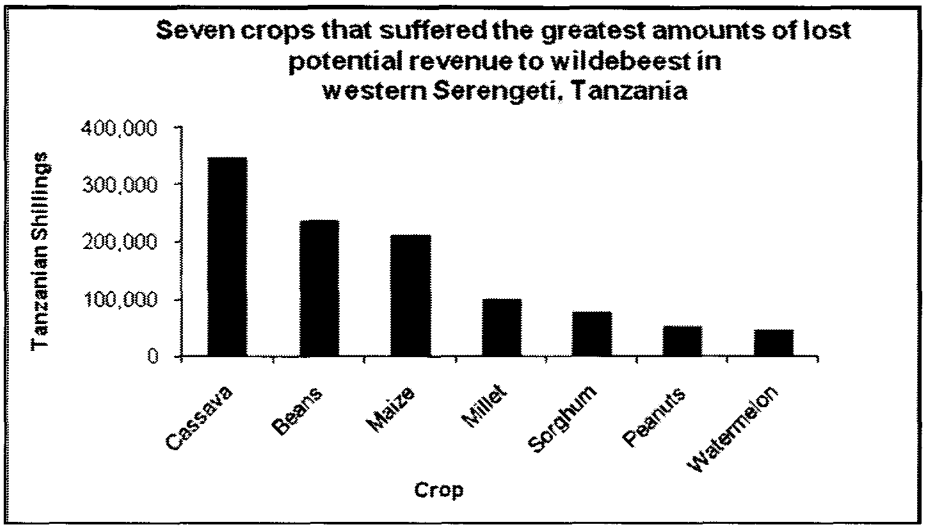

Figure 2.6.1 – Reported losses in potential revenue from households (N = 722) of the seven most heavily affected crops caused by wildebeest in western Serengeti, Tanzania.

Before examining the effects of other species, it is worth taking a brief look at the crops that were relatively unaffected by wildebeest. A total of five of the 22 planted crops in western Serengeti were completely unharmed by wildebeest and five others incurred average losses of less than TZS 15,000. Most of these unaffected—or little affected—crops were fruit trees (e.g., papaya, banana, lemon) that are often cultivated closer to actual homesteads. While this point may seem intuitive because wildebeest are grazers, it is emphasized here to make the point that crop raiders in western Serengeti are discriminatory in the crops they select. In some cases, of course, crops borne on trees are simply out of reach of ground feeders (e.g., porcupines, springhares, etc.) and ungulates. In other instances, however, crops are preferentially selected as a matter of choice – be it due to taste and/or the nutritive value they contain. While omnivorous elephants may eat most every crop they encounter, other species are necessarily more selective. This seemingly minor point can be of critical importance for households making decisions about which crops to plant and where the various types—or varieties—should be planted

(Naughton-Treves 1997). Clustering fruit trees around homesteads, for example, can deter raiding by primates but in turn make them more susceptible to herbivory from mice, rats, and even livestock.

2.7 – Impacts of other wildlife species on crops

The effects of other wildlife species on agriculture in western Serengeti may at first appear insignificant following the previous discussion of the large-scale destruction and losses of revenue caused by elephants and wildebeest (Figure 2.4.3). But such an assumption may be highly misleading. The reasons are several. One, in areas such as western Serengeti where large mammals are present, they may be unjustly blamed for damage caused by smaller animals and pests (Naughton-Treves 1997). This may be because smaller animals are simply harder to detect. Second, the mere ubiquity of smaller crop-raiding animals may cause respondents to simply neglect mentioning them due to their common presence around the homestead. Third, smaller animals, birds, and insects are less likely to evoke fear and as a result, their effects on crop are less likely to be remembered as acutely as those caused by larger species such as elephants and wildebeest. Fourth, with the notable exception of small mammals (Sinclair et al. 2002) and insect infestations, damage caused by smaller animals is rarely as fast-acting and catastrophic as that caused by larger mammals. In other words, where farmers may lose an entire season's production in one night by elephants or wildebeest, they are less likely to suffer such large-scale losses by smaller animals like porcupines (*Hystrix africae-australis*) or springhares (*Pedetes capensis ssp*). Although the cumulative effects of smaller animals are certainly significant, they have not apparently hindered livelihoods as greatly as larger animals.

For these reasons, and possibly several others, the following results presented in subsequent sections are likely biased toward the larger mammals already discussed (Sections 2.5 & 2.6). Such bias represents a long-standing weakness in the assessment of crop damage with the survey method which often fails to carefully compare local perceptions of crop loss with systematically measured damage (Naughton-Treves 1997). More detailed studies that compare reported damage to objectively measured damage would help close this gap that often exists in survey research (Kasperson 1992).

After elephants and wildebeest, the species most often reported for crop damage were porcupines, vervet monkeys (*Cercopithecus aethiops*), and bush pigs (*Potamochoerus larvatus*) (Figure 2.7.1).

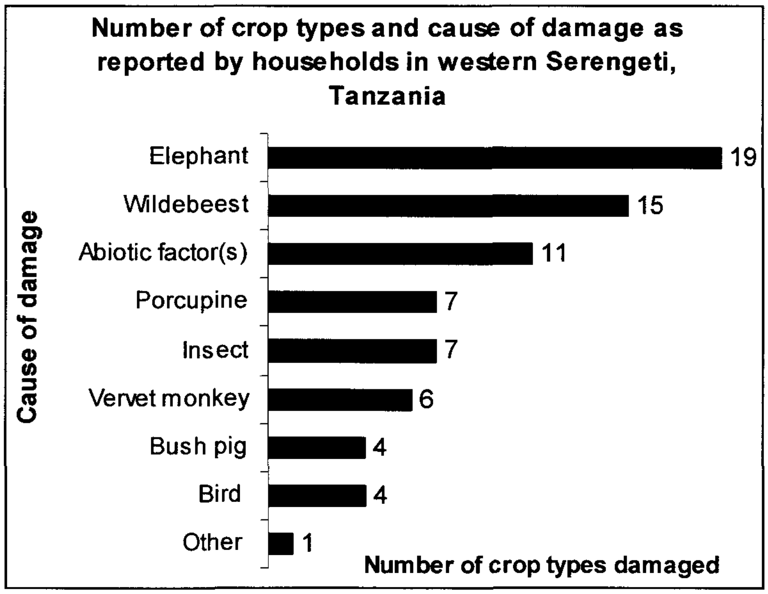

Figure 2.7.1 – Crop types damaged by biotic and abiotic factors as reported by households (N = 722) in western Serengeti, Tanzania. The category 'Other' included: olive baboon, rat sp., mongoose sp., spotted hyena, springhare, livestock sp., and human thievery. Abiotic factors included were drought, excessive rain, fire, and hail. 21 total crops were considered.

Porcupines were implicated in exacting damage on seven crops, vervet monkeys on six crops, and bush pigs on four crops. Porcupines were particularly destructive to groundnuts as they accounted for 17% of the damage events with average losses of TZS 100,063. This is not altogether surprising as groundnuts are high in protein and are easily excavated from the soil by porcupines which are accustomed to rooting for food. Like groundnuts, pumpkins are also easily accessed by porcupines. Porcupines were responsible for 13% of the damage events to pumpkins which amounted to an average loss of TZS 98,400. For all other crops, however, porcupines accounted for less than 10% of damage events with annual losses all falling below TZS 90,000.

As expected, vervet monkeys were implicated more heavily in damage to fruit crops which is corroborated by another crop raiding study (Naughton-Treves 1997) conducted in neighboring Uganda. But somewhat uniquely, crop damage caused by this species of primate was relatively minor as vervets never featured in more than 6% of the total damage events to any crop (Figure 2.4.3). The lack of crop damage attributed to vervets may be due to the relative lack of trees (which provide refuge for primates) around agricultural fields in addition to the tendency for farmers to plant fruit crops closer to homesteads which make them easier to guard.

The lack of habitat and refuge around agricultural fields in western Serengeti (due in part to high rates of tree harvesting) (Chapter One) may also account for the relatively low levels of crop damage caused by bush pigs. While bush pigs exert considerable effects on crops in other parts of Tanzania (Packer et al. 2005) they were reported as destructive agents on just four crops and average annual losses never surpassed TZS 170,000.[158]

The only other wildlife species that is worth mentioning for significant effects on livelihoods are invertebrates. Insects were implicated as destructive agents to seven different crops in western Serengeti. None of the crops damaged, however, were staple cereal crops. Rather, crop damage caused by insects consisted of vegetables, greens, and fruits. The lack of damage to food staples implies that insects appear not to considerably weaken food security (Chapter Four, Section 4.4). The fact that invertebrates damaged saleable fruits and vegetables (e.g., oranges, onions, and tomatoes), however, suggests that they do play a role—though not sizable—in decreasing a household's potential revenue (Chapter Four, Section 4.5), and with it, a household's resilience to future disturbance.

Insects damaged four crops (onions, tomatoes, oranges, and lemons) that featured positive income ratios (actual income earned compared to potential income lost) (Figure 2.4.2). Such losses to potentially profitable crops in western Serengeti are especially disconcerting because so many households are severely income-strapped (Chapter Four). One respondent, for example, reported that her household lost 17 sacks of tomatoes to insects. The respondent added, however, that the loss could have been prevented had pesticides been applied. Since the respondent could not afford pesticide, the household

[158] The relatively minor impacts of bush pigs on crops in western Serengeti may be related to the complete lack of lion-caused human fatalities reported in the region. A study by Packer et al. (2005) determined that lion attacks are directly related to the density of bush pigs because bush pigs constitute such a large part of a lion's diet. Moreover, the study reports that more than one-quarter of the lion attacks occurred at night while people were residing in makeshift 'guard huts' as they tried to protect their crops from bush pig consumption. Since the reported impacts of bush pigs were minimal in western Serengeti, their densities are likely lower than in other parts of Tanzania.

lost potential revenue of TZS 271,167. This amounts to over half of the average yearly income of a western Serengeti household.

From this example alone, it is clear that invertebrates are an important agent of western Serengeti crop damage. They are afforded such limited space here, however, due to the common role that crop pests play throughout the world. The same rationale is used for abiotic effects (discussed subsequently) which are obviously not unique to protected areas. Here, emphases are placed instead on the unique contributions that protected areas—and in particular, SNP—may have on household resilience to change.[159]

2.8 – Comparison of abiotic and biotic impacts on crop damage

Abiotic, or weather-related, factors must also be considered to fully understand biotic pressures on the park. In the following summary, biotic factors are defined by crop damage caused by all mammals,[160] birds, livestock, and invertebrates. Abiotic factors, on the other hand, are defined by crop damage caused by drought, flooding, heat stress, hail, wind, and fire. As seen in Figure 2.8.1, abiotic factors account only a small percentage of the total crop damage. For all crops, in fact, abiotic factors never accounted for more than 20% of the total number of reported damage events. Mirroring the case with invertebrates, abiotic factors caused more damage to fruit and vegetable crops than to the staple cereal crops.

[159] It should be mentioned, however, that the existence of protected areas can increase or decrease the role of invertebrates on crop damage, depending on a suite of localized variables.
[160] Mammals here also include common livestock species (cattle, goats, sheep, poultry).

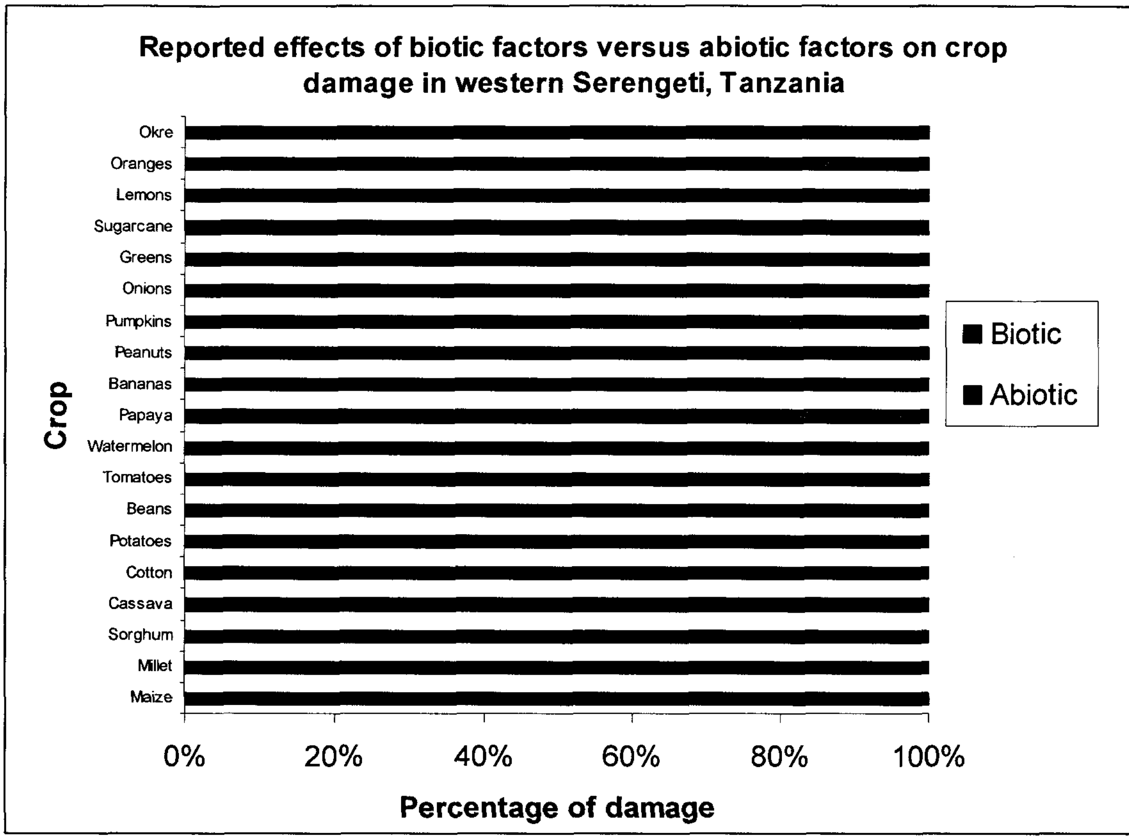

Figure 2.8.1 – Comparison of abiotic and biotic factors on reported crop damage among households (N = 722) in western Serengeti, Tanzania.

This is expected as fruit and vegetable crops (e.g., papaya, pumpkins, tomatoes, etc.) are more water-dependent than the more drought resistant cereal crops such as cassava and sorghum.[161] This is important to consider in household agricultural decision-making because of tradeoffs between fruits and vegetables and the more drought-tolerant cereal crops. Although fruit and vegetable crops suffered less wildlife-caused crop damage than the cereal crops, they suffered more from abiotic, or weather-related forces. Since the western Serengeti is a drought-prone semi-arid environment of western Serengeti, the advantages of planting fruit and vegetable crops for revenue-generating purposes seem poor. In addition to more labor, results here suggest that fruit and vegetables are more

[161] Maize is considered intermediate in its water requirements.

susceptible to drought. While these crops offer households a more varied diet and a potential source of supplemental income, these benefits are unlikely to materialize unless better irrigation techniques become available and pesticides become more affordable.

Lest this be misleading, this summary should in no way minimize the importance of abiotic factors on crops in western Serengeti. While abiotic effects may seem small in comparison with those exerted by wildlife (Figure 2.8.1), their effects may be more indirect due to the existence of significant feedbacks with biotic agents (Sinclair et al. 2007). In cases of severe drought, for example, elephants may suffer losses of natural forage and consequently increase their frequency and/or intensity of crop raiding.

Moreover, direct damage caused by weather-related phenomena can often be large in and of itself and cause households to radically change their livelihood systems (Chapter One – Section 1.34). Of the suite of damaging abiotic factors that were reported on the survey, drought affected 11 different crops while flooding affected two and wind, hail, and fire each affected only one crop each. Where drought did occur in western Serengeti, it caused extremely large losses of potential revenue. While only 2% of potato-growing households incurred drought damage, those unfortunate households lost averages of TZS 355,822. Likewise, the 6% of households that suffered drought damage to papaya lost an average of TZS 327,096 per household. These economic losses are only exceeded by those reported for elephant damage to sugarcane and onions (Figure 2.5.2).

Perhaps most important here is that while agricultural systems are vulnerable to abiotic factors the world over, they may be a greater threat to livelihoods in western Serengeti because their effects are often coupled with a high background rate of wildlife-caused damage. These separate—and often synergistic—effects of abiotic and biotic factors make agriculture a highly risky enterprise in western Serengeti. As depicted in Figure 2.8.2, agricultural crops suffered considerable damage. Figure 2.8.2 also reveals that the cereal crops, relied on as staple food sources, suffered greater percentages of damage than non-staple crops.

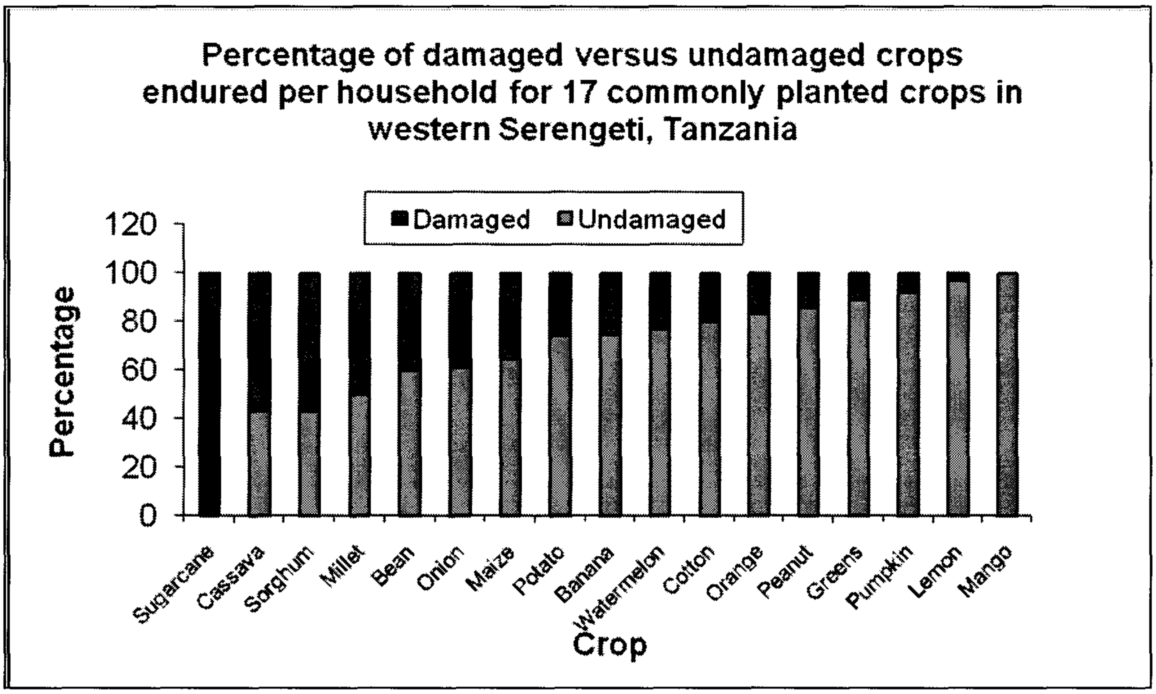

Figure 2.8.2 – Percentage of crops damaged and undamaged among households (N = 722) in western Serengeti, Tanzania. Included is damage caused by biotic and abiotic agents.

2.9 – Crop damage by district

A comparison of crop damage by district is a useful starting point for understanding the idiosyncratic nature of destruction in western Serengeti. Thus far, summaries have focused on the effects of crop damage on the household, which represents the finest scale of analyses of possible. Here, however, household-level results are aggregated and scaled up to the district level. Even a cursory glance of Figure 2.9.1, for example, quickly reveals that the average amount of crop damage per household is much higher in Serengeti District than it is for Bunda and Meatu Districts.[162]

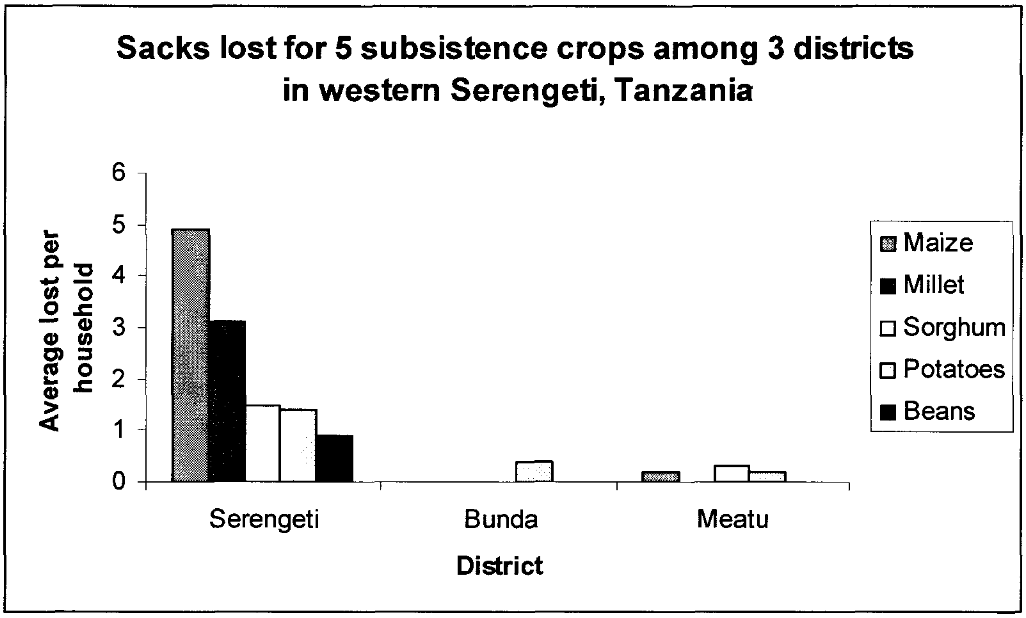

Figure 2.9.1 – Reported crop damage by households (N = 722) for Serengeti, Bunda, and Meatu districts in western Serengeti, Tanzania. Five staple food crops are shown. (Maize: $F = 11.961, p < .001$, df = 2; Millet: $F = 31.191, p < .001$, df = 2; Sorghum: $F = 8.712, p < .001$, df = 2; Potatoes: $F = 7.508, p = .001$, df = 2; Beans: $F = 5.628, p = .004$, df = 2)

While these three districts represent just half of the total number of districts that border the protected areas of the Greater Serengeti Ecosystem's western side, there is little reason to doubt that such variation does not occur in the other districts as well.[163]

Likely reasons for such variation include differences in human settlement densities (Newmark et al. 1994), differences in vegetation, proximity of households to wildlife migration routes (Thirgood et al. 2004), livelihood practices, and locations of key resources. At the time of this research, for example, personal observations revealed that

[162] Crop damage comparisons were also computed for cassava and cotton. But because cassava destruction was measured in acres and cotton in kilograms, the two crops are not shown in Figure 2.9.1. Results for these crops are observed in Appendix B.
[163] The three other districts that border the protected areas of the GSE on the western side are Magu, Bariadi, and Tarime districts.

many of the villages in Serengeti District had a "softer edge" than those in Bunda or Meatu districts. In Serengeti District, vegetation type and amount often changed incrementally as one moved from the park toward clusters of human settlements. In general, agricultural fields tended to be spaced more widely apart and human settlements appeared to be less densely positioned. While more auspicious for wildlife movements, a softer edge may also contribute to the greater amounts of crop damage in the district. An example of an edge—depicting differences in vegetation—is seen in Figure 2.9.2.

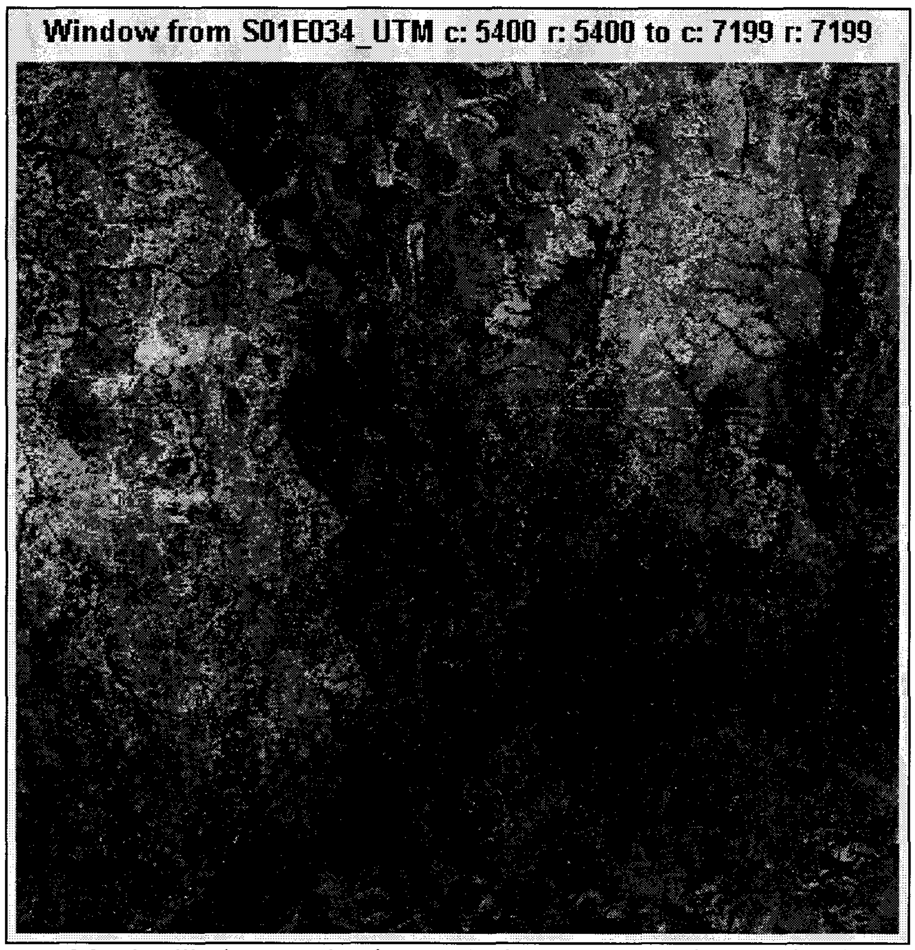

Figure 2.9.2 – Satellite imagery showing an edge between Serengeti National Park (greener portion) and villages from Serengeti District (browner region to the left). A harder edge is seen in the upper left. A softer edge is evident in the lower left (the boundary of the Park is less visible).

The villages sampled in Bunda and Meatu districts, on the other hand, were much more characterized as having a "hard edge." The boundary for all three villages sampled in Bunda District, for example, consisted of the Grumeti River. One side of the Grumeti was fully protected and forested while the other side was marked by closely positioned agricultural fields and water access points for livestock (E. Knapp, pers. obs). Several villagers also reported that the Grumeti River acted as an effective barrier preventing wildlife species from accessing their crops.[164]

In Meatu District, the harder edge was not formed by geography but rather by human land-use. Meatu District marks the northeastern most reach of an area of Tanzania generally regarded as Sukumaland (Meertens et al. 1995). In addition to being generally recognized as industrious and hardworking, the Sukuma have a reputation in Tanzania as 'slash-and-burn' agropastoralists that cut trees down indiscriminately to clear land for agriculture and livestock (Madulu 1996). Historically, when the nutrients and resources of an area were depleted, the Sukuma people moved on to other locations, pushing out other tribes and/or absorbing them (Meertens et al. 1995). This tendency for movement and displacement of other tribes has resulted in the very name of the tribe, "Sukuma," meaning "push" (Wijsen and Tanner 2002).

Such heavy-handed ecological practices of the Sukuma were plainly evident at the time of this research as agricultural fields in Meatu were largely devoid of natural vegetation. As a result, the vegetation of the protected area formed an easily recognizable edge with cultivated fields and settlements. The harder edge created by a lack of vegetation in agricultural fields likely contribute to the district's significantly

[164] Several informants added that the Grumeti River only provided a protective barrier from wildlife species when water levels were sufficiently high to prevent easy crossing.

lower amounts of crop damage. Although unlikely to curb the movements or raiding habits of elephants and wildebeest, a harder edge may be a deterrent for other more secretive ungulates.

2.10 – Crop damage by village

An examination of Figure 2.10.1 reveals that damage to five common staple crops varied significantly between the 15 sampled villages.[165]

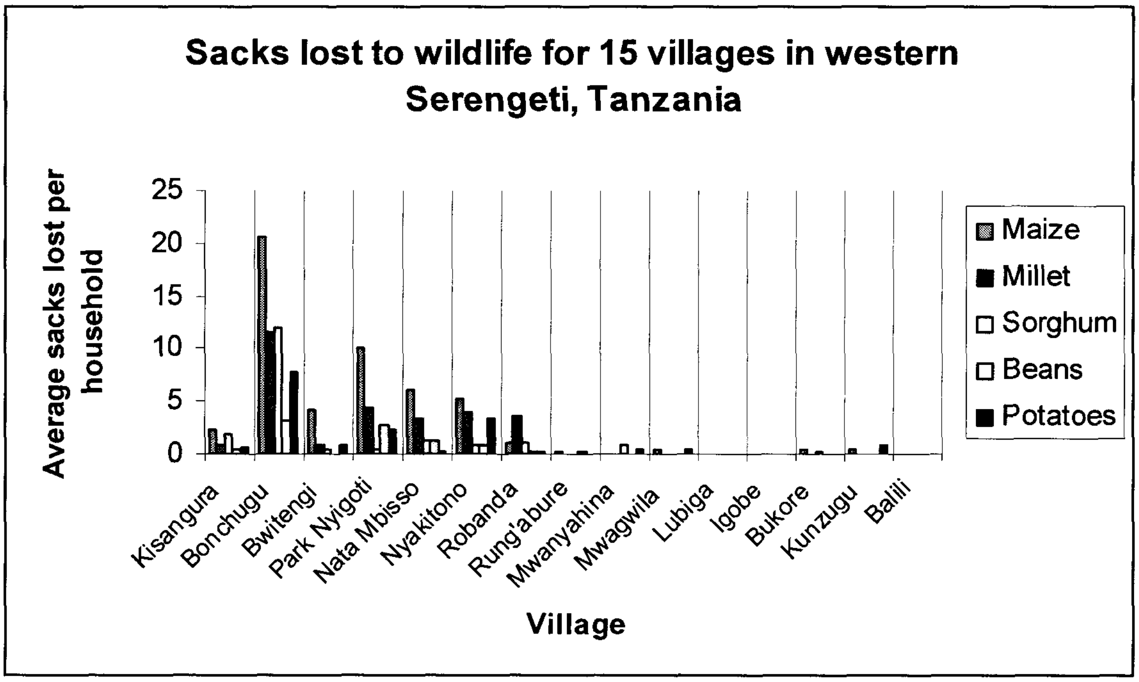

Figure 2.10.1 – Reported crop damage by households (N = 722) in 15 villages in western Serengeti, Tanzania. (Maize: $F = 6.620, p < .001$, df = 14; Millet: $F = 13.949, p < .001$, df = 14; Sorghum: $F = 18.728, p < .001$, df = 14; Potatoes: $F = 10.341, p < .001$, df = 14; Beans: $F = 3.616, p < .001$, df = 14)

At the village level variation was significant. This suggests that while generalizations can be made at coarser scales, finer-scaled analyses may render several significant exceptions. The village known as Kunzugu, for example, suffered more wildlife-related

[165] See Appendix-B for village-level results for cotton and cassava.

damage to potatoes (0.9 sacks per household) in Bunda District than did four villages (0.3 sacks per household) located in Serengeti District. This exception occurred despite the fact that Serengeti District had much more damage than did Bunda.

Likewise, Bukore village in Bunda District and Mwanyahina village in Meatu District suffered more sorghum damage (0.3 and 0.9 sacks per household, respectively) than did Rung'abure village (0.0 sacks) in Serengeti District. While these latter exceptions are likely due to the fact that Rung'abure is located further from a protected area than the Bukore or Mwanyahina (Section 2.12), they remain noteworthy because they suggest that the district level may be too general—and possibly misleading—for crop protection programs or wildlife damage intervention projects to succeed in western Serengeti. The next section discusses the profitability of examining crop damage at an even finer scale – the sub-village level.

2.11 – Crop damage by sub-village

As mentioned in Chapter One, villages in Tanzania are divided up into sub-villages for jurisdictional purposes by local and national government. Sub-villages are composed of clusters of households that are arranged solely for geographical and governmental jurisdictional convenience. For this reason, human densities and the household numbers vary considerably between sub-villages. Moreover, some sub-villages cover extensive geographical areas while others are quite small.

Since most villages are too large to survey entirely, the sampling strategy consisted of selecting one to three sub-villages from each village and sampling 20-25% of each sub-village (Section 2.2). While sub-villages were selected based on accessibility and feasibility of administering enough interviews, the decision to sample multiple sub-villages per village[166] ensured some degree of sample heterogeneity. Adding further heterogeneity was the fact that a household's agricultural fields were often scattered in multiple sub-villages.

In Robanda village, however, the sampling strategy was purposely altered to enable a finer-level analysis of several key variables. In Robanda, rather than sample just 20-25% of 1 to 3 sub-villages, 25% of Robanda's six total sub-villages were sampled.[167] This strategy ensured that all ensuing analyses were unbiased with regard to the sub-villages chosen.

Results from Robanda's more comprehensive sampling effort are illuminating. In this case, however, the results may be more illuminating for what they do *not* reveal. For all of the seven common subsistence crops planted, the amounts destroyed did not differ significantly across the six sub-villages (Figure 2.11.1). These "insignificant" results are meaningful in that they demonstrate that the sub-village level is unnecessary in the examination of crop destruction. In light of the previous section (Section 2.10), it becomes apparent that the village level may be a more appropriate scale for measuring wildlife-caused crop damage. Whereas the District level proved too coarse of a scale and riddled with exceptions, the sub-village level may be too arbitrary a designation for rendering useful results.

---

[166] The exception was Nyakitono village in which just one sub-village was sampled. Multiple sub-villages were intended in Nyakitono too, but information from village officials proved inaccurate during survey work.
[167] The Robanda sample had a total N of 92.

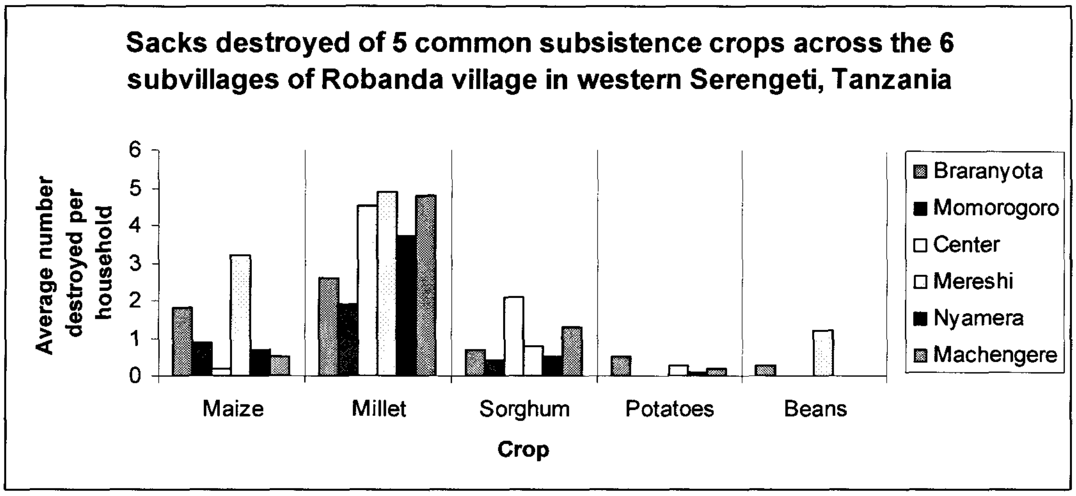

Figure 2.11.1 – A comparison of reported crop damage by households (N = 92) for five common subsistence crops in six sub-villages that comprise Robanda village in western Serengeti, Tanzania.

Possible reasons for the lack of crop damage variation at the sub-village level are several. One, as already alluded to, is that sub-villages are arranged largely for convenience by local governments. Because the primary mode of travel in rural western Serengeti villages is by foot or bicycle, it is difficult for local officials (e.g., sub-village chairman, village executive officer) to govern their constituencies if sub-villages are exceedingly large. In regards to crop damage, therefore, sub-villages are often geographically indistinct from one another and not based on vegetation, key resources, or land-use. Villages, on the other hand, may vary widely in their amounts of natural vegetation, access to key resources, and patterns of land-use.

Another possible reason for the lack of significance at the sub-village level may be due to an increasing tendency for households to own agricultural fields throughout several sub-villages. While this may appear unusual to outside observers, it is often advantageous for households to scatter their fields to take better advantage of microclimates and variations in soil and drainage. Due to this scattered arrangement, a sub-village assessment of crop damage is unlikely to yield significant patterns or trends than an assessment on a larger scale. While a sub-village level analysis may seem somewhat arbitrary, an assessment of crop damage according to distance from a protected area most certainly is not. This more useful variable is addressed next.

2.12 – Crop damage by distance from a protected area

The proximity of agricultural fields to protected areas is a well-established predictor of crop damage all over the world (Cai et al. 2008; Linkie et al. 2007; Rao et al; 2002). The relationship is straightforward; closer fields are to protected areas experience greater amounts of damage are caused by wildlife. Perhaps unsurprisingly, the same relationship occurs for agricultural fields located around Serengeti National Park and its affiliated game reserves.

Bivariate correlations conducted on seven common subsistence crops in Serengeti District showed that crop damage was inversely related to the distance that fields were located from a protected area[168] (Table 2.12.1).

[168] The relationship between crop damage and distance was only conducted for Serengeti District. This is because the crop damage and district analysis (Section 2.9) revealed that Serengeti District suffered far greater amounts of crop damage than did Bunda or Meatu districts. Since these other two districts suffered very little relative damage, they were dropped from the analysis.

Pearson Correlation coefficients between distance to a protected area and crop damage, income lost, and crops produced			
Distance to Protected Area *WITH*	Pearson R	p-value	St. Dev.
Sacks destroyed			
Maize	-.14	.005	13.1
Millet	-.24	<.001	5.4
Sorghum	-.20	<.001	4.2
Potatoes	-.13	.011	3.9
Beans	-.11	.023	3.4
Cotton*	-.12	.017	163.8
Cassava**	-.20	<.001	1.0
Income lost (TAS)			
Maize	-.14	.005	246,273
Millet	-.24	<.001	93,390
Sorghum	-.18	<.001	79,768
Potatoes	-.07	.144	61,607
Beans	-.11	.024	65,703
Cotton	-.11	.021	32,618
Cassava	-.16	.001	165,927

Table 2.12.1 – Correlations of distance of households (N = 422) from the nearest protected area boundary and crops damaged, income lost, and crops produced in western Serengeti, Tanzania. *Cassava measured in acres. **Cotton measured in kilograms.

Of the crops measured, beans correlated more weakly with distance from a protected area boundary (Pearson $R = -.11$; $p = .023$). One possible explanation for this is that far fewer households planted beans (15%) so the sample size was much less for this crop than for the others. The most strongly correlated crop, on the other hand, was millet (Pearson $R = -.243$; $p < .001$). From Section 2.4 it was shown that elephants were the destructive agent in 87% of raiding events on millet fields, which was higher than for any other crop (Figure 2.4.3). When coupled with the strong correlation between distance and millet damage, these results may suggest that when presented a choice, elephants preferentially raid millet fields over other crops. But it is important to recognize that farmers may preferentially plant millet crops closer to protected areas so as to deter crop raiding on more economically valuable crops, such as maize.

The relationship between the amount of income that households lost due to crop damage and the distance to a protected area mirrored that of the amount of crop destroyed

(Table 2.12.1). Much like the aforementioned results, the amount of income lost was inversely related to the distance that a household was located from a protected area. In other words, the closer a household was to SNP, the more potential revenue was lost due to crop damage.[169] This is possibly because potatoes fetch comparatively low prices and rarely sold in western Serengeti. Since potatoes are infrequently sold, determining loss from this crop was pointless.

Although crop damage and distances from the nearest protected area show significant negative correlations (Table 2.12.1), one might yet wonder why correlations shown are not stronger. The likely explanation is the same as that posited for the lack of statistically significant variability between crop damage and sub-villages (Section 2.11). There, it was shown that while most of a household's agricultural fields may lie adjacent to the actual homestead, others, as mentioned earlier, are often scattered throughout the village. Since this distance analysis was based on the distance of the household to the nearest protected area, some of each household's widely scattered fields actually may be quite farther from, as well as some nearer to, the closest protected area. Had GPS points been taken for each individual field, the correlations between crop damage and distance would likely be stronger.

Perhaps most useful in this analysis is determination of a distance from a protected area at which crop damage decreases to a negligible amount. Such knowledge might allow households to better determine where planting may be most profitable. Because the two primary variables utilized here are continuous, bivariate correlation is the most appropriate statistical method for determining their relationship to one another (Table 2.12.1). However, since correlative strength via a Pearson *R* can be difficult to

[169] All bivariate correlations were significant at the 0.05 confidence level except potatoes.

interpret, however, correlations have been supplemented with ANOVA tests. In this analysis, households were separated into three discrete categories dependent upon how far they were located from the nearest protected area boundary. A bar graph (Figure 2.12.1) and scatter plot (Figure 2.12.2) were made by which the effects of distance are perhaps easier to visualize than correlation values.

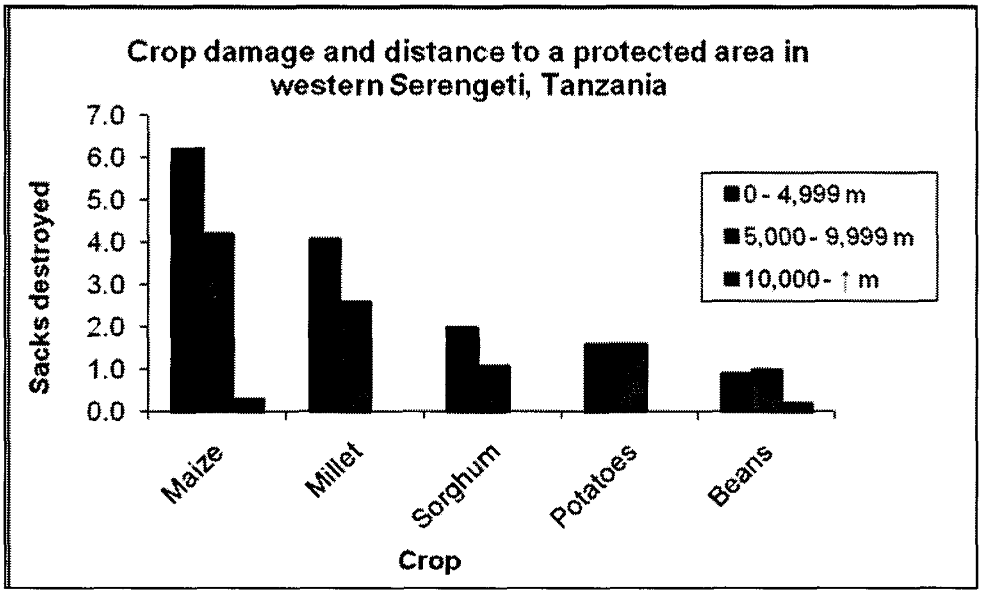

Figure 2.12.1 – Relationship between crop damage for five subsistence crops and distance of households (N = 422) to the nearest protected area boundary in western Serengeti, Tanzania. Results for cotton and cassava are not represented here because these two crops were measured in kilograms and acres, respectively. For results of these, see Appendix B.

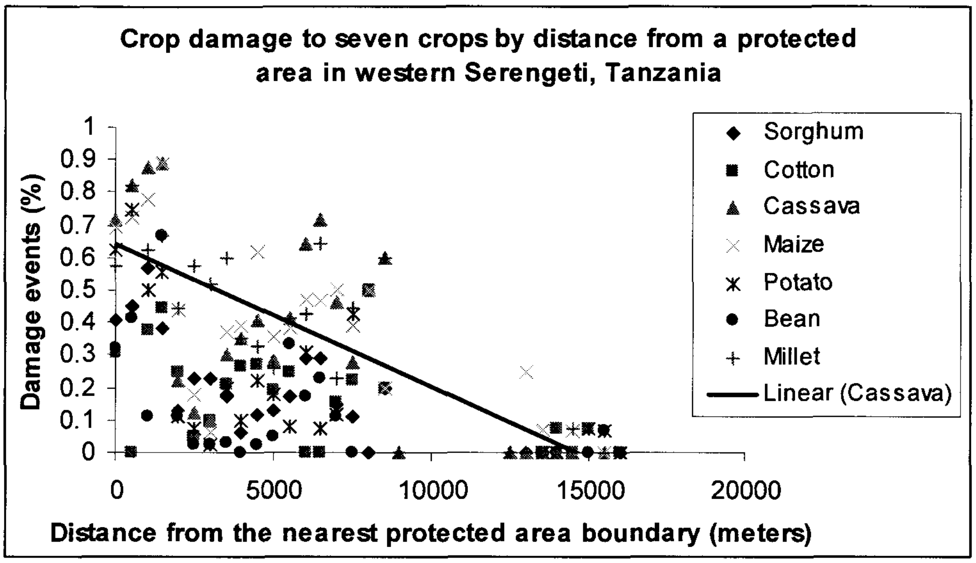

Figure 2.12.2 – Crop damage to seven staple crops according to distance from the nearest protected area boundary for households (N = 422) in Serengeti District, Tanzania. A trendline was included for cassava, to aid in comparison with Figure 2.12.2.

Perhaps the most telling feature revealed in these figures is that crop damage appeared to drop off considerably after 10km. In western Serengeti, a distance of 10km from the nearest protected area boundary appears to act as a sufficient buffer zone by which crop damage no longer exerts significant effects on households. This is shown more clearly in Figure 2.12.3 which shows wildlife damage on cassava.

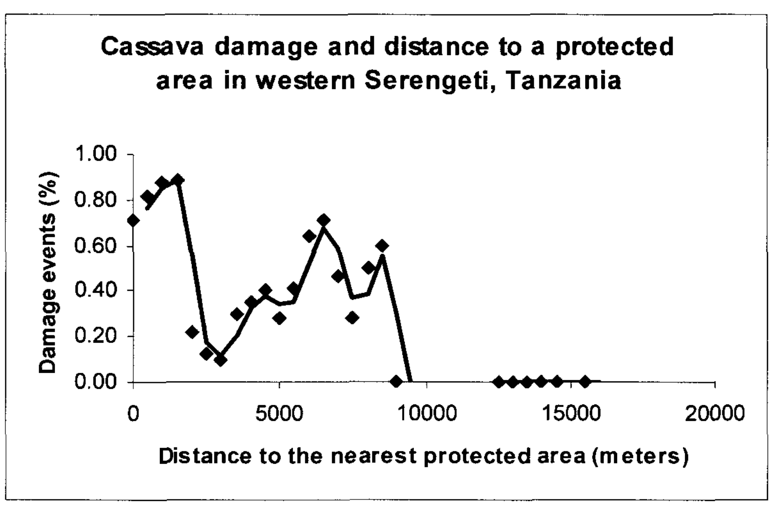

Figure 2.12.3 – Wildlife caused damage on cassava for households (N = 422) in western Serengeti, Tanzania.

A moving average was inserted in Figure 2.12.3 to more clearly illustrate the effects on cassava according to distance. The graph reveals that damage was highest from 0 to 2,000m from a protected area and dropped off completely after 9,000m. Somewhat interestingly, however, is that damage events dropped to a low of 10% around 2,500m before increasing to over 70% around 7,000m. This shows that crop damage and distance from a protected area is a nuanced relationship and likely affected by variables such as vegetation levels and settlement densities (Newmark et al. 1994). As vegetation continues to be cleared for agriculture and more households immigrate closer to SNP's boundaries (Chapter Four), it is likely that this relationship will become more linear and less affected by remnant tracts of natural vegetation.

As previously mentioned, Figure 2.12.3 also showed that crop damage for cassava (and the other staple crops) dips considerably from about 2,500m to 6,000m. As will be discussed in Chapter Four (Section 4.11), households located within this range appeared to maximize park-related benefits and minimize park-related costs.

To test whether levels of crop damage and distance from a protected area boundary was merely a function of cropping patterns, bivariate correlations were used to discern the relationship between distance and the amount of crops that were planted (Table 2.12.2).

Pearson Correlation coefficients between distance to a protected area and crops produced			
Distance to Protected Area *WITH*	Pearson R	p-value	St. Dev.
Sacks produced			
Maize	-.00	.951	7.6
Millet	.02	.758	3.7
Sorghum	-.05	.271	2.4
Potatoes	.10	.045	6.4
Beans	-.05	.276	1.5
Cotton	.01	.842	1256.2
Cassava	.06	.281	21.8

Table 2.12.2 – Pearson bivariate correlations between crops produced and distance from the nearest protected area boundary for households (N = 422) in Serengeti District, Tanzania.

Correlations in Table 2.12.2, reveal that amount of crops produced is not related to the distance of a household to a protected area. Only one crop, potatoes, were produced at significantly greater quantities as distance from a protected area increased (Pearson R = .10, p = .045).

For the sake of comparison, crop production was assigned into the same discrete distance categories that were previously devised for crop damage. Results graphically show that the amounts of crops produced varied insignificantly according to distance from a protected area (Figure 2.12.4).

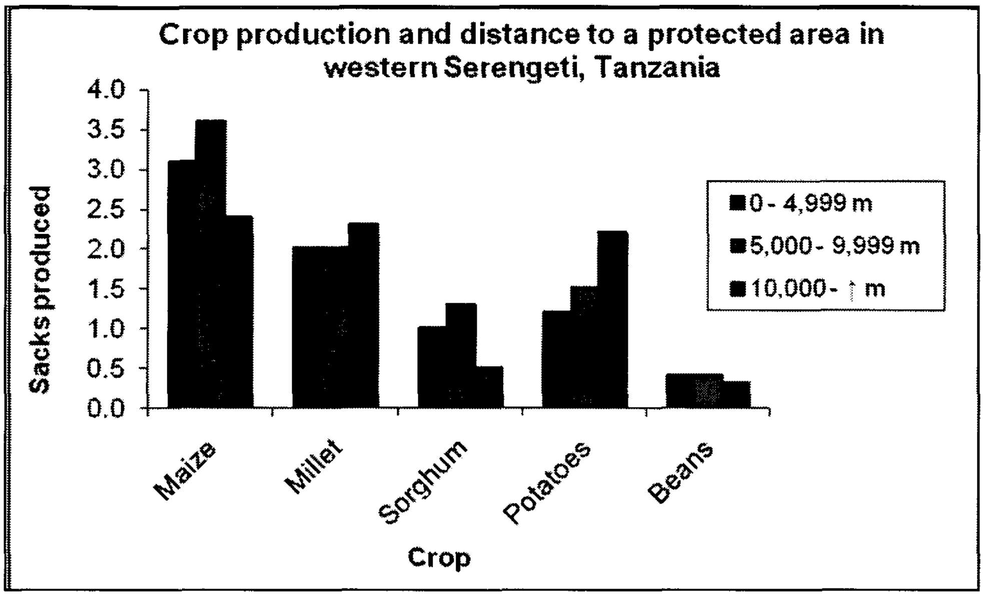

Figure 2.12.4 – The relationship between crop production of five staple crops and distance to a protected area for households (N = 422) in Serengeti District, Tanzania. Cotton and cassava were not included here because they were measured in kilograms and acres, respectively.

As depicted in Figure 2.12.4, households further from a protected area produced less maize and sorghum but more millet and potatoes. The amount of beans produced was roughly the same at all distances from the park. Unlike the stronger relationships found for crop damage and distance, all results for crops produced and distance featured weak correlations (Table 2.12.2) and weak *F*-values and were statistically insignificant.

In summary, household crop production was highly variable but the amount of crops destroyed depended greatly on how far they were from a protected area. In regards to western Serengeti households, this means that households that are closer to SNP suffer greater amounts of crop damage while not gaining appreciably in the amount of crops they are able to produce.

The take-home message is clear: it is unprofitable to farm within 10km SNP or its game reserves. The ramifications that these results have on household resilience to future disturbance will be revisited in Chapter Four (Sections 4.4 & 4.6).[170]

Part II.

2.13 – Wildlife depredation of livestock

Large carnivores and domesticated livestock have coexisted in Africa for millennia (Kolowski & Holekamp 2005). In recent decades, however, such coexistence has been seriously threatened due largely to increased levels of human persecution on carnivores. Much of this persecution is thought to be retaliatory-based, originally caused by actual—or often, perceived—predatory attacks of carnivores on livestock (Nyahongo 2007; Kolowski & Holekamp 2005; Ogada et al. 2003; Rao et al. 2002). Real and perceived retaliation by humans on carnivores has been widely documented on the outside of protected areas or unfenced reserves—like western Serengeti—where the greatest percentage of large carnivore mortality has been caused by people. Often, a high degree of wildlife mortality occurs in regions where reserves are surrounded by high human population densities (Harcourt et al. 2001). For many carnivore species, the net

[170] The relationships just presented between crop damage, crop production, and distance demonstrate a salient point to this discussion – that of the veracity of the questionnaire itself. Survey work relating to crop damage has historically been called into question (Naughton-Treves 1997) due to the supposition that respondents over-report damage in hopes of procuring greater amounts of compensation and/or local infrastructure. The simple fact that the majority of households located further from SNP reported very little—if any—crop damage strongly suggests that respondents did not fictionalize their agricultural portfolios in efforts to gain compensation. If false reporting had occurred, all households would have been expected to report equally large amounts of damage. But as Section 2.12 shows, this was not the case. The logical consistency in this part of the questionnaire lends considerable credence to other parts of the survey, such as wildlife depredation on livestock, or income analyses. It may also demonstrate the added benefits of trust-based, in-depth questionnaire work that is conducted with the help of local village officials.

result is that areas around reserves serve as severe population sinks (Woodroffe & Ginsberg 1998).

Commonly cited reasons for wildlife depredation on livestock include livestock composition and husbandry practices (Rao et al. 2002), prey availability (Polisar et al. 2003) and behavior (Rao et al. 2002), rainfall (Woodroffe & Frank 2005), and distinct characteristics of attacked farms, villages, and livestock enclosures (Ogada et al. 2003).

Regarding husbandry practices, a study by Ogada et al. (2003) asserts that depredation by large carnivores can be effectively mitigated through improvements in livestock husbandry. But the authors tempered these claims with the acknowledgement that livestock husbandry decisions are largely economic ones that depend most heavily on the local costs and benefits that better husbandry practices entail.

The study here picks up precisely where Ogada et al. (2003) stops with the use of a comprehensive examination of the economic costs and benefits of raising livestock in western Serengeti. While the impact of retaliatory killings on large carnivores is important, this question is outside the scope of this study. Rather, analyses here focus on the first part of the posited relationship – that of the wildlife depredation on livestock and the subsequent fiscal losses that these depredation events create. In so doing, this study argues that wildlife depredation on livestock must decrease if the general resilience of the GSE to change (Chapter One – Section 1.17) is to be maintained, or hopefully, enhanced.

The reasons that depredation needs to decrease are twofold. First, as mentioned above, retaliatory killings can—and often do—lead to local extinctions of large predators (Ogada et al. 2003). Second, as the ensuing analysis will show, local people living near protected areas are losing significant amounts of money (Kolowski & Holekamp 2005).

Although this study may appear one-sided through its focus on humans, the effect of reducing wildlife depredation on livestock should ultimately lower the retaliatory-based mortality of large carnivores that often result from their depredations.

Although wildlife-caused livestock mortality is the emphasis here, disease often factors equally—if not more so—in affecting livestock and household wealth (Holmern et al. 2007; Frank et al. 2005). A study by Nyahongo (2007) in western Serengeti, for example, reported that disease trumped wildlife as the primary factor of livestock death by a factor of ten. But wildlife-caused mortality and disease-caused mortality have several important differences. The debilitating effects of disease, for example, can often be softened somewhat because sick animals can be slaughtered for food or sold. Moreover, diseases often affect greater percentages of newborns or calves which result in smaller losses to households (Nyahongo 2007).

Wildlife depredation, on the other hand, usually results in wholesale livestock losses with young and old animals taken indiscriminately. With many wildlife species, the carcasses of livestock are often consumed or deemed otherwise irrecoverable by the household. Further complicating the relationship is the fact that livestock and wildlife can act as reservoirs for disease with resulting depredation events acting as transmission sites (Cleaveland & Dye 1995). Because of this close—and often intertwined—connection between disease and depredation, this study focuses on their combined effects before teasing out their singular effects in turn (Figure 2.13.1).

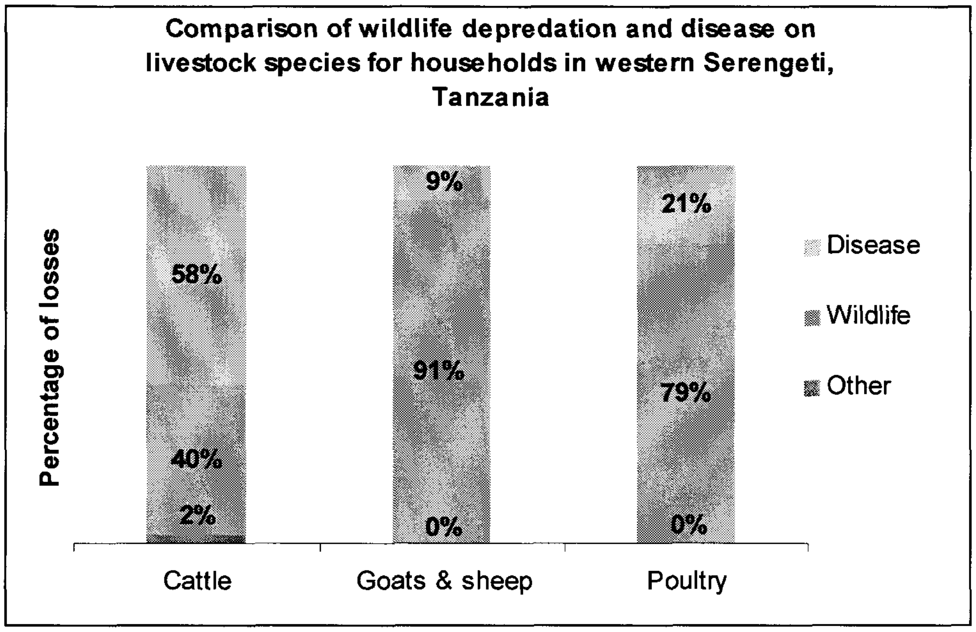

Figure 2.13.1 – Comparison of wildlife depredation and disease on livestock species for households (N = 722) in western Serengeti, Tanzania. The category "other" includes human thievery.

Part II proceeds as follows. First is a general examination of losses exacted on the four major livestock species – cattle (Section 2.14), goats (Section 2.15), sheep (Section 2.15), and poultry (Section 2.16). Mirroring the analysis done for crop damage, the next sections (2.17, 2.18) of this study focus on the varied effects of depredation according to district and the distance of a household to a protected area. Also examined here are the number of livestock owned, household size, and the presence of dogs. These variables are analyzed through both univariate and multivariate approaches. Part II (Section 2.19) concludes with a discussion about the role of dogs—and to lesser extent, cats—in western Serengeti, with speculation concerning their effects on the coupled human-natural GSE.

2.14 – Losses to cattle

Compared to goats, sheep, and poultry, the number of cattle that were lost per household to wildlife or disease is relatively small. When averaged over the total sample

(N = 722), each household lost just 0.4 cattle per year from their herd consisting of 7.1 animals. In contrast, the average number of calves born to a household was 2.2 per year[171]. This means that for households with cattle, the calving rate exceeded the mortality rate by 1.8 animals. In terms of depredation or disease events, 7% of the total sample lost at least one cow in the last year. The magnitude of these losses is heightened by the fact that under half (43%) of all households owned cattle. This means that 16% of households that owned cattle lost at least one cow in the last year.

For the 7% of households across the sample, disease comprised 4% of the annual losses while spotted hyena (*Crocuta Crocuta*) was responsible for 2.8%. The other 0.2% was lost to one episode of cattle raiding by human thieves.[172] Examined alone, the 2.8% of annual losses exacted by hyenas slightly exceeded the range of wildlife depredation events (0.02 – 2.6% of local livestock holdings) taken from a large subset of wildlife depredation studies conducted around the globe (Graham et al. 2005). Viewed apart from the total sample, the 50 reported losses of cattle reveal that disease featured prominently in 58% of the losses compared to 40% for hyena (Figure 2.14.1).

[171] Respondents were asked in two questions to report the number of calves born in the last 12 months, and the last 24 months. Due to the time-consuming nature of these questions, birth of calves was only asked in Serengeti District.

[172] Since the phenomenon of cattle raiding has waned significantly in western Serengeti, this episode was considered anomalous. As a result, it was not discussed in this section.

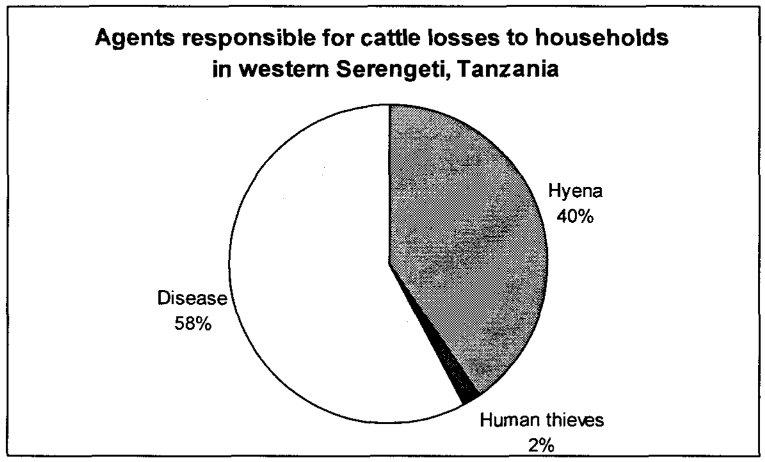

Figure 2.14.1 – Agents responsible for losses of cattle to households (N = 722) in western Serengeti Tanzania.

Of the 7% of households that lost cattle, disease and hyenas each claimed an average of 5.2 cows per household. While average losses were relatively low across the sample, the potential for severe loss existed as one household lost 50 cows when hyenas broke into the corral (or, "boma"), while another household suffered the loss of 25 cattle during an outbreak of disease.

As stated at the beginning of Part II, the monetary losses incurred from disease and wildlife depredation vary widely. Some of the income for sick or enfeebled cattle can be recouped if the cows are slaughtered or sold. But in the case of wildlife depredation, often the afflicted cow is eaten outright by the carnivore or otherwise unrecoverable. This is likely the reason that the average monetary loss for affected households due to disease was TZS 598,573 while that for depredation was TZS 2,655,930. Averaged over the entire sample, households suffered a loss of TZS 25,548 to disease and TZS 77,250 to wildlife. Combined, this amounts to annual losses of TZS 102,798, which exceeds the average cattle earnings (TZS 94,654) by TZS 8,144 (Figure 2.14.1).

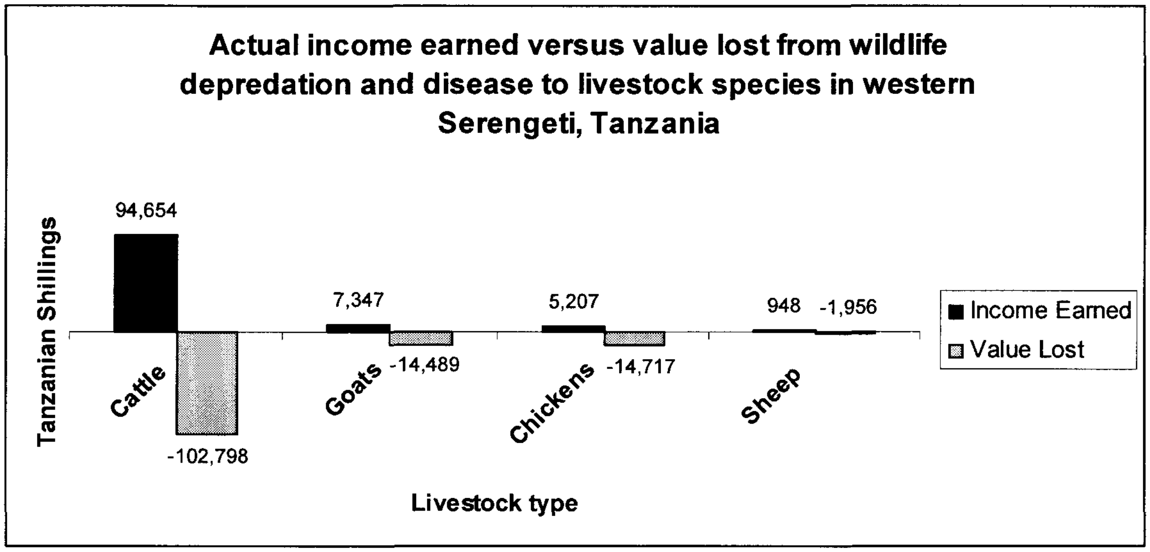

Figure 2.14.1 – Actual income earned compared to potential income lost from wildlife depredation and disease to four common domestic livestock species for households (N = 722) in western Serengeti, Tanzania.

Losses reported here are in line with several other studies of cattle losses in Africa (Holmern et al. 2007; Frank et al. 2005) which report that disease regularly accounts for the largest losses. Here, disease accounted for 4% of annual losses compared to 2.8% for wildlife depredation. This study was inconsistent, however, with recent findings in western Serengeti that reported disease to be approximately ten times higher for households closer to the Serengeti National Park boundary (Nyahongo 2007). Rather, work here suggests that cattle losses due to disease are actually higher further away from the park boundary. A possible reason for these contrasting results may be the unpredictable, more sporadic nature of disease and the dissimilar time frames within which these studies were conducted.

In regards to the prevalence of the spotted hyena, this is also not uncommon for western Serengeti. Nyahongo (2007) reported that 98% of all reported wildlife depredation claims indicted the hyena. Even in the most northern part of the GSE—the

Maasai Mara Game Reserve in Kenya—hyenas accounted for over half (53%) of 130 documented events between the years 2003-04 (Kolowski & Holekamp 2005). In addition to being the most numerous carnivore species in the Serengeti (Mill & Hofer 1998), hyenas are particularly troublesome for western Serengeti households due to their capability for long-distance commuting. In a singular nocturnal raid, a hyena—or often, several hyenas—can leave the confines of a protected area, dig through or under a thorn-laden corral, kill livestock, and return back to the protected area by dawn. This ability makes the species particularly adaptable to anthropogenic environments.

2.15 – Losses of goats & sheep

The percentage of households that lost at least one goat to disease and/or wildlife depredation was 14%, which was double the percentage of households that lost at least one cow. In light of the fact that about half (49%) of all households owned goats, this meant that 29% of all households that owned goats lost at least one in the last year. Higher numbers of depredation events on smaller stock are further reflected by the fact that over the entire sample, each household lost an average of 1.0 goat compared to 0.4 cow. Such a trend is not a function of households owning more goats than cattle in western Serengeti because households actually owned more cattle (7.1) than goats (4.7).[173] A more likely scenario may be that large carnivores preferentially prey on smaller stock.

This latter explanation is supported by several studies suggesting that carnivores such as hyenas mainly target goats and sheep (Nyahongo 2007; Mills & Hofer 1998).

[173] Although households owned more cattle than goats, a slightly higher percentage of households owned at least one goat (346/715) (48%) than did those that owned at least one cow (318/721) (44%).

Yet it may also be that western Serengeti herders are more vigilant and implement better husbandry practices with cattle than with smaller stock. This may stem from the fact that smaller stock are worth considerably less than cattle and therefore merit less custodianship. Several times in the field, for example, herds of smaller stock were observed without any herder in sight. In contrast, no herds of cattle were ever observed without at least one attendant herder. While research here cannot lend particular support for either of these explanations, it is likely that both of them are at least partly responsible for the much higher losses incurred to goats than cattle.

Another considerable difference between goat and cattle losses regards the agent causing the loss. For cattle, disease accounted for the greatest percentage of loss (58%) followed by wildlife depredation (40%). In the case of goats, however, disease accounted for just 9% of the losses compared to wildlife depredation, which contributed 91% of the depredation events (Figure 2.15.1).

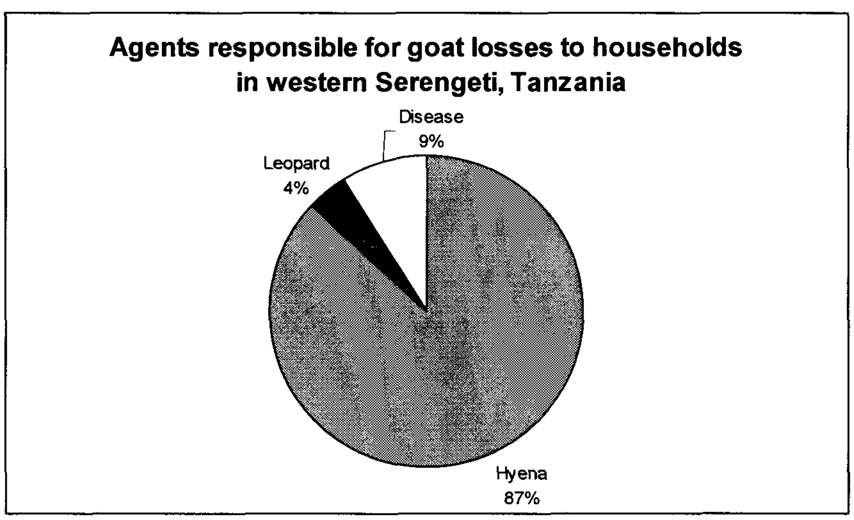

Figure 2.15.1 – Agents responsible for losses to goats for households (N = 722) in western Serengeti, Tanzania.

The amount of potential income lost is in line with these figures. Each household lost TZS 982 to disease while losing nearly 13 times that amount to wildlife (TZS 13,507). Combined, this amounted to TZS 14,759 of lost potential revenue which doubled the amount earned in the past year from goat sales (TZS 7,347) (Figure 2.14.1). Although the income lost to disease seems small when averaged over the entire sample, it exacted considerable tolls on households where it did occur. Households affected by disease lost an average of TZS 94,719 compared to TZS 103,157 for hyena losses. The margin of difference (TZS 8,436) is much smaller than the presented difference margin for cattle (TZS 51,902). The large gap between these margins of difference may be because households are less willing to slaughter or sell the meat of affected goats than they are for cattle. In the case of smaller stock, the risk of eating infected meat may not be worth the monetary loss incurred.

In regards to the households that suffered actual losses, hyena and disease claimed equivalent numbers of goats with averages of 7.2 and 7.1, respectively. Leopard (*Panthera pardus*), on the other hand, was reported in just 4% of the incidents (Figure 2.15.1) and took just an average of just 2.8 goats during each raid. Results here align with a recent study done in the northern part of the GSE that reported that while hyenas attacked cattle and goats indiscriminately, leopards never attacked cattle, instead focusing on smaller stock (Kolowski & Holekamp 2005).

Much like the case of cattle and goats, households lost more potential income (TZS 1,956) from losses of sheep than they earned from sales (TZS 948). These numbers are lower than those presented for goats because households owned an average of 0.9 sheep compared to 4.7 goats. Of the 0.9 sheep owned, households lost 0.2. In other words, households lost 22% of their sheep flock each year. In terms of actual depredation events, approximately one-fifth (19%) of all households reported losing at least one sheep in the last year. Unlike that of cattle and goats, however, all losses of sheep were incurred by hyenas.

Across the entire sample, 3% of households lost at least one sheep to hyenas. For that 3%, hyenas took an average of 7.3 sheep. Due to the relatively low level of sheep ownership in western Serengeti, further discussion is limited here. But lest the matter seem trivial, it is worth bearing in mind that over the course of a year, one household suffered the losses of 50 sheep to hyenas. Recalling that a sheep can be sold for an average price of TZS 10,942 (Chapter One – Section 1.32), this amounted to TZS 547,100, indicating a catastrophic loss for the household.

2.16 – Losses of poultry

The average household in western Serengeti owned 7.1 adult chickens[174] and reported losses of 3.9 in the past year. Across the entire sample, therefore, households lost over half (55%) of their chicken holdings to wildlife or disease in one year. This translated to roughly two-fifths (38%) of all households that owned chickens losing at least one in the last year. Due to such a high level of loss, potential income lost (TZS 14,717) exceeded that which was earned (TZS 5,207) by nearly three times (Figure 2.14.1).

In addition to being a major loss of potential income, the loss of 3.9 chickens per year is also a significant loss of protein. On average, households slaughtered 3.4

[174] Free-ranging chickens account for most of the 27.8 million poultry in Tanzania (MOA 1995). A small percentage of households also owned ducks. Due to relative rarity of duck ownership, however, ducks and chickens were considered equivalent in value. References to chickens here, therefore, also include ducks.

chickens per year. In contrast to the livestock species already discussed, households slaughtered an average of just 0.6 goat, 0.1 sheep, and 0.1 cow. The loss of nearly 4 chickens per year, therefore, implies that households are losing one of their most heavily consumed protein sources. The loss of adult chickens is compounded, of course, by the loss of eggs. Eggs constituted one of the nine most commonly reported protein sources as households consumed four servings of eggs[175] over two times per month (Chapter Three, Section 3.10).

In sharp contrast to the other livestock mentioned, the agents responsible for poultry losses were far more numerous and diverse. Twelve different wildlife species were implicated in losses and together accounted for four-fifths (79%) of all the depredation events. Disease accounted for the other losses (21%) and there was one reported instance of human thievery.[176] The heavier toll that wildlife exacted over disease is further reflected in the potential income lost versus actual income generated in the last year. Of the total income lost (TZS 14,717), households lost TZS 11,033 to wildlife and TZS 3,685 to disease (Figure 2.14.1).

As expected, smaller carnivores composed greater percentages of the losses than did larger carnivores (Figure 2.16.1).

[175] In the survey, four servings is equivalent to eating eggs two times (breakfast and lunch) per month.
[176] Since human thievery constituted just 0.4% of the losses to poultry, it was deemed anomalous and not considered in this analysis.

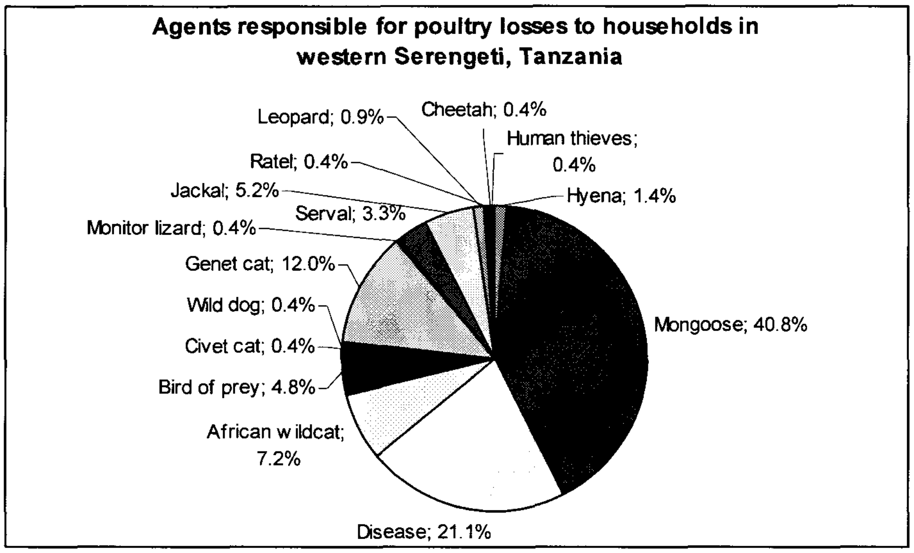

Figure 2.16.1 – Agents responsible for poultry losses to households (N = 722) in western Serengeti, Tanzania

The species reported most frequently was the mongoose, of which six species are known to prey on chickens in western Serengeti. The species most likely responsible for the most attacks is the slender mongoose (*Galerella sanguinea*), which was sighted frequently in and around villages during the 14 months of fieldwork. The slender mongoose adapts readily to semi-vegetated villages as it is a diurnal and solitary predator that is equally suited to subterranean or arboreal environments (Martinoli et al. 2006). Since most households let their chickens roam unenclosed around the homestead during the daytime hours, they become relatively easy prey for mongoose. In fact, on two separate occasions during the course of a two-hour household interview, mongoose caught and killed an adult chicken. These predation events plainly demonstrated that chickens are lost diurnally as they forage around the homestead.

Although chickens are normally kept inside an earthen-walled and roofed enclosure at night, they are still susceptible at night if enclosures were not properly built or are in disrepair. After mongoose and disease, genet cats (*Genetta genetta*), which are normally nocturnal, were the third most implicated species constituting 12% of all depredations. Another nocturnal predator, the African wildcat (*Felis silvestris*) constituted the fourth largest percentage of depredations (7%). Other nocturnal predators of poultry included: jackal[177] (5%), serval (*Leptailurus serval*) (3%), hyena (1%), leopard (1%), honey badger (*Mellivora capensis*) (0.4%), wild dog (*Lycaon pictus*) (0.4%), and civet cat (*Civettictis civetta*) (0.4%). Other diurnal predators included cheetah (*Acionyx jubatus*, 0.4%), and monitor lizard (*Varanus sp.*) (0.4%).

The only reported wildlife not yet mentioned are birds of prey, or raptors. Raptors were responsible for 5% of reported depredations.[178] The most frequently sighted raptor during fieldwork was the black kite (*Milvus migrans*), which is habituated to human settlements and features prominently in poultry predation throughout Sub-Saharan Africa (Sorley & Andersen 1994; Brandl et al. 1985). The ubiquity of the black kite, slender mongoose, and assortment of nocturnal predators combine to create considerable challenges for households interested in increasing the scale of poultry production.

In developing countries throughout the world, disease ranks as the primary production constraint to local free-ranging chickens (Sonaiya 1990). In western Serengeti, however, disease accounted for just one-fifth of all poultry losses (Figure 2.16.1). This discrepancy is likely due to the presence of SNP, which acts as a refuge for many of the aforementioned predators. Although more attention should be paid to

---

[177] The most likely species of jackal responsible for depredations on poultry are black-backed (*Canis mesomelas*) which are common in agricultural areas (Martinoli et al. 2006). Also possible in western Serengeti are side-striped jackals(*Canis adustus*).

[178] When asked, respondents often gave local names for specific raptor species that had preyed upon their chickens. But respondents rarely knew Swahili names of specific raptors, so they are not listed here. With many raptors, however, specific nomenclature does not exist in Swahili.

curbing wildlife depredation, development projects that alleviate disease—specifically Newcastle disease and Fowl typhoid (Musharaf 1990; Minga et al. 1989)—would undoubtedly increase poultry survivorship and enhance local holdings. Another possible option for increasing survivorship would be selecting more disease-resistant poultry breeds (Msoffe et al. 2002).

Conventional wisdom would suggest that keeping normally free-ranging chickens enclosed by day and provisioning them with commercial maize-based feed would reduce the number lost during the daytime hours. While the logic for implementing such a practice is sound, the acquisition of feed for chickens is not economically feasible for many cash-strapped households. Likewise, logic would suggest that improved nighttime enclosures might be constructed to better safeguard poultry. Again, households often cannot afford the materials necessary for even modest improvements (e.g., cement, brick, tin). Although such improvements are currently difficult for households to implement, better poultry-raising practices remains a potentially workable solution for provisioning households with much needed protein at a minimal cost (Msoffe et al. 2002) and reducing human-wildlife conflict in western Serengeti.

The greatest possibility for minimizing poultry losses, however, may be focusing efforts on newly hatched chicks. In addition to adult chicken reporting, respondents were also asked to report the losses of chicks, defined as chickens not yet capable of egg-laying. Not surprisingly, households lost a higher average of chicks (4.1) than adult chickens (3.9). When these losses were compared to the number presently owned, losses to chicks equaled 93% compared to 55% for adult chickens. Households were so accustomed to losing chicks, in fact, that many respondents could not recall how many had been lost in the last year, or even the last month. Like the case with adult chickens, mongoose were the most implicated species (52%) followed by birds of prey (19%), African wildcat (12%), and disease (9%).

While the loss of chicks may seem almost trivial, each loss represents a potential source of much-needed protein and income otherwise difficult for households to currently procure. An average adult chicken sells for TZS 2,940, roughly equivalent to a day's wages for seasonal employment such as weeding agricultural fields or harvesting crops. In Chapter Four (Section 4.21), this study argues that improving husbandry practices for chicks may serve as a more cost-effective and easy-to-implement means of minimizing poultry losses and safeguarding valuable protein and income sources.

2.17 – Livestock loss by district

Livestock loss at the district level mirrored the results observed for crop damage (Part I). Households in Serengeti District suffered significantly higher losses of cattle, goats and poultry than did the households sampled in Bunda or Meatu districts (Figure 2.17.1).

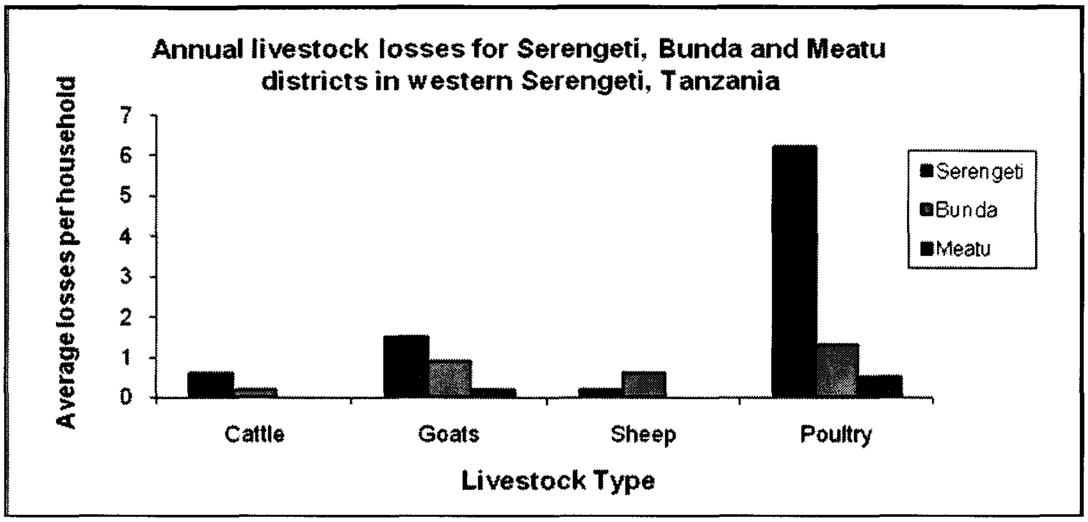

Figure 2.17.1 – Number of livestock loss for cattle, goats, sheep, and poultry to households (N = 722) in western Serengeti, Tanzania.

Households in Serengeti District, for example, reported losing 0.6 cattle in the last year compared to 0.2 and 0.0 for Bunda and Meatu, respectively ($F = 4.28$, df = 2, $p = .014$). For goats, households lost 1.5 in Serengeti compared to 0.9 in Bunda, and 0.2 in Meatu ($F = 6.01$, df = 2, $p = .003$).[179] The greatest differences observed for poultry loss for the average household in Serengeti were 6.2, compared to 1.3 for Bunda, and 0.5 for Meatu ($F = 28.30$, df = 2, $p < .001$).

The principle reason behind the higher livestock losses in Serengeti District is likely the same as that put forth for crop damage, namely that Serengeti remains more lightly settled than the other two districts and therefore, has a softer edge between the human settlements and the adjoining protected areas. Although Serengeti District's edge is rapidly becoming more defined, the existence of vegetated corridors and greater density of extant natural vegetation in the district may allow larger carnivores to travel undetected from protected lands to livestock corrals. By contrast, a large carnivore in

[179] Differences for sheep did not follow the pattern described above as households lost more sheep in Bunda (0.6) than did those in Serengeti (0.2) and Meatu (0.0). But this finding was not significant at the .05 confidence level ($F = 2.73$, df = 2, $p = .066$)

Meatu District has to cross many agricultural fields largely devoid of natural vegetation in order to access livestock. In Bunda District, the presence of the Grumeti River likely provides the greatest obstacle for large carnivores wishing to prey on livestock.

2.18 – Livestock loss by distance from a protected area

The effects that distance from a protected area has on wildlife depredation and disease were minor and statistically insignificant. Furthermore, in the case of poultry, the number of losses actually increased as distance from protected areas increased (Table 2.18.1).

Distance to Protected Area *WITH*	Pearson *R*	*p*-value
Individual animals lost		
Cattle	.04	.442
Goats	-.02	.665
Sheep	.04	.379
Poultry	.04	.043
Dogs	-.101	.042
Cats	.061	.224

Table 2.18.1 – Pearson bivariate correlations for livestock (cattle, goats, sheep, poultry) and domestic dogs and cats with distance of households (N = 422) from the nearest protected area boundary in western Serengeti, Tanzania.

Results here differed significantly from those concerning crop damage. Crop damage to six of the seven common crops was negatively correlated with distance from a protected area (Section 2.12). Here, however, the most likely reason for the lack of a relationship between livestock loss and distance is attributable to the simple fact that livestock are mobile while crops are not. Households located nearest to protected areas, for example, may graze their herds at other locations, farther from carnivore populations. A study by Rao et al. (2002) showed that the greatest number of livestock killings occurred when animals grazed away from dwellings. Also, as already noted (Section

2.14), heavily implicated species such as hyena are capable of long nightly commutes between protected areas and human habitations. Such a tendency may explain why the relationship between hyena depredation and distance to cover has generally been documented as weak (Ogada et al. 2003).

Yet another possible explanation involves the vegetation that characterizes western Serengeti and particularly, Serengeti District. Although vegetation studies outside protected areas in Tanzania are few (Pelkey et al. 2000), personal observations revealed that in Serengeti district, the density and type of vegetation varies considerably between villages. Unlike other districts, Serengeti has been more recently settled and land for settlement is still available—albeit in significantly lesser degrees—to immigrants (Chapter Four – Section 4.16). These remaining vacant parcels may be acting as corridors for wildlife which may be using them to access livestock that is less vigilantly guarded at greater distances from SNP. It may also be that typical predators of poultry are smaller than those of goats and cattle and more able to live in Serengeti District's remaining tracts of vegetation around villages. Vegetation requirements of larger predators are likely greater.

While high disease transmission often occurs at interfaces between human and natural areas (Cleaveland et al. 2000; Kock et al. 1999), outbreaks of disease remain highly unpredictable. Since disease can be transmitted by domestic (e.g., other livestock) as well as natural vectors (e.g., wildebeest), it is of little surprise that no relationship was found between disease-caused mortality and the distance from a protected area. Other explanations, however, might include the relatively small sample size,[180] small

[180] The sample size included 422 households. Less than half of these households, however, owned livestock.

geographic area,[181] and limited time scale of the research. Had livestock losses been documented at a greater distance than 18 kilometers from a protected area, or covered a larger area, significant patterns may have emerged. Likewise, had the study examined ten years of a household's livestock losses rather than one, trends in disease-caused mortality might have emerged. The propensity for disease to arise unpredictably is likely responsible for the lack of relationship seen here.

In addition to the aforementioned factors, the ubiquity of small carnivores may also obfuscate the relationship between livestock losses and distance from protected areas. Although this only applies to poultry loss, wildlife species such as mongoose, genet cats, and the various birds of prey are not as dependent on large tracts of unbroken natural areas that are characteristic of protected areas. Many species, such as the black kite, have habituated to human settlements and may even preferentially prey on domestic species that are easier to catch than wild prey (Sorley & Andersen 1994). Such characteristics likely explain why losses to poultry increased significantly as the distance from a protected increased (Pearson $R = .099$, $p = .043$).

2.19 – Losses of domestic dogs & cats

Wildlife depredation on dogs presents a paradox for households in western Serengeti. In other parts of rural Sub-Saharan Africa, households keep dogs specifically to deter large carnivores from preying on their livestock (Kolowolski & Holekamp 2005; Ogada et al. 2003; Rao et al. 2002). It is somewhat ironic, therefore, that dogs themselves oftentimes become prey and may even serve as attractants for larger wildlife species.

[181] Household surveys were conducted from 0 to 18km from the nearest protected area boundary.

Nearly one-fifth (18%) of all households reported losing at least one dog to wildlife in the last year. Across the sample, this translates to a loss of 0.3 dogs per household. Like cattle, goats, and sheep, dogs were preyed on primarily by hyena (84%) which claimed an average of two dogs per raid and disease (8%) (Figure 2.19.1).

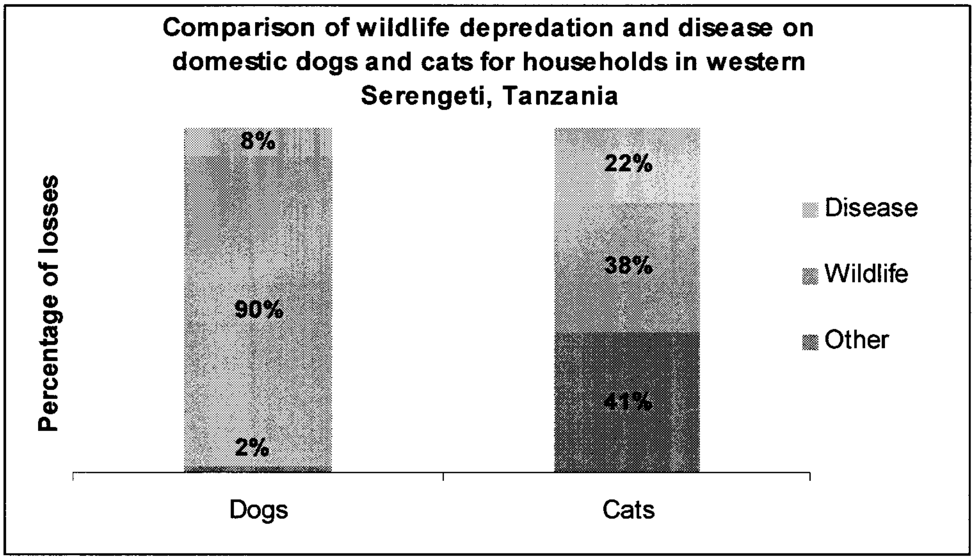

Figure 2.19.1 – Comparison of wildlife depredation and disease on domestic dogs and cats for households (N = 722) in western Serengeti, Tanzania. "Other" for dogs included car accidents, other dogs, and human thieves. "Other" for cats included car accidents, human thieves, and cats that went missing for unknown reasons.

Anecdotally, respondents reported that the main reasons that dogs are kept are to guard livestock from wildlife and human thieves, clean up garbage around homesteads, and hunting (Chapter Three – Section 3.5). Dogs are not kept to fend off wildlife but rather, to warn household occupants of the presence of wildlife. While the presence of dogs in other studies correlated with lower incidences of wildlife depredation (Kolowski & Holekamp 2005; Ogada et al. 2003), there was no relationship in the research conducted here. This study suggests that rather than providing a safeguard against wildlife, dogs in western Serengeti may in fact be attracting wildlife to settlements. But this possibility needs further investigation.

While dogs are ostensibly kept to minimize livestock loss, cats are kept to minimize crop loss, which are often stored in "garas" close to the homestead. In general, ownership of cats was lower than dogs in western Serengeti. Across the sample, households owned an average of 0.6 cats compared to 1.0 dogs.

For the 5% of households which lost cats in the previous year, the primary responsible agents were disease (22%), and hyena (16%).[182] Although this study did not examine the value of cat ownership through rodent control, several informants asserted that cats provide a considerable level of crop protection. Much like the argument for improving poultry-rearing practices, development projects that increase cat ownership could potentially safeguard stored crops and ultimately make households more food secure (Chapter Four – Section 4.21). Moreover, the small percentage of households that lost cats coupled with the fact that just 16% percent were taken by hyena may imply that cats are less likely than dogs to attract wildlife species to homesteads as a potential food source.

Part III.

2.20 – Benefits from Serengeti National Park

The first two parts of this chapter (I & II) have dealt with two common impacts that Serengeti National Park and its affiliated protected areas exert on western Serengeti households near its boundaries. Due to the nature of these impacts (crop damage & wildlife depredation), much of the resultant discussion has focused on the costs—or, disadvantages—that households accrue due to these forces. But living near SNP may have benefits, too. Benefits can come in the form of better infrastructure, better

[182] Twenty-five percent of cats had an unknown cause of mortality.

educational and employment opportunities, greater access to healthcare, and a suite of illegal benefits which include poaching, fishing, and resource collection. Of the aforementioned list, however, and notwithstanding the illegal activities (Chapter Three), perhaps the greatest potential advantage of living close to SNP is the opportunity for employment.

Hypothetically, advantages such as better infrastructure, education, and healthcare should be significant for western Serengeti households. Part of SNP's annual budget, for example, includes a community development program which aims to benefit villages living close to the park's boundaries. The theory behind the program is that benefits which are given to households living closer to the park will help offset some of the costs incurred from wildlife (Parts I & II).

While the park's policy is well-intentioned, very little money actually returns to the villages. Between the years 1990-1991, for example, Emerton and Mfunda (1999) reported that the benefits per household for schools, roads and dispensaries amounted to only $2.50 (USD) per year. On the flipside, an assessment of annual reports for SNP revealed that tourism earned the park approximately $31 million (USD) between the years 1992-1999. Of this, a sum of only $0.5 million (USD) trickled down to the local communities in the form of supporting social services to be split among all districts bordering the park (ibid).

Incidentally, this amount is much lower than the residents on the eastern side of Serengeti have received. On the eastern side, the Maasai Pastoral Council receives 10% of the annual Ngorongoro Conservation Area Authority (hereafter, NCAA) budget (Charnley 2005). This revenue—the equivalent of $550,000 (USD)—is divided between the 52,000 residents, (MNRT and NCAA 2001). Assuming approximately seven members per household, households in eastern Serengeti receive approximately $74 (USD), which is much higher than that recorded in western Serengeti. The point here is not to compare Serengeti's eastern and western sides, but rather, to argue that households have historically not benefited sufficiently through government-commissioned community development. Until this changes, and because so little revenue has trickled back directly or indirectly to western Serengeti households, this study argues that the only tangible benefits are those that come through employment of western Serengeti people.

2.21 – Park-related employment

As was made clear in Chapter One, viewing the western Serengeti economy as strictly composed of agriculture and livestock is inherently flawed. Rather, western Serengeti households are earning an increasing share of their income from nonfarm employment. In developing countries across the world, rural nonfarm income constitutes up to 40% of a household's annual budget (Reardon et al. 2006). Furthermore, rural nonfarm income far exceeds income generated through agricultural wage-labor by a factor of 20:1 in countries across Africa (Reardon et al. 2001).

Although all forms of nonfarm employment are valuable for enhancing the resilience of households in western Serengeti to disturbance, the form most pertinent to this discussion concerns employment specifically related to SNP and its affiliated tourism venues. This includes park personnel (e.g., park rangers, accountants, shopkeepers, etc.), lodge personnel (e.g., managers, cooks, etc.), and tour operators (e.g., tour guides, drivers, etc.).

In short, focus is made here on all employment varieties that depend in some way on Serengeti National Park. In the following discussion, all employment relating to SNP is dubbed "park-related employment" (Figure 2.23.1).

Park-related employment is given priority here for the sole theoretical reason that local persons employed by SNP will have greater incentive to protect the system that provides their livelihood. This is a common theoretical tenet of a growing industry called "ecotourism" which seeks to promote livelihood alternatives that improve human well-being while simultaneously reducing overexploitation of forest products and other natural resources (DeFries et al. 2007). Terborgh and Van Schaik (2002) have called this "the greatest conservation challenge for the coming decades."

The analysis to follow seeks to examine the effect of ecotourism on western Serengeti through four interrelated angles. First, a general description of employment will be presented for western Serengeti. Second, using the subset survey results, qualitative comparisons will be made between households with park-related employment and those without. The third section will include an analysis of common obstacles that may be preventing households from accessing park-related employment. Lastly, two "win-win" ecotourism scenarios are discussed with implications for western Serengeti.

2.21 – Park-related employment in western Serengeti

One-eighth of all households in western Serengeti had some form of year-round employment. Despite such a small percentage, average earnings (TZS 61,729) made year-round employment the third highest income source ranking behind agricultural sales (TZS 167,751) and livestock sales (TZS 71,400) when averaged over the entire sample

(Chapter One). Park-related employment, on the other hand, is embedded within general employment and was reported for only 6% of all households. Interestingly, park-related employment was only reported in Serengeti District, where it comprised 10% of all households. No households were currently involved in park-related employment in Bunda or Meatu districts ($X^2 = 32.690$, df = 2, $p < .001$, N = 679).

Park-related employment was strongly correlated with households that reported having received some form of benefit from SNP (Pearson $R = .376$, $p < .001$). As a result, a greater percentage of households in Serengeti District reported benefits from SNP than the other two districts. More than two-fifths of Serengeti District households reported that they benefitted compared to one-third of Bunda households and under one-tenth of Meatu households ($X^2 = 77.935$, df = 2, $p < .001$). Although seemingly minor, this is important as it supports the idea that households with park-related employment are more likely to have positive feelings toward SNP. Ecotourism theory predicts that individuals with more positive feelings toward protected areas will be more likely to protect them (Charnley 2005).

The subset survey examined the components of park-related employment more closely. Keeping in mind that results here are from a judgment sampling approach (Section 2.2) and respondents chosen based on their availability and willingness to divulge sensitive information, several noteworthy items emerge. Average ages of male and female respondents on the subset questionnaire were 35 and 28, respectively. Ages here were approximately ten years younger than their male ($F = 12.694$, df = 1, $p < .001$) and female ($F = 9.387$, df = 1, $p < .001$) counterparts from the primary sample.

Respondents had been employed in some capacity with the park (or protected area) for 7.2 years and three-fifths of the sample was male. Household sizes were similar for both samples ranging between 7.7 and 7.9 members. The average number of children per respondent was 1.7 which is well below that of households from the primary sample that averaged 4.9 per respondent. Although fewer offspring may be a result of the lower average age of respondent, it could also indicate of the commonly observed trend by which more developed households (e.g., those with nonfarm income) choose to have fewer children. If such conjecture is true, then increasing year-round employment opportunities might be a useful strategy to slow the rampant population growth in western Serengeti (Chapter Four – Section 4.16).

2.23 – Park-related employment and the household economy

The logical starting point for a discussion concerning the effects of park-related employment on the household economy is the income that such work provides (Sherbinin 2008). Employment venues that generated the greatest income were government jobs associated with Tanzanian National Parks (TANAPA) (Figure 2.23.1).

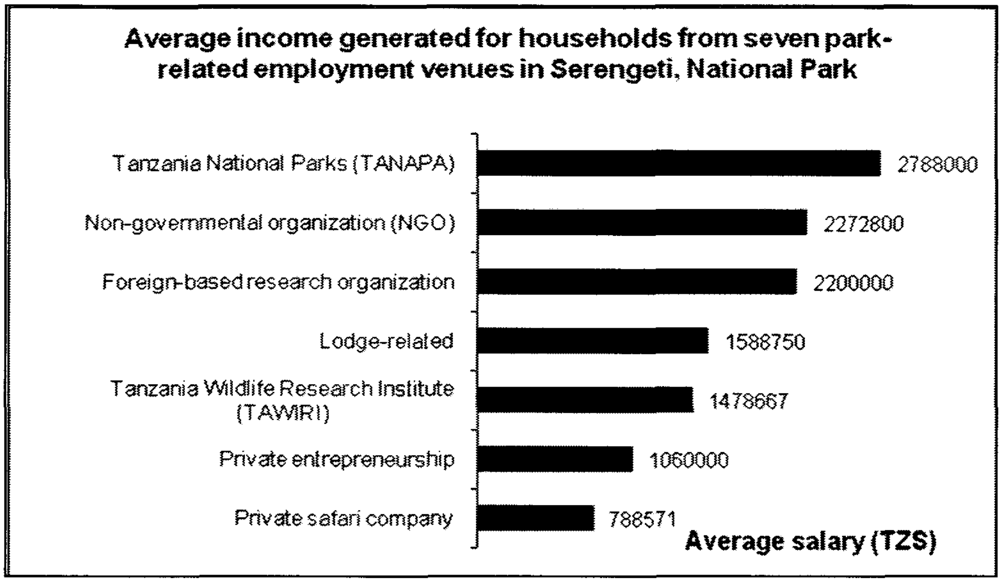

Figure 2.23.1 – Average income generated for households (N = 47) from seven park-related employment venues in Serengeti National Park in 2007 ($F = 2.895$, df = 6, $p = .019$).

By contrast, the lowest wage earners were those working for a private safari company. That said, average incomes for all respondents with park-related employment were higher than the average income from respondents from the primary sample.

The subset survey showed average income of the employed respondents to be TZS 1,722,426.[183] This was over one million shillings greater than the sum of the all of the income sources combined from the primary survey. When the primary sample's sum of total income sources was divided by the adult equivalent value (6.46) (Chapter One – Section 1.9), the total earned amounted to TZS 57,483 annually per person. This fell below Tanzania's national poverty line for rural areas in 2001 (TZS 61,284) and is likely even further below it now (NBS 2002). When the employed respondents' total income (TZS 1,722,426) is divided by the same adult equivalent value, however, the total is TZS

[183] This value included the sum of earning from livestock sales, agricultural sales, and year-round park-related employment. Beer sales, trade, and remittances received were not included on the subset survey as they are believed to be negligible for employed households.

266,629, which is well above the poverty line. This simple fact cogently demonstrates the ability of park-related employment to lift entire households out of poverty.

2.24 – Remittances from park-related employment

In addition to lifting households out of poverty, employment income is often able to keep relatives and friends out of extreme poverty as well. Nine-tenths of the subset sample reported giving some portion of their income to other people. Over two-thirds (70%) of the respondents provided part of their income to their parents while one-third (34%) provided monetary assistance to their siblings.

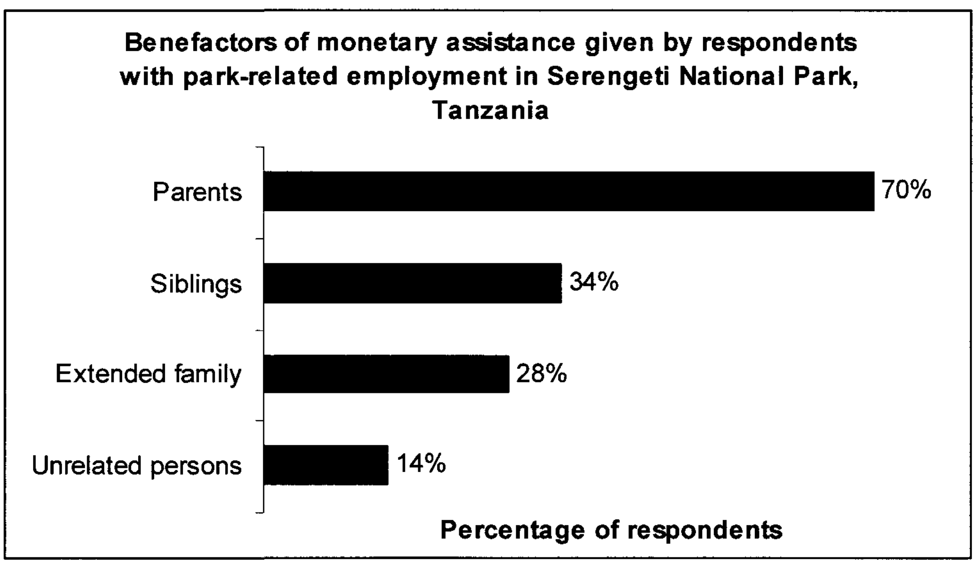

Figure 2.24.1 – Benefactors of remittances given by households (N = 50) with park-related employment in Serengeti National Park, Tanzania. Categories were not mutually exclusive.

Over one-quarter (28%) gave money to extended family members and 14% gave to unrelated persons who they deemed "needy." For the 90% of respondents that gave portions of their income away, 60% did so for assistance in acquiring "basic necessities" such as food. Another tenth gave assistance for helping friends or relatives overcome hardship brought on by sickness. In regards to assisting parents, employed respondents gave TZS 182,800 over the course of the preceding year, which was higher than the average income earned from agricultural sales. To all other parties, respondents disbursed an average sum of TZS 291,160, which was more than half of the total income earned by the core sample.

In a region where most people live on little more than TZS 361 per day (NBS 2002), supplementary "gifts" from employed persons may provide the extra income needed to get through an average year. Or, in the case of a perturbation (e.g., drought, livestock disease epidemic, personal sickness, etc.), outside gifts may allow affected households to cope—or buffer—adverse effects through difficult years. Remittances to parents are especially critical in a country like Tanzania where social security programs are nonexistent. Elderly parents who no longer have the physical strength to farm or herd livestock are often entirely dependent on remittances from offspring.

The importance of remittances is underscored by the fact that 8% (59 households) of the primary sample reported that they had generated zero income in the past year. While some of these households likely subsisted on past savings and/or stored crops, others claimed that they subsisted almost entirely on remittances provided by relatives. Lastly, remittances may function to foster bridging (vertical) and bonding (horizontal) ties among households which can augment adaptive capacity in difficult circumstances (Adger and Kwon 2002). Bridging ties may be fostered when money is disbursed to external relations. Bonding ties, on the other hand, may be enhanced when money is shared more internally among more closely related households.

In addition to helping households of friends and relatives subsist through the present, remittances from employed individuals may also increase the chances of offspring and siblings to obtain their own respective income generating opportunities. As will be made clear in a subsequent section (Section 2.28), limited education is the primary obstacle that prevents local people living around parks from procuring employment. In the case of employed individuals and their dependents, however, educational limitations may be more readily circumvented. Nearly one-third (32%) of respondents provided an average of TZS 225,395 to dependents or siblings to assist them with fees associated with secondary school. Since 98% of Tanzania's citizens lack secondary education (the equivalent of high school in the U.S.) (NBS 2002), completion of secondary school often guarantees future employment opportunities (E. Makoye pers. comm.). Although speculative, it is easy to envision how households with park-related employment may spawn subsequent generations that are likewise enabled to attain park-related employment due to the education opportunities that they once received.

2.25 – Expenditures

An examination of expenditures revealed that the subset sample spent an amount which was double that of primary sample ($F = 30.077$, df = 1, $p < .001$) (Figure 2.25.1).

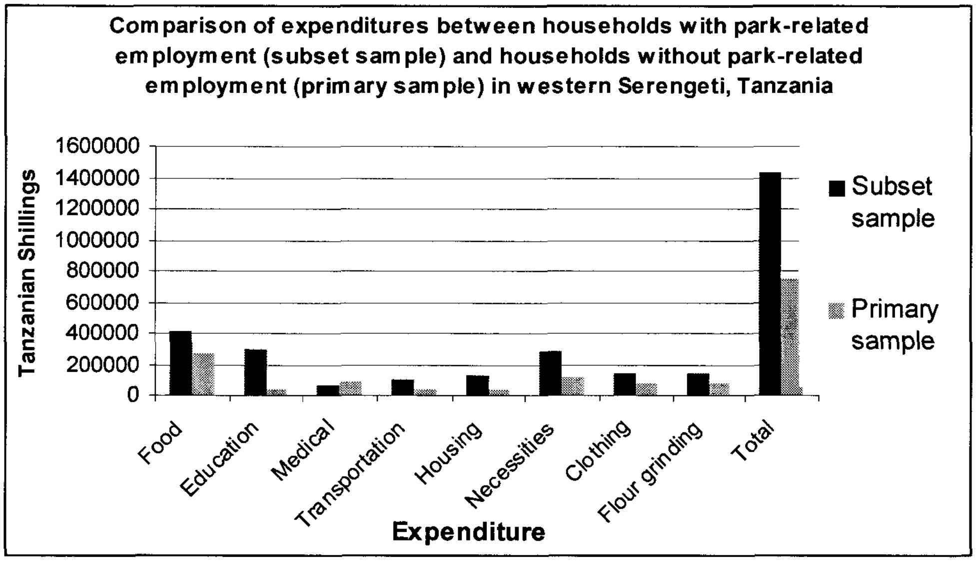

Figure 2.25.2 – Comparison of expenditures between households with park-related employment (N = 50) and households without (N = 676) in western Serengeti, Tanzania.

Because households with park-related employment had higher incomes, the fact that they reported higher expenditures comes as little surprise. What is noteworthy, however, is the fact that the core sample reported that they spent TZS 180,719 more than they earned.[184] In contrast, individuals with park-related employment reported earning TZS 291,106 more than they spent.

As mentioned previously, the differences shown here between net profit and net losses between the primary and subset samples most likely represents the dependence that unemployed agropastoralists often have on the fraction of society that have year-round employment. While such dependence upon employed households undoubtedly strengthens social networks, the phenomenon may also hold back employed households from diversifying more intensively into other economic sectors.

[184] This may be due to the fact that two sensitive income sources that were not captured by the primary survey included prostitution and illegal bushmeat sales (Chapter Three). These sources were not asked in the subset survey, either.

Households with park-related employment spent significantly more money in six out of seven expenditure categories that were compared.[185] The largest difference was in educational expenses, where the subset sample spent TZS 295,040 compared to the TZS 44,962 for the primary sample (F = 97.212, df =1, p <.001). Considering how highly western Serengeti respondents value education (Section 2.29) and how education can lead to employment, it is of little surprise that households with ample income invested highly in it.

The other two noteworthy differences were in the arenas of regular necessities (e.g., batteries, kerosene) and housing materials. The fact that the subset sample spent more in regular necessities (F = 33.471, df = 1, p < .001) may be due to several reasons or a combination thereof. Like many households in developed countries, it may simply be a function of employed households having more surplus money to spend. Or, it may be because one (or several) of the household members live away from the homestead due to their employment obligations and therefore need to buy more regular necessities to subsist.

Hypotheses explaining why employed households spent a larger average sum on housing materials than the primary sample are more straightforward. (F = 21.274, df = 1, p < .001). With surplus income, many respondents reported to making incremental investments in the construction of "permanent" houses[186] replete with concrete flooring, brick (or concrete) walls, and tin roofs. The tendency for Tanzanians to build houses incrementally acts as an indivisible asset, or safeguard, for periodic monetary surfeits.

[185] The category in which households from the primary sample spent more money was medical expenses. This was statistically insignificant, however (F = .527, df = 1, p = .468). Flour grinding expenses were not compared due to the low sample size for the subset survey (N = 7).
[186] Respondents referred to their goal of building a "nyumba ya kudumu," which best translates to permanent house.

By spending money quickly on construction materials, individuals better avoid the cultural necessity of disbursing excess funds to those who make requests. While some remittances are commonplace and socially necessitated, employed households may potentially lose all profits to needier members of their social networks if not for such incremental building schemes and/or asset augmentation

While assessments of park-related employment's effects on income and expenditures are illuminating, it is still unclear as to how nonfarm income tangibly affects the household. To gain a better foothold for these lesser known impacts, an examination of livelihood indicators, self-assessments of wealth, and protein intake are made in subsequent sections.

2.26 – Livelihood indicators

Livelihood indicators reveal that a greater percentage of households with park-related employment live in more soundly constructed houses and have more material assets than households without park employment (Figure 2.26.1).

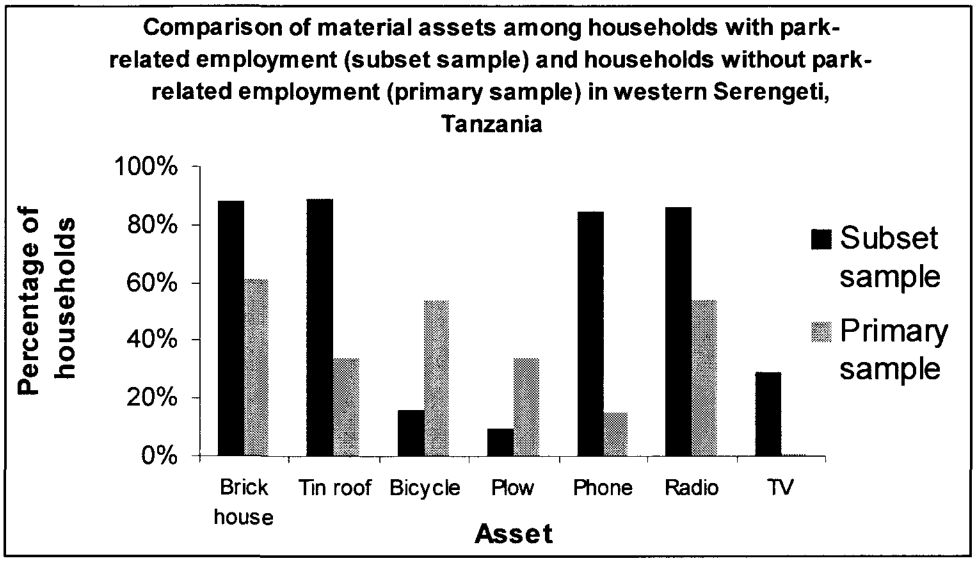

Figure 2.26.1 – Comparison of material assets among households from the subset sample (N = 50) and households from the primary sample (N = 722) in western Serengeti, Tanzania.

Nearly ninth-tenths (~88%) of employed households lived in a brick house compared to 61% of unemployed households ($X^2 = 9.971$, df = 1, $p = .002$). The gap is even larger for tin roofs. Again, approximately nine-tenths (89%) of employed households have a tin roof compared to just one-third (34%) of unemployed households ($X^2 = 45.043$, df = 1, $p < .001$).

In regards to material assets, a greater percentage of employed households owned a radio ($X^2 = 19.053$, df = 1, $p < .001$), TV ($X^2 = 74.949$, df = 1, $p < .001$), and cell phone ($X^2 = 99.461$, df = 1, $p < .001$) than did unemployed households. In contrast, however, a greater percentage of unemployed households owned a bicycle ($X^2 = 27.569$, df = 1, $p < .001$) and plow ($X^2 = 12.542$, df = 1, $p < .001$). The fact that employed households owned assets more characteristic of developed nations (radio, TV, cell phone) while unemployed households owned assets more in line with agropastoral livelihoods emphasizes the role that park-related employment can have in developing livelihoods and weaning households off of agricultural dependence. More straightforwardly, these results show that higher levels of income from employment are generally indicative of asset accumulation.

2.27 - Protein

Another common indicator of wealthier and more developed livelihoods is protein consumption (Fujita et al. 2003). Much like living in better made houses with more advanced material goods, households with park-related employment consumed higher amounts of protein for five out of the nine most common protein sources in western Serengeti (Figure 2.27.1).[187]

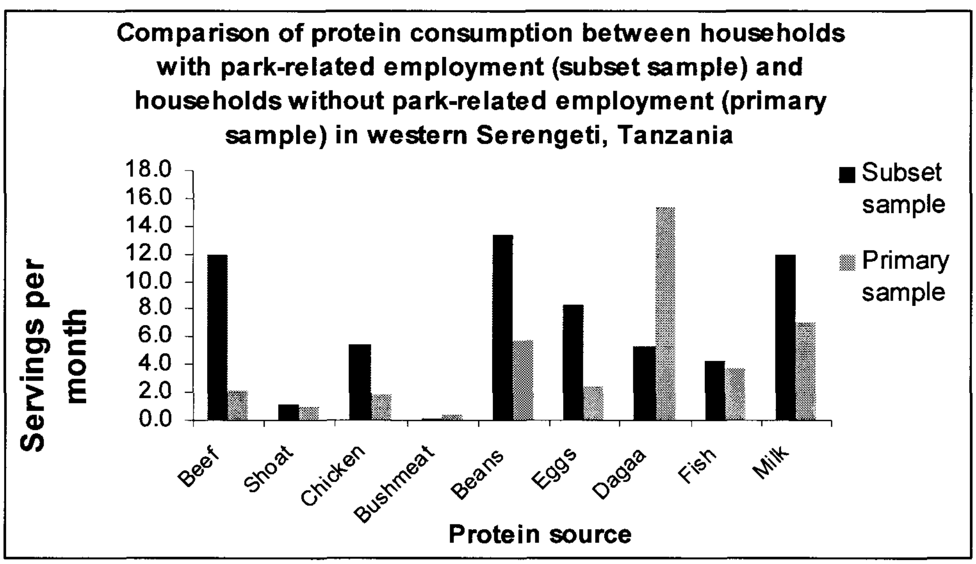

Figure 2.27.1 – Comparison of protein consumption between the subset sample (N = 50) and the primary sample (N = 722) in western Serengeti, Tanzania. The category "dagaa" is a type of locally harvested minnow (*Minnow sp.*) that Tanzanians distinguish from fish.

[187] Differences between the samples were statistically insignificant for three protein sources including shoats (F = .649, df = 1, p = .421), bushmeat (F = 2.812, df = 1, p = .094), and fish (F = .377, df = 1, p = .539).

The greatest difference was observed for beef consumption. Households with employment consumed 11.9 servings of beef per month compared to 2.2 servings for households without employment (F = 262.476, df = 1, p < .001). Since employed households owned fewer cattle than unemployed households, they are more likely to buy more beef. The results from the expenditures analysis support this notion as employed households spent more money on food than did unemployed households (Section 2.25).

Other protein sources that employed households consumed greater monthly averages of included milk (F = 68.75, df = 1, p <.001), chicken (F = 66.246, df = 1, p <.001), beans (F = 61.670, df = 1, p <.001), and eggs (F = 41.331, df = 1, p <.001). The only protein source that unemployed households consumed a greater average of than employed households was "dagaa," a minnow-sized fish (*Minnow sp.*) that are much less expensive than the other aforementioned protein sources. Unemployed households ate approximately three times more monthly servings (15 servings per month) of dagaa than employed households (F = 41.331, df = 1, p < .001). The most parsimonious explanation is that unemployed households are relegated to purchasing the most inexpensive sources of protein due to income shortfalls while employed households are equipped with the financial capabilities of purchasing quantities of any of the possible protein commodities.

These results are potentially more useful than livelihood indicators (Section 2.26) as they suggest that income-derived benefits of park-related employment may extend into improved health, one of the key tenets of the human well-being goals outlined in the Millenium Ecosystem Assessment (MEA 2005).

Also noteworthy is the consumption of bushmeat (Chapter Three). Although only significant at the .10-confidence level, results here showed that illegally obtained bushmeat consumption was slightly higher among unemployed households than employed households ($F = 2.812$, df = 1, $p = .094$). The likely reason is that income deficits may be causing unemployed households to augment their limited protein intake with bushmeat (Loibooki et al. 2002). This possibility may lend support for the idea that households with park-related employment are less dependent on illegally harvested resources. Or, employed households may be less willing to harvest resources on which their livelihoods depend.

2.28 – Common obstacles

As suggested in the previous discussion, the merits of park-related employment on the household economy and food security are many. So why is it that at the time of this study, only 6% of the primary sample had attained it? Of all the possible answers to this question, one stands out, although it has myriad correlates. According to the work of Charnley (2005) on the eastern side of Serengeti National Park, the primary obstacle is education and skills. Around parks, Charnley argues, local people rarely have sufficient education required to compete for jobs that require higher skills (e.g., English proficiency, auto mechanics, accounting, etc.). As a result, most park-related employers often end up targeting areas away from protected areas, such as urban locales which include larger pools of educated people to draw from. While ecotourism companies cannot be faulted for needing educated employees, the fact that few of their workers come from areas surrounding the park means that the principal benefits of employment are lost on households which are incurring the greatest costs of living more closely with wildlife (Section 2.12).

This hypothesis is supported by results from the subset survey of employed people. Of the 50 respondents interviewed, only 28% had been born in a district that directly borders SNP or its protected areas. Even fewer respondents (26%) were currently living in a district bordering SNP. The subset survey revealed that individuals came from 23 districts, which may account for the fact that 20 ethnic groups were represented in the sample which only included 50 respondents. Moreover, the ethnic group with the greatest representation—the Chagga people—are largely from the area around Mount Kilimanjaro, several hundred kilometers away from SNP. The fact that three-quarters (74%) of the subset sample lives in a district not bordering SNP means that most of the income they earn does not directly augment the livelihoods of those incurring the largest costs of wildlife around SNP. This constitutes a sizable amount of income as the average employee earned TZS 1,722,426, which was over four times more than the total average income earned by Serengeti households (TZS 371,337).

2.29 – Education

An examination of education between the primary sample and the subset sample lends support to the notion that educational shortcomings often prevent local people from procuring employment opportunities. In Tanzania, primary education goes up to standard seven, which is ideally followed by four additional years of secondary schooling. While primary education is provided pro bono by the government, secondary school often requires tuition expenses, often in addition to fees for room and board (Chapter One – education). As a result, relatively few in western Serengeti are able to continue with secondary schooling. Furthermore, if households are particularly impoverished or facing a drought, sickness, or death, children are often removed from primary school to help with the family's particular concern. This practice, however, greatly reduces a child's chances for procuring gainful employment in the future. At the time of this study, completion of secondary schooling was often sufficient for making individuals competitive for nonfarm employment opportunities. Further schooling, such as college or technical school, effectively guaranteed an individual's chances for later employment.

Males who worked for the park had completed an average of 6.7 of the possible 7.0 years of primary schooling (Figure 2.29.1).

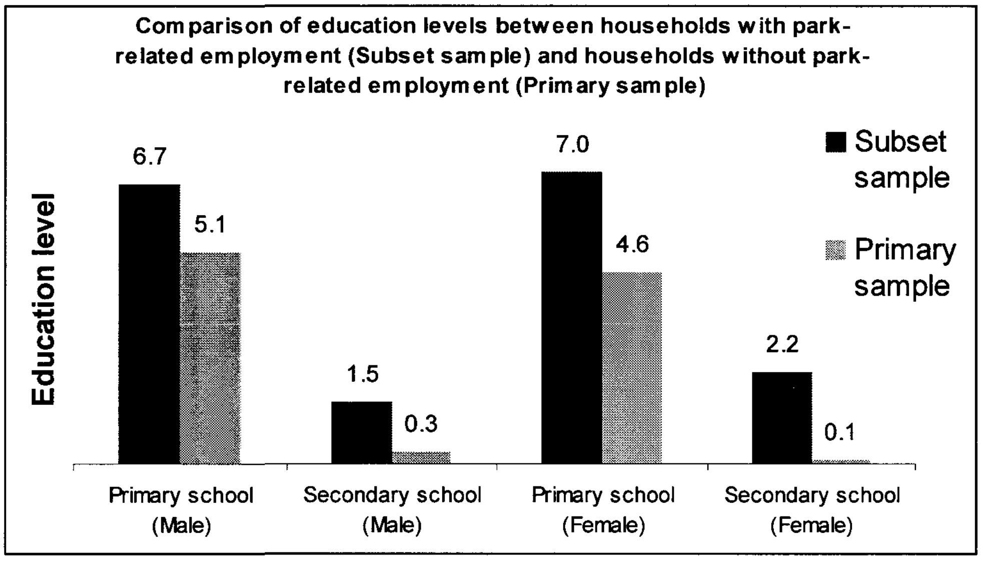

Figure 2.29.1 – Educational levels for households from the subset sample (N = 50) and the primary sample (N = 722) in western Serengeti, Tanzania.

In contrast, males without park-related employment had completed just 5.1 years of primary school ($F = 9.073$, df = 1, $p = .003$). The gap between females was even greater. All females with park-related employment had completed primary school. Females without park-related employment, on the other hand, finished an average of just 4.6 years of primary ($F = 11.522$, df = 1, $p = .001$).

As suspected, secondary education appeared to have a greater effect on the attainment of park-related employment than primary education. Males with park-related employment finished an average of 1.5 years of secondary schooling compared to 0.3 years for males without employment ($F = 30.858$, df $= 1$, $p < .001$). As in the case of primary schooling, the gap between females in the two samples for secondary education was greater than it was for males. Females with park-related employment finished an average of 2.2 years of secondary education compared to 0.1 years for those without it ($F = 268.695$, df $= 1$, $p < .001$). Higher amounts of education attained by females than males with park-related employment may suggest that employment is generally more difficult for females to attain. As a result, females may have to attain more education to be equally competitive.

What these results most clearly show is that park-employed people had more primary and secondary education than those without it. The fact that only (36%) of the subset sample had completed some amount of post-secondary education reveals that completion of secondary—or in some cases, primary—was sufficient for most respondents to procure park-related employment.

While the differences in education between these samples are important, perhaps equally interesting is the fact that not all of those with employment had finished secondary and two of them had not even finished primary. This simple observation implies that at least some forms of park-related employment can be attained without higher education. Such employment venues likely involve more on-the-job training or labor-oriented tasks. This study argues that these types of jobs ought to preferentially be given to local residents from villages and districts that directly border SNP, and especially those in western Serengeti. Such preferential targeting would better provide local households with much needed nonfarm income and help delink them from agricultural and abiotic shocks (Chapter Four – Section 4.21).

2.30 – Connections to opportunity

Perhaps the greatest obstacle that prevents locals from getting park-related employment is a lack of connections to would-be employers. In other words, local people often lack adequate information about what is necessary to secure jobs. In many cases in rural parts of Tanzania, jobs are preferentially given to family or extended family. The subset survey, for example, revealed that two-thirds of respondents acquired their employment through a family- or friendship-based contact (Figure 2.30.1).

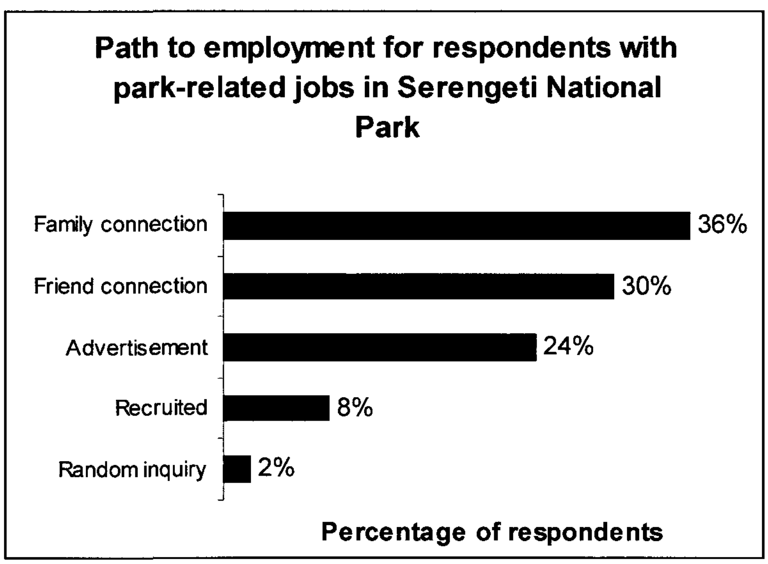

Figure 2.30.1 – Path to employment for respondents (N = 50) with park-related jobs in Serengeti National Park.

Only one-quarter of the respondents (26%), on the other hand, did so via an advertisement or random inquiry. Just 8% of those interviewed were intentionally recruited by employers. In Tanzania, kinship and social ties are strong (Narayan & Pritchett 1999) and it is of little surprise that social networking plays a large role in personal advancement. If park-related employment and its associated benefits are to increase in western Serengeti, however, some sort of preferential selection for local residents will need to be implemented by potential employers. Until this happens, and regardless of how much more educated local western Serengeti people become, longstanding social networks are likely to continue to keep jobs out of the immediate areas suffering from human-wildlife conflict.

2.31 – The Catch-22

Advocating an increase in education for western Serengeti households presents a classic conundrum for development. This is because education in Tanzania—like many parts of the developing world—requires money. The scenario becomes a Catch-22 because western Serengeti people need money to attain education, but need education to earn money. As a result, most of Tanzania's educated people were initially given money by their parents or a particular benefactor. Many of the employed respondents in the subset sample reported that their parents had in fact paid for their schooling.

When respondents were asked to place their parents' economic status into one of three categories (poor, middle class, or rich), for example, 88% reported that their parents had been middle class or above. Much of this can likely be attributed to the fact that over half (56%) of the respondents' fathers had been employed and one-third (35%) of the respondents' mothers. Such relatively high figures for parental economic and employment status suggest that employment in one generation likely leads to employment in the subsequent generation. While this is a common trend in developing nations, it often serves to widen the gap between the rich and the poor. In the case of western Serengeti, it implies that uneducated households are unlikely to attain education without outside intervention. The obvious conclusion here is that western Serengeti households must increase their education and training if they are going to successfully compete for park-related jobs thereby increasing their respective allotment of nonfarm income. Left to their devices, the Catch-22 of education and wealth will likely prevent this from happening. This may be the most profitable opportunity for national or outside agencies aiming to break the poverty trap and improve the well-being of households (Chapter Four – Section 4.21).

2.31 – Win-win scenarios

Two relatively successful ventures in global ecotourism is one near the Wolong Nature Reserve in China, and a partnership between a tour company and Robanda village, in Tanzania. This latter example is fortuitous, as Robanda is one of the sampled villages making up this research (Chapter One – Methodology). In the case of the Wolong Reserve, a "win-win" tourism scenario was achieved in that the reserve's tour companies provided nonagricultural employment opportunities for local populations living around the reserve (DeFries et al. 2007). By providing additional sources of income, local people were able to reduce their agricultural activities and use alternate energy sources other than fuelwood (Vina et al. 2007). The result of this socioeconomic shift was a reduced rate of habitat loss and even afforestation due to decreased dependence on the natural resource base.

The study here lends support to the hypothesized relationship between employment opportunities and reduced dependence on agriculture. One indicator of such a reduced dependence is the amount of land owned per household. Households without park-employment in western Serengeti owned an average of 8.8 acres compared to just 1.4 acres for households with park-related employment ($F = 11.180$, df = 1, $p = .001$).

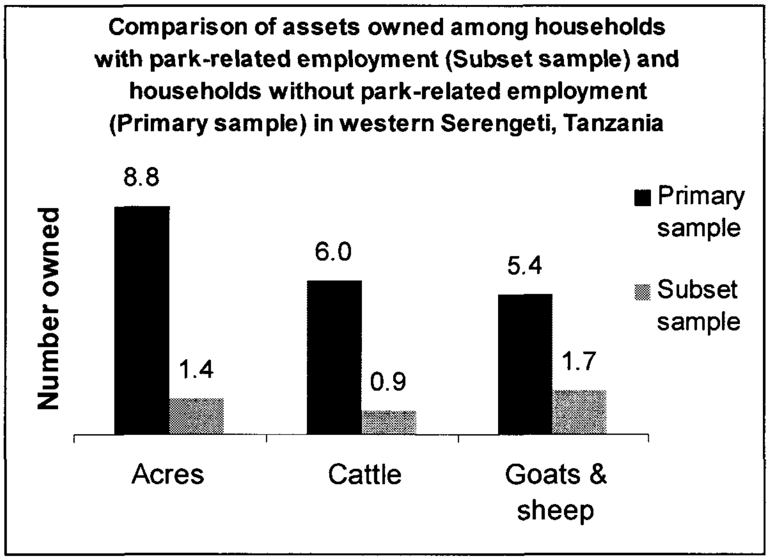

Figure 2.31.1 – Comparison of assets owned among households the subset sample (N = 50) and the primary sample (N = 722) in western Serengeti, Tanzania.

Knowing this, it is of little surprise that employed households earned less (TZS 64,040) from crop sales (TZS 64,040) than did households without park-related employment (TZS 149,931) ($F = 3.906$, df = 1, $p = .049$).

The amount of livestock holdings also differed significantly between the two groups. Households without park-related employment owned an average of 6.0 cows compared to 0.9 for households with park-related employment ($F = 5.247$, df = 1, $p = .022$). Due to this difference, income earned from cattle was nearly six times as high for households without park employment ($F = 3.663$, df = 1, $p = .056$). A similar difference was found for goats and sheep ("shoats").[188] Households without park employment owned 5.4 compared to 1.7 for households with park employment ($F = 8.147$, df = 1, $p = .004$).

The other ecotourism venture is noteworthy for two reasons. One, it has been successful in returning direct benefits to a local village. And two, because it is located in western Serengeti and fortuitously constituted one of this study's sample villages. The venture in question is a partnership made between Sengo Safaris Ltd. and Robanda village. Beginning in 1993, Robanda village contributed its land on which Sengo constructed a tour camp. Overseen by the presiding village council, an agreement was reached in which the company returns an unspecified rate per tourist back to the village. Between 1996 and 2000, the partnership provided Robanda with 86% (TZS 18,645,000) of the village operating funds which were used for interest-free loans, educational facilities, health facilities, etc. (Campbell et al. 2001).

Perhaps more significantly, however, and pertaining to the study at hand, is contribution that the partnership has made in the form of employment opportunities for Robanda villagers. Campbell et al. (2001) reported that 27 individuals from Robanda received employment from the camp. As has already been mentioned, this is important because year-round employment correlates with higher incomes, greater levels of education, and less dependence on agriculture.

[188] Significant differences were not observed for income earned from the sales of goats, sheep, or poultry. A possible reason for this is that households with park-related employment may have chosen to diversify into smaller stock requiring reduced labor-related inputs (e.g., herding). Two households in the subset sample, for example, reported owning 70 and 150 chickens earning TZS 1,440,000 and TZS 2,700,000, respectively (for selling eggs). Such supplementary income likely stems from diversification driven more out of a desire to increase asset holdings than out of a necessity to withstand household or environmental perturbations (Reardon et al. 2002).

Robanda village's greater level of employment was corroborated with results from the primary sample. Of the fifteen sampled villages, for example, Robanda had the highest percentage of households with park-related employment (Figure 2.31.2).[189]

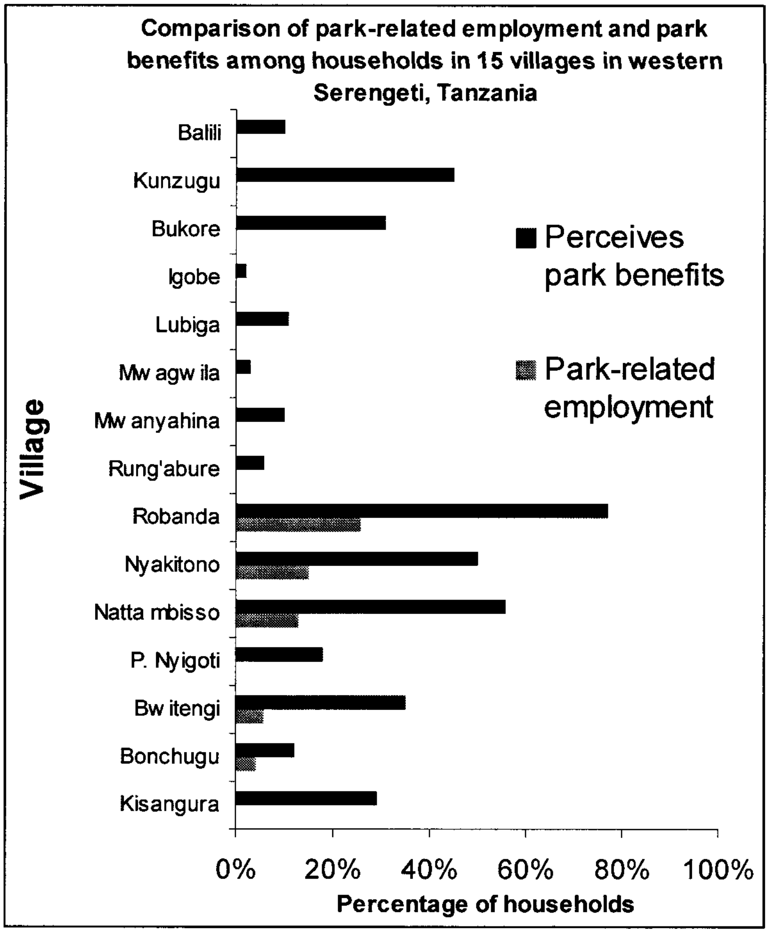

Figure 2.31.2 – Comparison of park-related employment and park benefits among households (N = 722) in 15 villages in western Serengeti, Tanzania.

Over one-quarter (26%) of all households in Robanda had park-related employment which was at least 11% more than the second ranking village ($X^2 = 1.035$, df = 14, p <.001). Further analyses revealed that over three-fourths (77%) of households in

---

[189] While the partnership with Sengo Safaris Ltd. is thought to be primarily responsible for Robanda's higher rates of village-wide employment, other related ventures have recently been created and may be contributing to Robanda's higher percentages.

Robanda reported that they benefitted in some way from SNP. This was 20% higher than the second ranking village ($X^2 = 2.067$, df = 14, $p < .001$).

While some of Robanda's higher reported benefits are likely due to the annual financial contributions from Sengo, a large part is likely attributed to Robanda's greater percentage of households with park-related employment. Reported benefits were strongly correlated with park-related employment (Pearson $R = .381$, $p < .001$). As importantly, all households with park-related employment recognized that their employment was a benefit from SNP (Pearson $R = 1.000$, $p < .001$). To a lesser extent, employed households also reported that roads, security, healthcare, and tourism were also benefits from the park. This lends support for the idea that households with direct links to protected areas through employment perceive more benefits than households that do not tangibly benefit. More positive perceptions may even engender a greater likelihood for such households to protect the resource upon which their livelihood depends, which is one of the primary tenets of the theory of ecotourism (Charnley 2005).

Despite the success of the Robanda and Sengo Safaris partnership, such occurrences are rare in the villages surrounding SNP (Campbell et al. 2001). Of the 15 sampled villages, only Robanda was benefitting from such a joint venture. If done wisely, the creation of similar partnerships are feasible—and necessary—means for western Serengeti households to prosper, and gain incentive to preserve the ecosystem in which they live. Unlike other types of indirect benefits, park-related employment gives households a reason to protect the park. In so doing, it also delinks them from weather-related shocks and decreases their overall ecological footprint. This confers greater specific resilience to households as they cope with disturbance and greater general resilience to the Greater Serengeti Ecosystem as it deals with system-level, long-term change.

Chapter Three

Illegal hunting in western Serengeti and its effects on household economies

Part I.

3.1 – Introduction

The preceding chapter examined several effects that Serengeti National Park (hereafter, SNP) and its affiliated protected areas have on household economies in western Serengeti that are located less than 20 kilometers away from its boundaries. These effects include crop damage, wildlife depredation on livestock, and park-related employment. Crop damage and wildlife depredation are costs that local households endured while employment served as a benefit derived from the park. This chapter continues with an examination of the household economy, but here, focus shifts to the household economy in the context of human consumptive practices.

As might be expected, anthropogenic effects on SNP are many and multifaceted (Thirgood et al. 2005). For simplicity, however, just one will be examined here – illegal hunting. Illegal hunting, or "poaching," was selected because it is considered the primary threat to Greater Serengeti Ecosystem (hereafter, GSE) (Sinclair 1995). The migration of the wildebeest determines the structure and function of the system. A large-scale interruption of the migration, at the hands of poachers, could potentially result in a collapse of the entire system (ibid). Since the human-natural system is coupled, damage to any part of it could also have significant impacts on livelihoods and household economies in western Serengeti (Nyahongo 2007).

While illegal hunting is widespread over the entire GSE, recent studies have suggested that it is concentrated on the western boundary of the ecosystem where human population density is high (Thirgood et al. 2004; Loibooki et al. 2002; Holmern et al. 2002; Arcese et al. 1995). Districts with high human population growth rates that have experienced higher rates of poaching are situated on the western edge of SNP and include: Serengeti, Bunda, Magu, Bariadi, Tarime, and Meatu (Ndibalema & Songorwa 2007). Three of these districts—Serengeti, Bunda, and Meatu—are represented here.

For organizational purposes, this chapter has been divided into three parts comprising 26 sections. Following a brief examination of the methodology (3.2) and a general history of illegal hunting (3.3-3.5), Part I focuses on why people hunt. Part II, on the other hand, examines the costs of poaching with a special emphasis on court records. Part III synthesizes Parts I and II and discusses possible steps to mitigate poaching and thus build the general resilience of the Greater Serengeti Ecosystem to long-term change (Chapter One – Section 1.17).

3.2 – Methods

Methods for the analysis presented in this chapter utilized semi-structured household interviews from the primary sample (N = 722). Interviews from this sample were conducted in Kiswahili and administered in 15 villages selected from Serengeti, Bunda, and Meatu districts. Households were chosen in a stratified-random format dependent upon their proximity to Serengeti National Park or the Ikoma, Grumeti, or Maswa game reserves. Each household was located within 18 km of one of these designated areas. For matters of simplicity, the study area encompassed by these specifications is referred to hereafter as "western Serengeti."

To ensure adequate spatial heterogeneity, 1-3 sub-villages were selected from each village and 20-25% of selected sub-villages were sampled.[190] Due to logistical

[190] Two exceptions with sub-village selection occurred in Nyakitono and Robanda village. In Nyakitono, data collection was limited to one sub-village due to the relatively large size (N = 48) of the randomly

constraints (e.g., inaccessible roads, excessive walking distances), sub-villages were selected using judgment sampling (Bernard 2006) based upon the feasibility of administering interviews. A total of 46 sub-villages were selected across the 15 villages. Interviews were administered with the male head of the household. If unavailable, interviews were carried out with the household head's spouse.[191] All respondents were 17-years-old or older.

Interviews with the primary sample were integrated with a subset sample obtained during the same timeframe of the primary sample. The subset sample consisted of in-depth interviews conducted to 104 acknowledged poachers in western Serengeti. Since poaching is a sensitive issue that carries penalties if arrested (Chapter Three), respondents were selected with "snowball sampling" techniques (Bernard 2006). Interviews were organized with the help of trust-based relationships developed with three key informants. Respondents remained anonymous and interviews were conducted in remote areas to ensure full confidentiality.

Analyses for Part II (Sections 3.12-3.22) were based upon archival data collected from two district courts in Serengeti and Meatu. Other archival data were collected at two prisons in Serengeti District (Section 3.15).[192] In Serengeti District, court records were available for years 2000-2006 but were incomplete for unexplained reasons.[193] In Meatu, records were complete and successfully obtained for the years 2000-2006. Key informant interviews were conducted with court and prison officials to supplement and

---

selected sub-village. In Robanda, all sub-villages were selected for the purposes of completing an exhaustive assessment of crop destruction and wildlife depredation on livestock (Chapter Two).

[191] In several cases, interviews were conducted with a coalition of respondents of respondents who corporately demonstrated knowledge of household affairs.

[192] Attempts to obtain court data in Bunda District were not successful.

[193] Court officials were ostensibly unable to locate all relevant court documents.

explain relevant information therein. Contextual examples (Section 3.16) were obtained from interviews from the subset sample.

At the time that this study was conducted, one Tanzanian Shilling (hereafter, "TZS") was equivalent to approximately one U.S. dollar. In the analyses to follow, all percentages are rounded to the nearest whole number with several exceptions indicated in the text.

3.3 – History of hunting in western Serengeti

For centuries, hunting in Africa has been a largely unregulated open access resource acting as a sole, or supplemental, protein source. Now, however, from both conservation and development perspectives, hunting for bushmeat is said to be in crisis (Bennett et al. 2006). Although a loaded term, "crisis" has been applied due to threats that bushmeat hunting imposes on wildlife populations and livelihood security of impoverished peoples (ibid). The World Conservation Monitoring Center has recorded 486 documented bird and mammal extinctions since 1600. Of these, 80 have resulted from hunting pressure alone (Bulte and Horan 2003). Not surprisingly, hunting pressure has directly correlated with human population pressure due to households competing for a growing scarcity of resources (Thirgood et al. 2005). This correlation is most readily seen around protected areas which sometimes result in local extinctions (Hofer et al. 1996) and as a result, more heavily enforced hunting regulations (Hilborn et al. 2006). While likely essential for maintaining biodiversity, regulation and enforcement regimes have made traditional hunting illegal for some human longstanding populations in rural areas.

The emergence of hunting regulations and gradual increases of enforcement has also occurred in the GSE. But this is complicated somewhat by the important fact that hunters have not always been "poachers." Before the German and British colonial governments, for example, the GSE was completely unregulated and provided western Serengeti households with a reliable source of protein (Shetler 2007). Viewed within this historical context, ascribing the pejorative label of poacher to a western Serengeti individual caught with impala meat may be technically accurate but culturally misleading.

Existing largely as an oral culture, very little documentation of native hunting practices in western Serengeti have survived apart from anecdotal documents recorded at the outset of German and British colonial regimes. What is known is that hunting was used primarily as a means for local bands of nascent agropastoralists to recover from a semi-frequent series of ecological disasters. Following an extensive drought, for example, western Serengeti peoples made trips to Sukumaland located to the southwest of the GSE to trade hunting products for livestock to replenish their herds (Shetler 2007). Beginning around the early 1900s, the trade route was restricted by the German colonial government and western Serengeti natives were for the first time branded as "poachers" (ibid).

Within the context of their times, German and British colonial officers viewed bushmeat hunting by the local populations as a primitive enterprise carried out with crude implements such as bows and pitfall traps. But since the local human population was low, ruling colonial governments rarely and irregularly enforced anti-hunting regulations. Historian Jan Shetler proposes, however, that this uneasy period of inchoate but unenforced regulations changed shortly after WWII. From this time to present, Shetler argues, hunting likely changed from a local strategy to diversify local economies, restock herds, and stave off famine into the current phenomenon that has turned bushmeat into a regular trade and widespread commodity (Shetler 2007).

Following WWII, the local human population grew and anti-hunting regulations became more tightly enforced. Many longstanding hunters, now recognized as poachers, gave up hunting due to the greater levels of enforcement. But this trend was suddenly interrupted when Tanzania officially closed its shared border with Kenya in 1977 as a result of political turmoil. With the border closure, tourism revenue to SNP dropped by 90% and anti-poaching activities ceased for more than a decade (Sinclair et al. 2007). Not surprisingly, this surcease of enforcement resulted in a spate of hunting as western Serengeti natives—and opportunistic newcomers—sought short-term economic gain through trophy hunting[194] for rhinos and elephants (Hilborn et al. 2006). In the late 1980s, however, the border reopened and tourism revenue subsequently increased. The return of revenue allowed park budgets to expand and anti-poaching patrols to increase significantly as enforcement was afforded a higher priority in SNP's annual budget (ibid). The subsequent decline in poaching from the late 1980s to present is attributed primarily to the increase in antipoaching effort (ibid).

This desultory and nuanced history has created a complex milieu in which to view the current western Serengeti hunter. While the colonial legacy often sees hunters as cruel, hardened, and indiscriminate killers (Shetler 2007), the reality may be that the majority of local hunters are poor and uneducated young farmers (Loibooki et al. 2002) seeking to supplement income shortfalls and household protein sources (Noss 2000;

[194] This form of hunting was done primarily for ivory rather than bushmeat (protein).

Bennett et al. 2006). In the sections to follow, these critical questions will be explored in depth.

3.4 – Who is poaching?

The predominant view in the literature is that the majority of local hunters are poor and uneducated young farmers (Loibooki et al. 2002; Holmern et al. 2007, Kaltenborn et al. 2006). While this may be an accurate generalization, there appear to be several important exceptions. For a case in point, two individuals from the hunter survey subset will be described who appear to be representative of the potential diversity that may lie behind a simplistic label of "poacher." The first individual would likely fit the more common stereotype found in the literature. At the time of the survey, this respondent was an unmarried 20-year-old man of Ikoma descent whose father died when he was 4 and his mother died when he was 11. He had no crops or livestock and was renting a single room. His friends taught him at age 14 how to hunt as a way to supplement income earned from seasonal wage labor. Money from hunting was used for basic necessities and for paying school fees. He hunted three weeks per year for an annual income of approximately TZS 30,000. He was able to stop hunting when he found park-related employment as a cook for Serena hotels but this job lasted for only one year. He reported that hunting is "difficult" and would immediately stop if he procured further employment.

The second individual would most definitely not fit the mold of the average "poacher" found in the literature. At the time of the survey, this individual was a 41-year-old man of Sukuma descent with two wives, four children, and a household size of eight individuals. He grew crops for food and earned a total of TAS 641,000 from selling cattle, goats, and chickens in the last year. He supplemented this income with seasonal wage labor and by selling firewood and charcoal. He hunts one week of every month and earns a total of TZS 240,000 to obtain regular household needs. Hunting knowledge was passed down to him through his grandfather and his father as he has hunted for the last 11 years. In contrast to the first individual, this respondent described hunting as "easy" and claimed that hunting is his heritage and no amount of incentives would cause him to stop.

When juxtaposed, the differences between these two individuals—both acknowledged and active poachers in western Serengeti—are stark. More importantly, however, the differences between two such individuals and their respective household livelihood portfolios likely imply that they would respond quite differently to governmental and nongovernmental management programs aimed at curbing poaching levels. Such a scenario raises several interesting questions. One, are the exceptions so significant that they invalidate coarse generalizations that have predominated the literature? And two, are these differences between poaching households large enough to merit varying anti-poaching policies and strategies?

While these questions examine differences between actively poaching households, other equally important questions concern differences between actively poaching households and households that reported not ever having poached. Perhaps most fundamental here is to uncover why one household poaches and another does not. To answer the former questions, comparisons in this study will largely be made between households *within* the subset sample of admitted poachers (N = 104). The latter, in contrast, will require comparisons between the subset sample of admitted poachers and the primary sample of household surveys (N = 722).[195,196]

Analysis of the demographic variables of this study's examination of 104 admitted poachers are characteristic of similar studies conducted in the western Serengeti region (Loibooki et al. 2002; Holmern et al. 2004). Admitted hunters were all relatively young males (mean age 34.8), which was younger than the average 44.9 years for males from the core sample ($F = 42.004$, df = 1, $p < .001$). Over three-fourths (84%) of the sample were married and 17% were married to more than one wife. A lower percentage (~20%) of admitted poachers married outside of their ethnicity than the core sample (~30%) ($X^2 = 4.101$, df = 1, $p = .043$) but reasons for this are highly speculative. Household sizes of the subset and core samples were similar with 8.0 persons and 7.7 persons, respectively. Poacher families were composed of an average of 3.5 children which was lower than the core sample's average of 4.9 ($F = 17.949$, df = 1, $p < .001$). Although the number of children currently living in poaching households was lower, this is likely attributable to the fact that male respondents (and therefore, their wives) from the subset sample were younger than male respondents from the core sample.

Ethnic backgrounds of the admitted hunters were largely Ikoma (~52%), Kuria (24%), and Sukuma (~15%). Eight total tribes were represented among the 104 interviews. Due to the fact that a snowball sampling strategy was used (Bernard 2006) and interviews were necessarily predicated on trust generated through relationships built with key informants, the ethnic composition shown here is only significant in that it

---

[195] Comparisons made between the subset sample of acknowledged poachers and the core sample of household surveys have some inherent bias as the core sample also likely includes a certain percentage of respondents that poach.
[196] The primary sample may contain households that hunt.

shows that illegal hunting in western Serengeti is not limited to one or two ethnic groups. The fact that over half of the admitted poachers were of Ikoma descent is most likely because sampling was focused in predominantly Ikoma villages in Serengeti District where trust had built up by the author over repeated visits. Had sampling been focused in any of the six other districts that border SNP's western's side—and relationships similarly fostered—it is likely that the ethnic constituency would have differed in turn.

Rather than attributing poaching behavior to one or two key attributes, this study argues that a suite of demographic, economic, and cultural variables may synergistically interact in such a way that determines whether or not an individual will poach. In other words, rather than attributing poaching behavior solely to age or livestock holdings, the case will be made here that the decision to poach may hinge on the existence of many seemingly insignificant variables. One, for example, may include the religious background of the respondent.

Religious backgrounds were different between the primary sample and acknowledged poachers (but only at $p = .073$). A third of admitted poachers reported they were "not religious"[197] compared to under a quarter (24%) of respondents from the core sample ($X^2 = 3.224$, df = 1, $p = .073$). In and of itself, this point may be of little interest. However, when considered with other variables, they gain import. For example, 31% of "religious" respondents reported that religion had some effect on their attitude about how they use wildlife compared to approximately 8% of nonreligious respondents ($X^2 = 53.078$, df = 1, $p < .001$). A pilot study found that the four most significant effects about religious teaching and wildlife included: 1) direct discouragement of hunting (due

[197] "Not religious" was a category on the survey that also included respondents who were animistic or pantheistic, although no respondents attested to these beliefs.

to its illegal status), 2) encouragement of conservation[198], 3) encouragement to plant trees, and 4) restrictions about eating certain animals.

Apart from tree planting, all of these religious teachings bore some relation to poaching activities. The most directly related teaching was the discouragement of hunting. Over a third (35%) of religious respondents reported that their religion actively discouraged them from hunting. This is greater than the 3% of nonreligious respondents—with backgrounds of animism, pantheism, or atheism—who reported being actively taught not to poach ($X^2 = 16.390$, df = 1, $p < .001$). The obvious implication here is that religious individuals have been more actively dissuaded from poaching for moral reasons than nonreligious individuals. Consequently, it is not unexpected to find that a greater percentage of acknowledged poachers are nonreligious as compared to the core sample.

The principle of wildlife conservation is a more general teaching than those that discouraged participation in hunting. Approximately two-fifths (40%) of religious respondents reported that they were instructed in this accord compared to 3% of nonreligious respondents ($X^2 = 20.473$, df = 1, $p < .001$). This shows that in addition to being taught not to poach, respondents with religious backgrounds also received more generalized teachings about the value of wildlife preservation than did nonreligious respondents.

The last effect that bears mentioning here involves restrictions—or taboos—from eating various animals. Such restrictions varied depending on the respondent's specific religious background. In general, restrictions included animals without a cloven hoof,

---

198 Encouragement of preservation was a more general religious teaching than 'direct discouragement of hunting' as it included preservation of all natural resources (e.g., trees, water, etc.).

totemic animals of a certain tribe (Fleisher 2000), wild animals, or in some cases, specific animals for unspecified reasons. Over one-third (36%) of religious respondents reported the presence of one, or multiple, restrictions from consuming animals compared to 3% of nonreligious respondents ($X^2 = 16.794$, df = 1, $p < .001$). Since the principle manner of hunting in western Serengeti is snaring and therefore indiscriminate (Nyahongo et al. 2005), there is little reason to believe that the presence of taboo animals or dietary restrictions influenced an individual's decision to poach as much as the aforementioned teachings.

While variables testing for religious background tended to show a greater percentage of poachers to be nonreligious and bereft of teachings on wildlife, analyses from education showed more nuanced results. Admitted poachers had actually attained a higher average level of primary schooling ($F = 11.232$, df, = 1, $p = .001$) but a lower level of secondary schooling than the primary sample ($F = 5.210$, df, = 1, $p = .023$) (Figure 3.4.1).

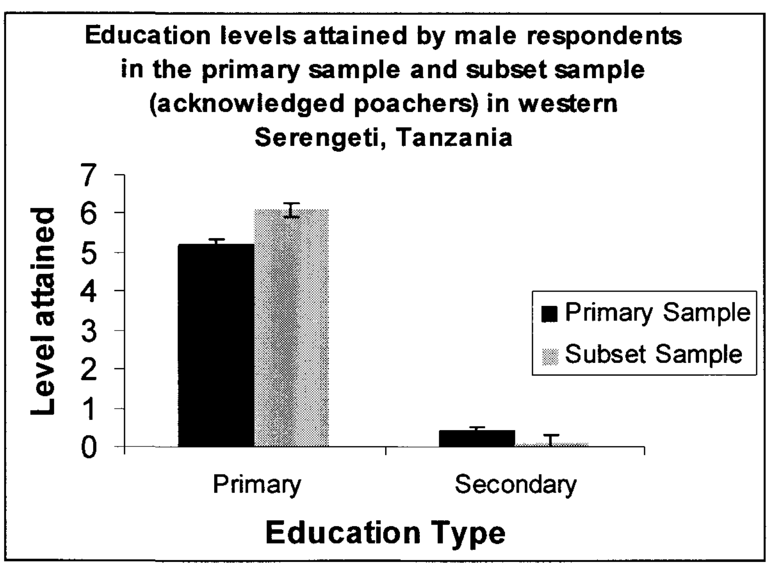

Figure 3.4.1 – Primary ($F = 11.232$, df = 1, $p = .001$) and secondary ($F = 5.210$, df = 1, $p = .023$) educational differences among males between the subset sample of acknowledged poachers (N = 104) and primary sample (N = 425).

To generalize that poachers are uneducated in comparison to the general population, therefore, is technically incorrect. The generalization is fair, however, in regards to the utility of a primary versus a secondary education. In Tanzania, seven years of primary education are provided free by the government to all children. Except in various cases where children are kept home to help with household duties, most children—even in rural settings such as western Serengeti—attend and finish primary school. As a result, primary completion does not go very far to distinguish individuals and affords only remedial skills such as that afforded by elementary education in the U.S. Completion of secondary school, however, does appear to distinguish students in rural parts of Tanzania making them more job-ready and employable. However, secondary education has annual fees that many rural households cannot afford.

As depicted in Figure 3.4.2, just 1% of admitted poachers had finished secondary school compared to 7% of male respondents from the core sample ($X^2 = 5.105$, df = 1, $p = .024$).

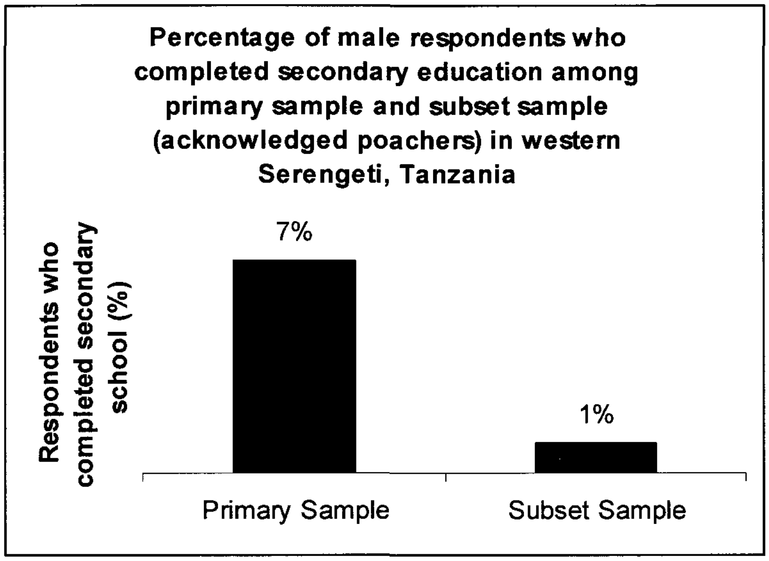

Figure 3.4.2 – Differences in completion of secondary education among males between the subset sample (N = 104) and the core sample (N = 425) ($X^2 = 5.105$, df = 1, $p = .024$)

While this may not seem to be a sizable difference, I argue here that the line between poaching and nonpoaching households is exceedingly thin, and seemingly minor differences between education levels, income amounts, time availabilities, protein intake, etc. may aggregate in such a way that will cause one household to poach while keeping another from it. The sections to follow will demonstrate this point more clearly.

3.5 – How is poaching occurring?

To understand the context for how poaching occurs, it is first necessary to ascertain the most parsimonious reason for why poaching continues to occur in western Serengeti. Most simply, it is because the value of the resources acquired outweighs the costs associated with their acquisition (Bennett et al. 2006). The "how" question, therefore, necessitates an examination of the varying strategies used by poachers to acquire their resources.

The primary means of poaching in and around the SNP is through the use of snares (Nyahongo et al. 2005; Arcese 1995) which is relatively cheap and unskilled (Noss 1998). In addition to being inexpensive, snares can be easily concealed and set up under cover of darkness, therefore reducing chances that poachers are detected. The easy accessibility of snares was confirmed by a 23-year-old, unmarried respondent from the subset sample who reportedly earned most of his present income by selling snares to hunters. While he still hunted one month of the year for earnings of TZS 36,000, his present occupation was more characteristic of a middle man, receiving large quantities of wire from Musoma, fashioning it into workable game snares and subsequently reselling it to hunters. From this business, he had been able to generate TZS 180,000 per year, which was more than the average household from the primary sample earned from selling crops. This individual, of Ngoreme descent, emphasized that the primary skill his craft required was simply being judicious and discrete in his daily business transactions. Because the man lacked a wife, children, and livestock, he claimed his snare-making business was done to earn money for further schooling, as his dad had passed away when he was 16-years-old and had therefore been unable to help him with secondary school expenses. Noting the secondary education gap between the primary and subset samples, such a life history narrative gains considerable credence.

The existence of easily obtainable snares in western Serengeti ensures that the financial costs of poaching—measured here only by raw materials—are exceedingly low. In terms of wildlife, snaring also dictates that hunting is indiscriminate, with off-take determined more by relative abundance of species rather than intrinsic preferences of taste or monetary value (Ndibalema & Songorwa 2007). Statistics for unintentional carnivore death ascertains the indiscriminate killing that snares exact on wildlife populations. A subset of 17 respondents was randomly selected and surveyed with specific questions directed toward the snaring of lions, leopards, and cheetah. More than half (59%) reported unintentionally killing an average of 2.2 lions over their hunting careers compared to 53% who killed an average of 1.5 leopards, and 6% who killed an average of 0.1 cheetah. Although the practice of snaring largely prevents selective harvesting, snares are constructed and targeted for large herbivores (Holmern et al. 2007).

Snaring is not, however, the exclusive form of hunting in western Serengeti (Nyahongo et al. 2005). Other relatively inexpensive methods include self-made traps (pit traps), poison darts or arrows[199], torches and headlamps, dogs, spears, and—in the unique case of the wildebeest migration—clubs. While poachers may use each of these separately, the reality is that most hunting forays involve a combination of these implements, augmented by knives and machetes. When hunters discover a live animal caught in one of their snares or pit traps, the animal is often dispatched with a poison arrow or thrust from a spear. Furthermore, it bears mentioning that several respondents reported using bows and spears primarily for reasons of self-defense against lions (*Panthera leo*), leopards (*Panthera pardus*) and buffalo (*Syncerus caffer*).

The subset survey revealed that 88% of respondents hunted with snares.[200] Nearly two-thirds of hunters used a bow (64%) and nearly half used a spear (45%).

[199] According to one respondent, poison was composed of a mixture containing a half part of venom from an (unidentified) species of cobra and half part of residue from the Akokanthera tree native to western Serengeti.

[200] Percentages exceed 100% because hunters reported using a combination of methods when hunting.

Other frequently used tools and methods included knives (38%), dogs (36%), pit traps (28%), machetes (28%), spotlight or torch (24%) and club (5%). One respondent reported frequently using fire in dry season to drive prey toward snare lines (Figure 3.5.1).

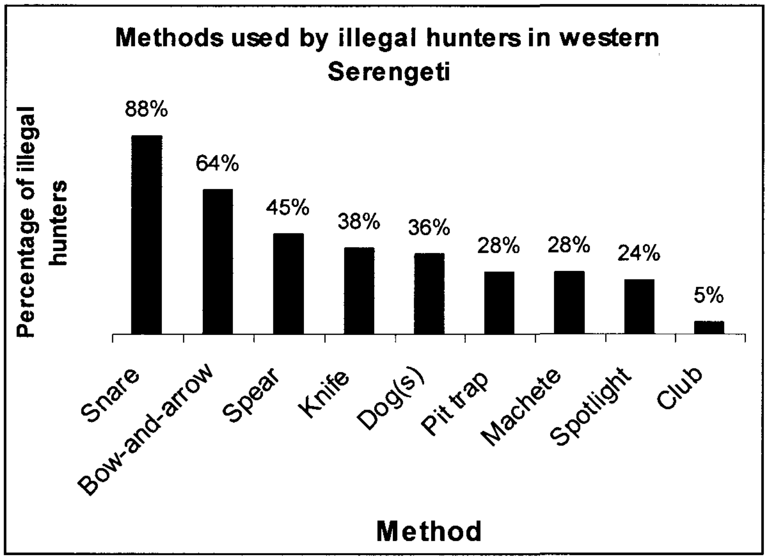

Figure 3.5.1 – Reported methods used by acknowledged illegal hunters (104) in western Serengeti during hunting trips. Percentages exceed 100% because hunters reported using a combination of methods.

Perhaps most revealing is the fact that not any of the admitted poachers reported using, or even owning, a firearm. This differs considerably from other locations in Africa (Willcox & Nambu 2007) and may be primarily attributable to two factors. First, it may support the existing hypothesis that poachers are poor and the costs of purchasing a gun and ammunition may exceed the added value that it would allow the respondent to obtain. While such a hypothesis likely applies to a fraction of the poachers, another possible reason is that firearms create too much noise, which would increase the chances of detection by anti-poaching units, as well as potentially scare away possible quarry. This latter explanation is corroborated by an anecdotal account from one hunter who suggested that he chose not to hunt with dogs because they create too much noise and increase the probability of detection.

Dogs were used more often by hunters who hunted fewer months of the year than other hunters. Anecdotal evidence suggested that dogs are used primarily for warthogs (*Phacochoerus africanus*) and impala (*Aepyceros melampus*) and coupled with the use of a spotlight or torch during nighttime hours. The fact that dogs are used by more than one-third (36%) of all poachers adds considerable import to the discussion concerning the role that dogs may play in the general resilience of the GSE to long-term change. As stated in Chapter Two, dogs are kept to deter carnivores from livestock, protect homesteads from human thievery, and act as general custodians of the local environment.

Such a utility, however, may be undermined by the fact that dogs may unintentionally attract carnivores to homesteads by serving as prey themselves (Chapter Two – Section 2.19) in addition to spreading disease to wild populations (Lembo 2006; Cleaveland et al. 2000). Aside from potentially contributing to greater hunting success rates, common use of dogs in poaching may exacerbate disease transmission between domestic and wild populations. This raises fundamental questions about the merits of dog ownership in relation to the long-term persistence of the coupled human-natural system.

Poaching for bushmeat is done throughout the year. The greatest concentration of poachers hunted during the dry season months (June, July, August) which tapered off during the wet season months (January, February, March) (Figure 3.5.2). September recorded the lowest percentage (27%) of poachers. Two possible explanations for this considerable dip in September are that 1) the migration of wildebeest is often at the extreme northern reaches of the GSE and 2) that local planting schedules often begin in September.

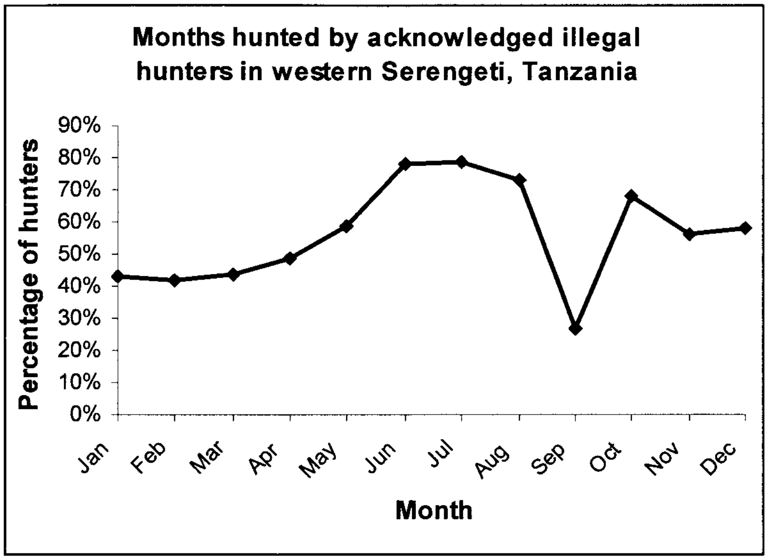

Figure 3.5.2 – Months hunted by illegal hunters (N = 90)

In addition to being practiced throughout the year, illegal hunting is by no means a solitary activity in western Serengeti. Over two-thirds (70%) of all hunting excursion were conducted with unrelated persons while over a tenth (13%) included nuclear family members. The role that families play in the transmission of hunting knowledge adds a layer of complexity to the existing milieu. Research has shown that hunting knowledge that is passed down through family lines not only increases hunter skill but also potentially adds affiliative social values to the endeavor (Willcox & Nambu 2007). While this point will be returned to shortly (Section 3.6), suffice it to say here that the 13% of hunters who reported that they hunted with family members may feel more culturally entitled to hunt and therefore, may be less likely to give the practice up in the face of various incentive schemes.

Two-fifths of all admitted poachers reported that they hunted with unrelated friends or acquaintances.[201] This is significant since it underscores a fundamental point about how illegal hunting is viewed by the local community. Research by Leader-Williams (1993) posits that social barriers to illegal activity often exist but are typically circumvented if bushmeat hunting is viewed as a cultural necessity and/or traditionally rooted. The fact that individuals hunt with unrelated local people offers supports for the idea that bushmeat hunting has few—or relaxed—social barriers.

This idea of wide social acceptance may be particularly evident in Meatu District where the six respondents reported poaching with an average of 105 people per trip.[202] In the context of social acceptance, such high numbers of community members who make regular hunting forays implies that poaching is not a shunned activity conducted by ostracized members of a community. A total of 18 respondents also volunteered that some of their hunting partners came from surrounding villages. Evidence such as this corroborates the idea that poaching may be widely accepted and not limited to specific villages or communities.

3.6 – Why is poaching occurring?

Understanding why people poach is of fundamental importance for management efforts to succeed in mitigating the activity. Like many locations in sub-Saharan Africa where poaching occurs, the most oft-cited driver is poverty and its associated lack of protein and income (Ndibalema & Songorwa 2007; Kaltenborn et al. 2005; Loibooki et al. 2002; Hofer et al. 2000). On a finer scale, factors that influence an individual's

[201] Categories to this question were not mutually exclusive.
[202] One respondent in Meatu District reported hunting with an average of approximately 200 people per hunting trip.

decision to poach include fluctuations in mean monthly densities of wild herbivores (Nyahongo et al. 2005), the distance between a poacher's residence and the protected area (Holmern et al. 2007; Campbell & Hofer 1995) and its associated travel time (Nyahongo et al. 2005), rainfall amounts (Kaltenborn et al. 2005), the likelihood of arrest (Holmern et al. 2007), and the value of the resources acquired (Nyahongo et al. 2005). While all of these finer-scale factors are undoubtedly important, this dissertation will focus instead on the ultimate driver of poverty with a corollary discussion concerning the effects of tradition. For organizational purposes, therefore, the question of why poaching occurs will be structured into the following three sections consisting of income (3.7), expenditures (3.9), protein (3.10), and traditions (3.11). Factors relating to the likelihood of arrest will be addressed in part II.

3.7 – Income as a driver as poaching

Approximately 60% of all admitted poachers directly cited income or monetary shortages when asked why they first decided to engage in poaching activities. Other responses, such as food shortages (8%) or the lack of employment (7%), are likewise indirectly linked to income shortfalls. On the flipside, income generation surfaced as the leading benefit that admitted poachers receive from SNP (Figure 3.7.1).

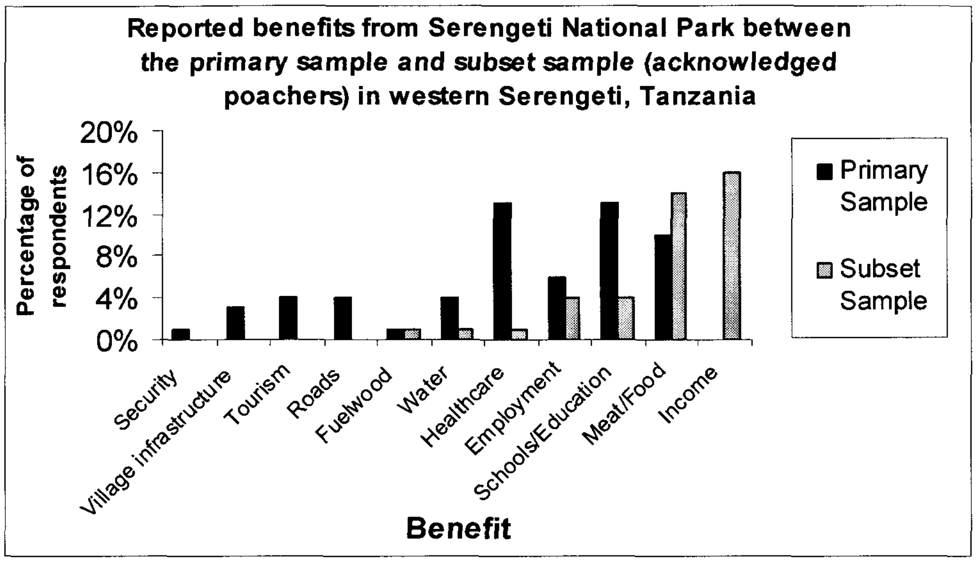

Figure 3.7.1 – Reported benefits received from Serengeti National Park between the primary sample (N = 722) and the subset sample (N = 77).

The generation of income through the sale of bushmeat is also largely—and ironically—responsible for why a greater percentage of hunters from the subset survey (55%) reported that they receive benefits than the primary sample (31%) ($X^2 = 22.619$, df =1, $p < .001$). While bushmeat was also recognized as a benefit through its contribution of protein, recent research suggests that it is the market sale rather than the consumption of wild foods that is most important to households living in poverty (de Merode et al. 2004). The aforementioned study adds an important caveat, however, stating that the income generated by bushmeat sales remains insufficient to lift households above the threshold of extreme poverty (ibid). Due to the potentially important ramifications of this claim, and the overall significance that bushmeat plays in income generation for poaching households, the next few paragraphs will examine income generated by poaching households in greater depth.

The sale of bushmeat has been officially illegal in western Serengeti since 1942 when a law stated:

> *No person shall, except with the written permission of a Provincial Commissioner, sell or offer for sale the meat derived from any wild animal.* (Government Notice no. 368 of 1942, TNA)[203]

Bushmeat sales have been illegal in western Serengeti since this time with the exception of government initiated sales occurring through initiatives such as the Serengeti Regional Conservation Project (SRCP). The SRCP was initialized in 1985 as a means of organizing village conservation committees for the oversight of natural resource development. The project is funded by the Norwegian Agency for Development Corporation (NORAD)[204] and originally targeted toward 14 total villages, seven in Serengeti District and seven in Bunda District.

One of the primary objectives was for villages located near SNP to directly benefit through the sales of legally harvested bushmeat and skins at greatly discounted prices. Through systematized game cropping by government employees, meat and skins were—and continue to be—offered to villagers with the ultimate aim that the added benefit of inexpensive meat and animal products will reduce levels of local poaching (Kaltenborn et al. 2008).

Although well-intentioned, consensus among several studies is that the incentive-based SRCP has done little to reduce poaching in western Serengeti and largely failed as a community-based initiative (Kaltenborn et al. 2008; Holmern et a. 2002; Barrett & Arcese 1998). A study by Holmern et al. (2002), for example, showed that the economic

---

[203] Quotation found in: Shetler J.B (2007). See References at end of chapter.
[204] NORAD has provided US$ 330,000 from 1998-2002.

value of poaching wildlife is 45 times greater than the sum of benefits received from the SRCP's legal game-cropping initiatives. While measuring the success or failure of the SRCP is out of the scope of this study, suffice it to say here that such forms of direct and indirect assistance from government departments, non-governmental organizations (NGOs), political parties, and other outside agencies have rarely been able to lift significant numbers of households out of poverty (Krishna 2004). A study by Krishna (2004) found that such assistance was important for a household's escape from poverty just 8% of the time. Rather than various forms of supplemental food or income, various forms of personal enterprise (e.g., employment, development of a trade, etc.) were required 54% of the time while remittances from relatives played a role in 42% of the cases (ibid) (Chapter 2 – Section 2.24).[205]

With the noted exception of the SRCP, all other forms of bushmeat sales—both private and governmental—remain illegal. The majority of enforcement effort in western Serengeti has focused on patrols in SNP and its buffer zones. To a lesser degree, various law enforcement agencies in western Serengeti such as those directed by the Grumeti Fund for Conservation have performed house raids in which any and all forms of discovered bushmeat have been confiscated and the homeowners relegated to fines and/or imprisonment (C. Lewis – pers. comm.).

Despite the existence of such enforcement measures and bushmeat's illegal status, the product, locally called "kimoro," was relatively easy to find at the time of this research. On two separate occasions during survey work, interviewers were offered giraffe (*Giraffa camelopardalis*) and impala (*Apyceros melampus*). If the study team, as relative outsiders, was able to obtain bushmeat without even asking for it, there is

[205] Percentages exceed 100% because cases were not mutually exclusive.

insufficient reason to believe that it is not easily accessible to all western Serengeti villagers. One key informant added that bushmeat plays a significant role in western Serengeti communities as it is the primary food offered to guests.

In addition to commonly being offered to guests, bushmeat appears to be frequently sold in the poacher's village of residence. A little over half (51%) of admitted poachers reported that they sold bushmeat in their home village (Figure 3.7.2).

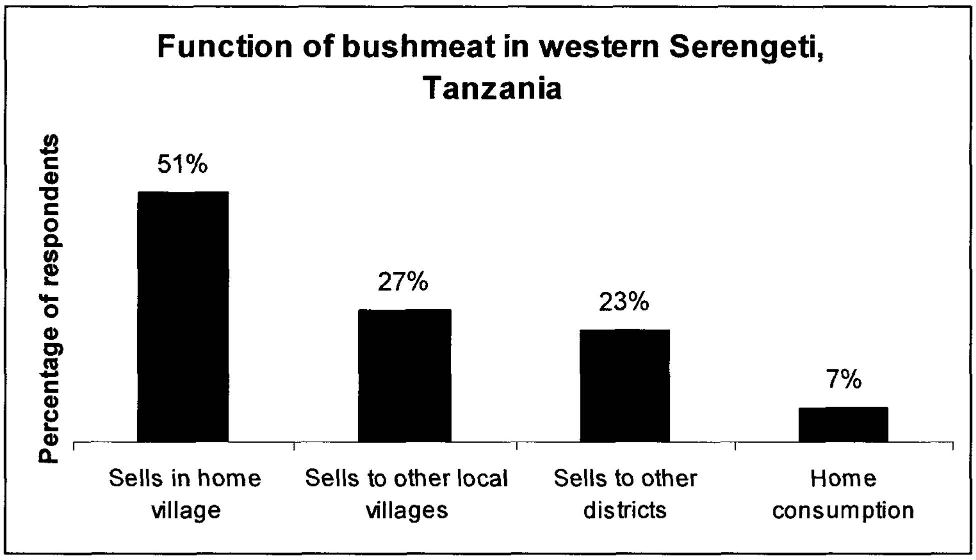

Figure 3.7.2 – Function and destination of bushmeat as reported by the subset sample of acknowledged poachers (N = 104). Categories were not mutually exclusive.

A lesser number of poachers (23%) reported selling bushmeat to contacts in neighboring villages. One informant revealed that bushmeat is placed into plastic containers (typically used for water and milk collection) and strapped onto bicycles. Poachers—or middle men—pedal through villages and marketplaces calling out "maziwa," which is Swahili for "milk." Buyers take that as a cue that bushmeat is available and transactions are made accordingly. This is an extremely effective distribution technique as it renders the sale of bushmeat virtually indistinguishable from the sale of milk. The ubiquity of western Serengeti bicyclists in possession of similar plastic containers further confounds any would-be law enforcement from effectively policing the illegal trade.

The market for bushmeat is not, however, limited to the local village and surrounding villages. Bushmeat appears to travel widely as some even leaves Tanzania altogether. Over a quarter (27%) of all respondents sold meat to individuals who regularly commute into western Serengeti from other districts. Key informants revealed that people of Luo descent, who are known primarily for their involvement in the fishing trade in Lake Victoria along the eastern shores in Tanzania and Kenya, act as primary middlemen for bushmeat. In addition to bicycles, the Luo use covered pickup trucks which make routine trips into western Serengeti. When profitable amounts of bushmeat are obtained, the Luo transport it north to Itegi village in Tarime District, which is located on the border between Tanzania and Kenya. From here, bushmeat is purported to travel to many locales, including Nairobi.

Such a wide-ranging market for bushmeat implies that demand is considerable for bushmeat coming out of Serengeti. This could explain why programs such as the SRCP that attempt to curb demand are unlikely to succeed. While demand may be satiated locally, for example, it may still be high in other districts, regions, or even neighboring countries. To satisfy bushmeat demand at all spatial scales is a difficult—if not impossible—endeavor. Rather, effort should be concentrated on reducing supply. This dissertation argues that the best way to do this is through opening up employment opportunities to the local population who are doing most of the poaching and by improving existing forms of enforcement (Chapter Two – Section 2.21).

Somewhat surprisingly, just 7% of acknowledged poachers reported using bushmeat for home consumption. This is likely an underestimate, however, as key informants from the subset sample claimed that they subsisted entirely on bushmeat when out on hunting trips. Since many poachers spent approximately three weeks per month hunting, much of their produce is necessarily consumed for daily sustenance. Regardless, what is clear is that bushmeat hunting in western Serengeti is largely conducted for the primary purpose of obtaining income. This will be elucidated further in the sections to follow.

3.8 – Income generated from bushmeat sales

The five primary sources of income for the subset sample of poachers included bushmeat sales, agricultural sales, seasonal wage labor, beer sales, year-round employment, and livestock sales. As expected, bushmeat sales (TZS 482,094) composed nearly three-quarters (73%) of total income.[206] In stark contrast, livestock sales (TZS 19,241) contributed just 3% to a poacher's total income. This supports the notion that poachers are generally livestock deficient (Loibooki et al. 2002). Although livestock ownership is generally viewed as a source of wealth (ibid), the lack of income derived from livestock does not necessarily support the idea that poachers are poor, however. A comparison of total income between the subset sample and the primary sample revealed that acknowledged poachers generated TZS 243,471 more income per year ($F = 15.215$,

[206] Totals for bushmeat sales were tallied based on the reports of 'active' (respondents who had hunted during the last 12 months and 'inactive' (respondents who had hunted sometime during their lives) interviewees. For inactive respondents, the sum for the most recent year they had hunted was used for this calculation.

df = 1, $p < .001$).[207] A closer inspection of income sources between the two groups better accounts for this difference.

Income derived from livestock accounted for the largest difference between the two groups. The primary sample generated over three times more income (TZS 70,238) for livestock sales than the subset sample (TZS 19,241) ($F = 7.481$, df = 1, $p = .006$).

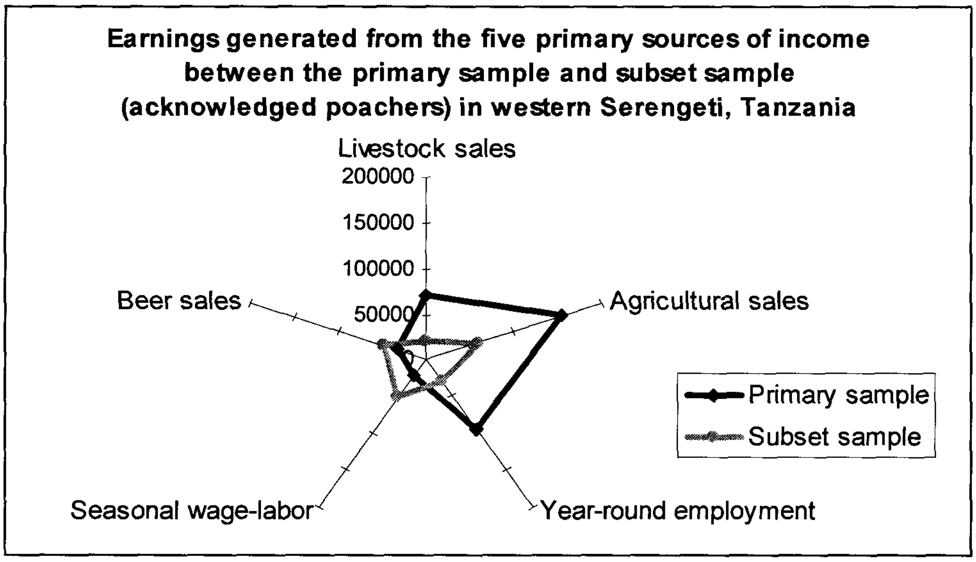

Figure 3.8.1 – Earnings generated from the five primary income sources. Differences were significant for livestock sales ($F = 7.481$, df = 1, $p = .006$), agricultural sales ($F = 6.619$, df = 1, $p = .010$), year-round employment ($F = 3.814$, df = 1, $p = .051$), seasonal wage labor ($F = 5.791$, df = 1, $p = .015$). Differences in beer sales were not significant.

A similar trend was seen for agricultural sales where the primary sample earned an average of TZS 152,822 compared to TZS 58,272 for the subset sample ($F = 6.619$, df = 1, $p = .010$). The only other income source in which the primary sample generated a significantly greater amount of income was year-round employment earnings. After agricultural sales, year-round employment contributed the highest average income (TZS 94,834) to households compared to TZS 28,846 for acknowledged poachers ($F = 3.814$,

[207] Interview #280 from the primary sample was deemed an outlier and not used for this analysis due the household's disproportionate income earnings (TZS 106,240,000)

df = 1, p = .051). Due to the ramifications this finding has on this study's thesis, this point will be returned to Chapter Four.

Although acknowledged poachers earned a lower amount of income from year-round employment, they earned nearly double the amount of income (TZS 51,000) than that of respondents from the primary sample (TZS 21,748) for seasonal wage labor (F = 5.971, df = 1, p = .015). The sale of beer also contributed to poaching households (TZS 48,376) and the primary sample (TZS 32,469) although the difference was not significant between the two groups.

The differences observed between income sources reveal several important realities. First, the fact that many poaching households generate income from five sources in addition to that derived from poaching reveals they—like nonpoaching households sample—also diversify their livelihoods. In other words, it is incorrect to assume that poachers hunt exclusively at the expense of doing other income-generating activities. Second, income generated from poaching seems to be an attempt by poaching households to make up for their shortfalls in livestock sales, agricultural sales, and employment.

The actual amount of income that is generated through bushmeat sales is strongly linked to the amount of time that an individual devotes to poaching. The correlation between income earned and time spent poaching was stronger for months poached per year (Pearson R = .484, p < .001, N = 86) than with days poached per year (Pearson R = .350, p = .002, N = 77). Poachers appear to earn more income from hunting during the dry season because they are often able to harvest a greater number of animals per trip. For example, hunters killed 2.5 animals per month per person in the dry season (June –

September) compared to 1.3 animals per month in the wet season (January – April). The difference between the number of animals harvested during the dry and wet seasons is likely due to two factors. One, respondents reported that rivers are more difficult to cross during the wet season and vegetation often impedes hunting ability. Two, the presence of the wildebeest migration during the dry season months often allows for greater numbers of animals and higher catch rates in snare lines. Since wildebeest comprise such a large percentage of the annual harvest (48%) (Figure 3.8.2), it is of little surprise that the presence of the migration allows for a higher number of animals harvested.

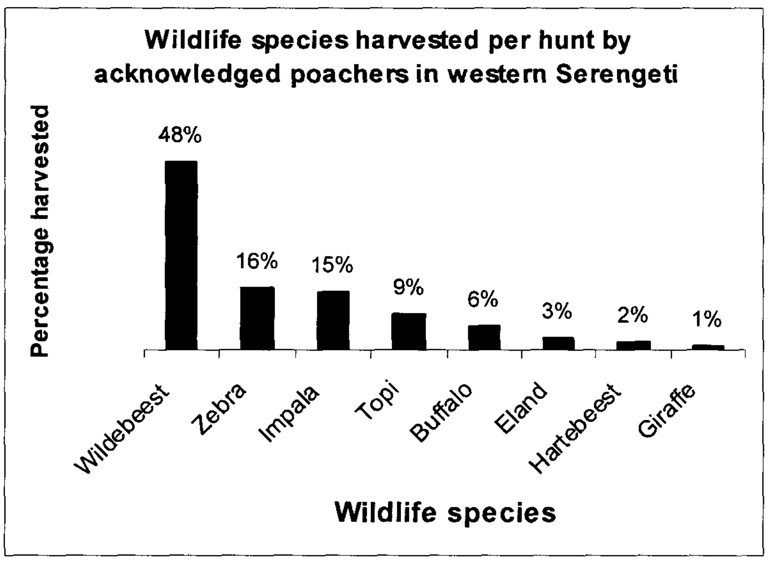

Figure 3.8.2 – Wildlife species harvested per hunt by a subsample of acknowledged poachers (N = 25)

Despite the greater probability of harvesting more animals during the dry season, it can still be profitable to hunt during the wet season due to stochastic market forces and price fluctuations of common protein sources (Ndibalema & Songorwa 2007). Income earned from poaching was not related to the number of years that an individual had hunted, however, suggesting that experience may not confer appreciable levels of income because the primary method of poaching – snaring – does not appear to require great levels of sophistication.

3.9 – Expenditures

An analysis of expenditures between the subset sample of acknowledged poachers and the primary sample of western Serengeti households reveals that poachers spent more average money in the last year than did the core sample. Whereas households from the primary sample spent TZS 744,833, poaching households spent TZS 980,496 ($F = 7.649$, df = 1, $p = .006$). This difference could be attributed to the fact that poaching households have more money to spend, as indicated by their higher incomes than the primary sample. Or, it could be attributed more to a more profligate lifestyle, the possibility of which will be discussed shortly.

Categorically, poaching households spent more money than households in the primary sample on food purchases, flour grinding, monthly goods, and beer (Figure 3.9.1).

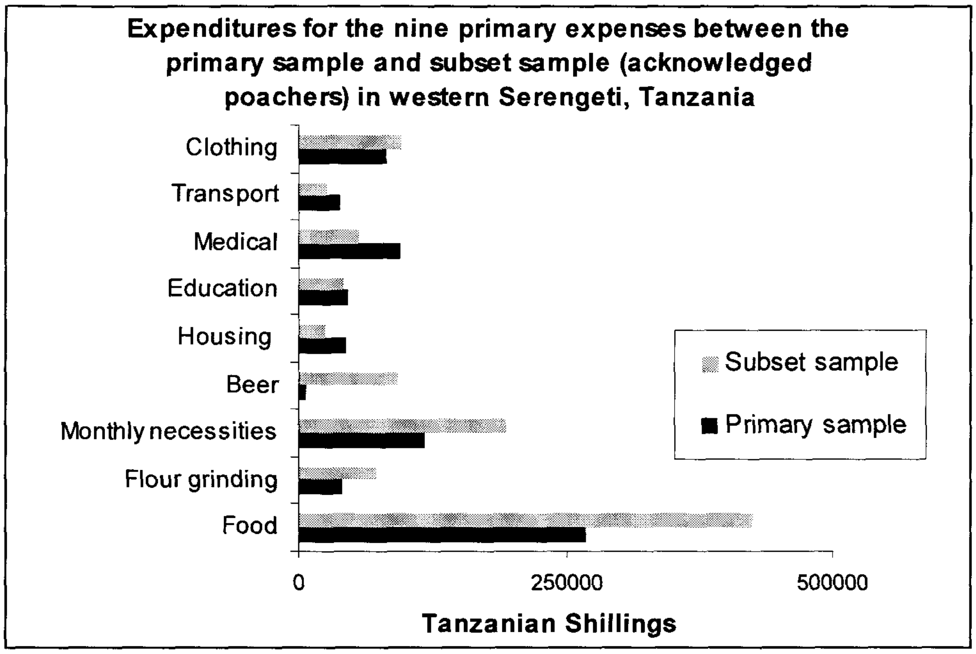

Figure 3.9.1 – Expenditures between the primary sample (N = 722) and the subset sample (N = 104). Differences were significant for expenses pertaining to food (F = 17.35, df = 1, p < .001), flour grinding (F = 20.10, df = 1, p < .001), monthly necessities (F = 14.66, df = 1, p < .001), beer (F = 17.59, df = 1, p < .001), and housing (F = 3.72, df = 1, p = .054)

Households from the primary sample, on the other hand, spent more money on housing costs. Food purchases for poaching households amounted to TZS 423,884 compared to TZS 267,830 for the primary sample (F = 17.35, df = 1, p < .001). The implication from these findings suggests that poachers sell the meat they procure in order to buy grains (e.g., maize, millet, sorghum, etc.). This hypothesis is further substantiated by the seemingly minor fact that poaching households also spent significantly more money on the grinding of flour than did households from the primary sample (F = 20.10, df = 1, p < .001). Research here did not uncover why poaching households choose to sell bushmeat rather than use it in lieu of crops. One reason might be that many people prefer grain crops such as maize over bushmeat.

Monthly necessities constituted the second highest expense for poaching households and the primary sample alike. For this expenditure, which included such goods as matches, kerosene, tea, etc., poaching households spent an average of TZS 193,976 compared to TZS 116,346 for households from the primary sample ($F = 14.66$, df = 1, $p < .001$). Recalling that there was not a significant difference between household sizes, possible explanations for this are highly speculative. Poaching households may need to spend more on monthly goods solely because one (or several) members poach. Embarking on routine poaching excursions likely requires supplies unaccounted for in the survey which could have resulted in their higher expenses. Or, poaching households may spend more on monthly necessities simply because they had a higher income than households from the primary sample. A longitudinal study of income and expenditures over several years might better explain this difference.

As noted in the previous section, households from the two samples earned equivalent amounts of income from the sale of beer. There is a conspicuous difference, however, for money spent on beer. Poaching households spent an average of TZS 91,948 on beer compared to households from the primary sample that reported spending TZS 6,264 ($F = 17.59$, df = 1, $p < .001$). The fact that poaching households spent nearly 15 times more money on beer resulted in these households incurring an annual net loss of TZS 43,572. Conversely, households from the primary sample incurred an annual net profit from beer which amounted to TZS 26,205. This suggests that the primary sample, which likely includes a majority of nonpoaching households, may be generating significant amounts of income from poaching households. This is corroborated by the fact that poaching households reported that they imbibed 5.6 servings of local beer per month which was five times more than the 0.6 servings per month that households from the primary sample revealed ($F = 55.130$, df = 1, $p < .001$). Although conjecture, it may also imply that poaching is associated with a certain kind of lifestyle, where a portion of income generated from the activity is squandered rather than used to enhance the asset base of the household. Money spent on beer could, for example, be spent on enlarging livestock herds or investing in better housing materials. The lifestyle associated with poaching that is referred to here may be partly derived from idleness that results from a lack of employment opportunities (Kaltenborn et al. 2005).

The only category that households from the primary sample spent a significantly greater amount of money on was housing costs ($F = 3.72$, df = 1, $p = .054$). This could be associated with the aforementioned speculation concerning a less judicious lifestyle practiced by poaching households. Or, it could be attributable to the fact that poachers do not spend as much on housing materials because they have less available time to build due to frequent hunting trips. Expenditure categories that did not show large differences between the two groups included: education, medical, transport, and clothing.

3.10 – Protein

In her work, *Imagining Serengeti*, Historian Jan Shetler interviewed an elder of western Serengeti who remarked, "If hunger comes, you have to know how to hunt" (Shetler 2007). Such a comment is characteristic of the historical impetus to hunt which included subsisting through times of famine and crop failure. Shetler asserts that when men went to trade grain in times of famine, they would take wild or domestic animal products in addition to dried bushmeat (ibid). Now, however, the emphasis on bushmeat hunting has seemingly shifted to income generation. But this point may be little more than semantic. Although poaching is ostensibly for income, the fact that poachers spent significantly more money per year on food purchases than households from the primary sample reveals that ultimately, poaching is likely driven by food—and more specifically—protein shortfalls (Chapter Four). Bushmeat appears to play a more direct role as a protein source for at least 12% of households from the subset survey (Section 3.10) Similarly, 14% of respondents from the subset and 10% of respondents from the primary sample revealed that protein is a benefit they received from SNP (Figure 3.7.1).

The most common sources of protein in western Serengeti are beef, goats & sheep (also referred to here as "shoats"), and poultry (chickens & ducks). Much of the rationale for protein deficiency as a driver of poaching is because poaching households are thought to be livestock poor (Loibooki et al. 2002). This paradigm is supported here for cattle, goats, and sheep. Regarding cattle, poaching households owned an average of 1.0 cow compared to households from the core sample that owned an average of 6.0 ($F = 10.79$, df = 1, $p < .001$) (Figure 3.10.1)[208]

[208] Interview #280 from the primary sample was judged an outlier and left out of the analysis. The respondent reportedly owned 800 cattle and sold 100 during the previous year.

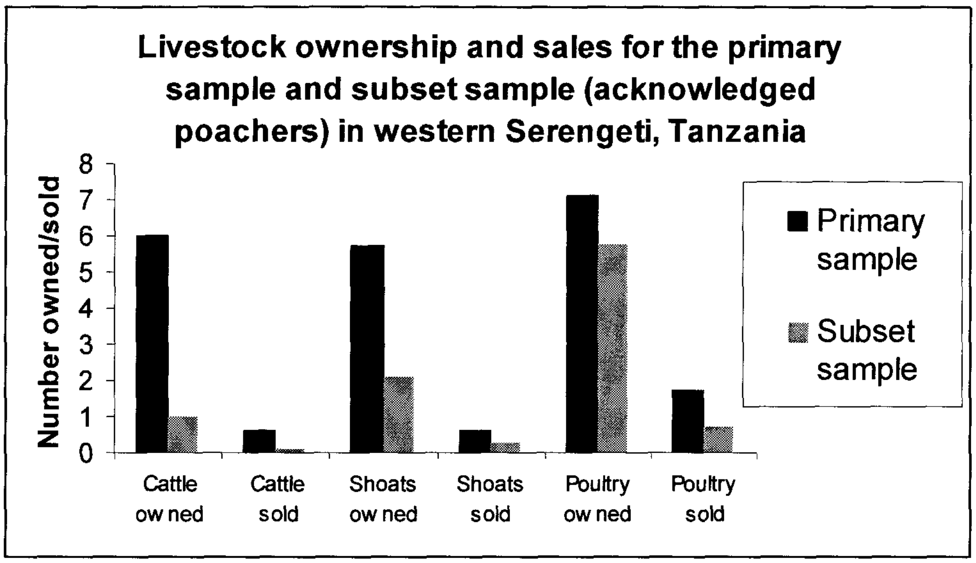

Figure 3.10.1 – Differences in livestock ownership and sales for the primary sample and subset sample. Significant differences were observed for cattle ownership ($F = 10.79$, df = 1, $p < .001$), cattle sales ($F = 9.44$, df = 1, $p = .002$), and shoat ownership ($F = 14.28$, df = 1, $p < .001$)

As a result, poaching households sold fewer cattle ($F = 9.44$, df = 1, $p = .002$) and earned less annual income from cattle sales ($F = 6.60$, df = 1, $p = .010$) than households from the primary sample.

Similarly, poaching households owned fewer goats and sheep. Poaching households owned an average of 2.1 shoats compared to 5.7 for households from the primary sample ($F = 14.28$, df = 1, $p < .001$). The two groups did not differ significantly, however, in how many shoats were sold in the last year or from income generated from selling shoats. This is likely because shoats, unlike cattle, are slaughtered more frequently than they are sold. With fewer shoats owned, poaching households were therefore limited in their consumption of this common protein source.

The number of poultry owned, sold, and the income earned from poultry by the two groups did not differ significantly. This is likely because poultry are much less expensive to obtain and less labor-intensive than cattle, goats or sheep. Both groups owned between ~5.8 and ~7.1 chickens (and ducks) and sold between 0.7 and 1.7 per year for earnings amounting to less than TZS 5,150. As will be argued in Chapter Four, increasing poultry holdings and turning it into a substantial and reliable protein source could potentially offset general protein deficiencies among poaching households and nonpoaching households alike.

Arguably more revealing for protein than the number of livestock owned is the dietary recall of protein sources. Two of the ten surveyed protein sources—beef and "dagaa"[209]—may factor more significantly than the others in shedding light on a household's decision to poach. In addition to owning fewer cattle, poaching households consumed fewer servings[210] of beef in the last month of recall than did households from the primary sample (Figure 3.10.2).

---

[209] 'Dagaa' is the local name for a small fish common to Lake Victoria, often caught in nets and usually 1-2" in length.

[210] The term "servings" here is defined as the number of days the protein source is consumed in the household. As such, a serving typically constitutes two meals (the afternoon and evening meals).

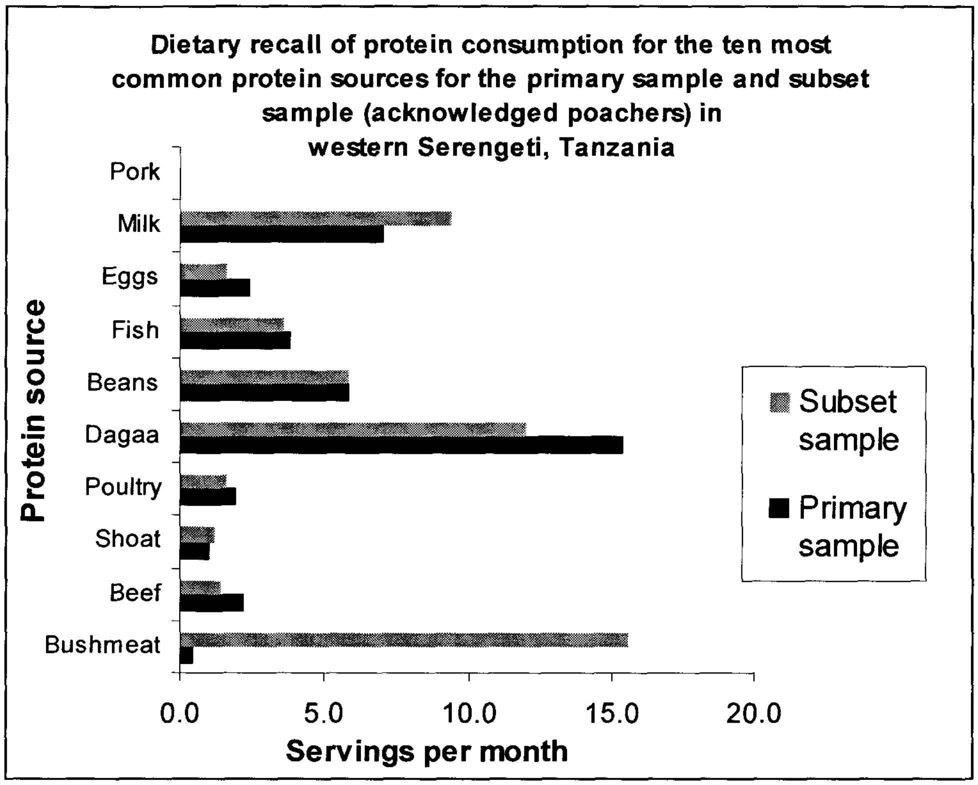

Figure 3.10.2 – Dietary recall for protein sources for the primary sample (N = 722) and the subset sample (N = 104). Differences were significant for beef ($F = 4.720$, df = 1, $p = .030$), dagaa ($F = 8.704$, df = 1, $p = .003$), and bushmeat ($F = 992.14$, df = 1, $p < .001$).

Whereas the primary sample consumed 2.2 servings per month, poaching households consumed 1.4 ($F = 4.720$, df = 1, $p = .030$). Dagaa provided the greatest number of monthly servings of protein for the primary sample (15.4) compared to 12.0 for the subset ($F = 8.704$, df = 1, $p = .003$). Poaching households appear to offset the significant shortfalls in their beef and dagaa servings with bushmeat intake. Bushmeat intake featured the largest difference between the two groups with poaching households consuming bushmeat 15.6 times per month compared to 0.4 times per month for households from the primary sample ($F = 992.14$, df = 1, $p < .001$). None of the other seven protein sources featured significant differences between the two groups.

Also noteworthy in a discussion about protein intake as a possible driver for poaching concerns the distance a household lives from SNP. Holmern et al. (2007) reported that an illegal hunter's home village had an average distance to the closest protected area border of 12.8 km (range: 2.2 – 40.8km, N=83). This implies that poaching households are clustered relatively close to SNP's boundaries and that beyond 40.8 km, the benefits of poaching are likely offset by the cost of travel time (Nyahongo et al. 2005).

These ideas are further illuminated when viewed in the context of an analysis conducted here that examined annual servings of beef and shoat as a function of distance. Results showed that while shoat intake increased closer to a protected area boundary, beef intake decreased (Figure 3.10.3).

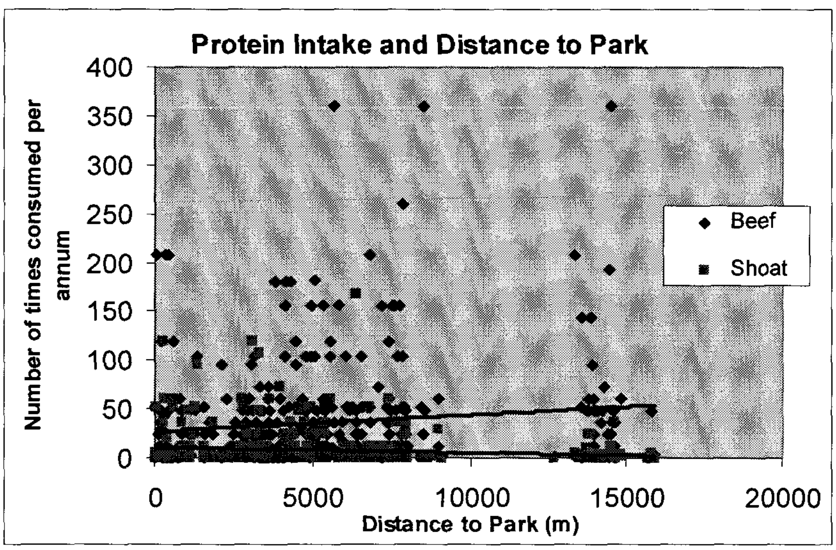

Figure 3.10.3 – Protein intake of the primary sample (N = 722) as a function of distance of the household from the nearest protected area boundary.

Although data from this research cannot confirm this idea, ideas presented here may imply that reduced beef intake among households located near SNP is correlated with a greater percentage of households that poach. Less speculatively, the relationship between beef intake and distance substantiates the notion that shortages of beef likely drives poaching to a greater extent than do similar shortages of goat or sheep.

3.11 – Traditions

Cultural and traditional motives for hunting are much more tendentious and difficult to tease apart than the aforementioned motives of income and protein. Despite hunting being described as a "way of life" for western Serengeti people, its impact is thought to be less significant than economic and consumptive drivers (Kaltenborn et al. 2005). Embedded in traditional hunting is the idea that knowledge and skill are passed from father to son, thereby increasing skills and adding affiliative social values to the activity (Willcox & Nambu 2007). Hunting is thought to be so deeply-rooted in tribes such as the Ikoma and Kuria, in fact, that several respondents reported they will continue to hunt regardless of improved food security and income (ibid).

The inveterate position of hunting in western Serengeti communities can be heard in "emergence stories" among the Ikoma, Issenye, Ngoreme, and Nata peoples which all include a hunter in addition to a farmer in descriptions of how their respective communities emerged (Shetler 2007). The Nata people (whom collectively constituted a large portion of the primary sample), for example, reported in oral testimonies that the first Nata man was a hunter while the first Nata woman was a farmer. These two individuals stayed together to form the Nata ethnic group (ibid). Shetler (2007) uncovered from another origin story that the Ikoma people came from Sonjo (east of SNP) because their ancestral father, who was a prophet, had given them wild animals to herd like livestock.

Although ancestral ties to hunting have grown more tenuous in recent generations due to intermarriage and migration, it still appears to play a role with a portion of western Serengeti hunters. When asked why they first decided to poach, for example, 7% of the subset of acknowledged poachers responded that they were doing so because their father and grandfather had done it. Although this figure is low, cultural transmission of hunting knowledge from father to son is much higher. Approximately 60% of interviewed poachers reported that they were taught how to poach by their father or grandfather compared to 39% who were taught primarily by unrelated persons (Figure 3.11.1). Moreover, respondents from the subset sample reported began hunting at the age of ten and had continued for an average of 14.5 years.

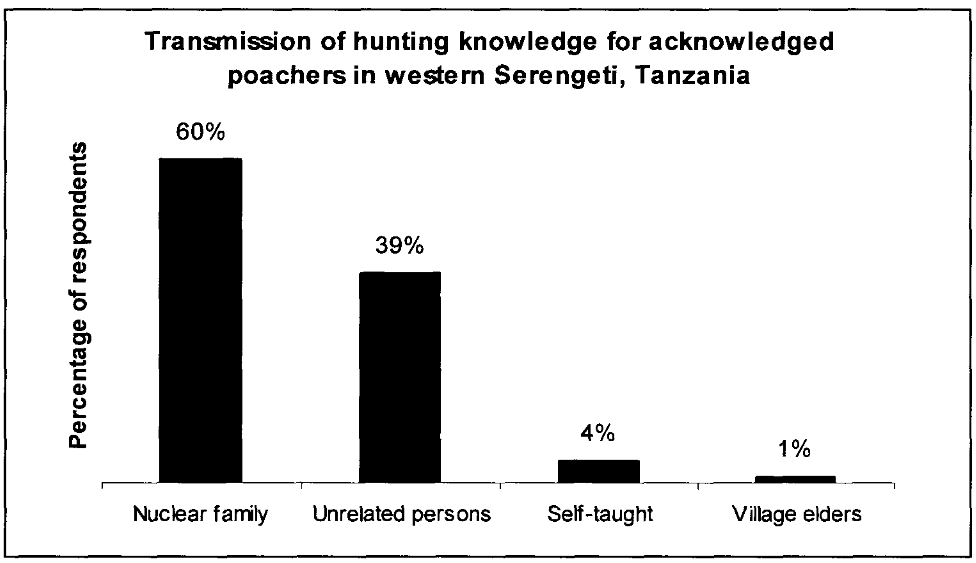

Figure 3.11.1 – Transmission of hunting knowledge for acknowledged hunters (N = 104) in western Serengeti, Tanzania. Total percentage exceeds 100% because cases were not mutually exclusive.

Adding a layer of complexity is the fact that the father figure for over half (55%) of the poachers had died before the poacher was able to wed and over a quarter (28%) of the respondents had suffered losses of both parents. Economically, the majority of poachers (58%) ranked their parents as poor while a third ranked them as middle class. Under one-tenth (9%) ranked their parents of rich. These figures are reflected in the fact that just one-quarter of the fathers and 2% of the mothers of current poaching households had ever procured year-round employment.

The basic premise here is that poachers appear to be the offspring of relatively poor parents who teach them how to poach, often die at relatively early, and are otherwise unable to contribute financially to the lives of their offspring. This supports an idea Shetler (2007) has proposed that present-day poachers turn to poaching as a way to earn income that will be spent on obtaining necessary bridewealth for marriage. In the past, bridewealth in Mara Region was attained primarily by cattle raiding (Fleisher 2000). Now, however, the frequency of cattle raiding has decreased significantly due to higher levels of governmental enforcement and stricter penalties (ibid). As a result, poaching may be serving as a substitute allowing younger men a relatively quick means for generating the requisite cash needed for obtaining sufficient bridewealth.

Part II.

3.12 – Costs of poaching

In any discussion concerning why individuals hunt and the time they invest in doing so, it is paramount to consider the costs. This is because the levels of illegal resource extraction in western Serengeti are influenced both by the value of the acquired resources and the costs associated with their acquisition (Nyahongo et al. 2005). Ndibalema and Songorwa (2007) suggest that western Serengeti poachers consider the tradeoffs between costs and benefits continuously and subconsciously, such that their preferences are motivated primarily by profitability. Apparently, knowledge about costs and benefits are disseminated quickly and widely and is not limited solely to the network of actively poaching households. A study by Holmern et al. (2007), for example, revealed that when the value of the resources exceeds the costs, more illegal hunters engage in the activity, rather than a constant number of hunters increasing their effort.

Historically, the greatest cost incurred by hunters was the possibility of contracting malaria and sleeping sickness brought about by the tsetse fly (Shetler 2007). This greatly regulated the intensity and duration of hunting trips as the farther afield poachers went, the greater the chances they incurred for contracting one of these prevalent diseases (ibid). Currently, however, the potential for contracting malaria or sleeping sickness is perceived to be of far less importance than other potential costs. When poachers from the subset were asked why they viewed poaching as a "difficult" activity, responses were roughly divided between the prospect of encountering a wild animal (39%), the possibility of arrest, fines and imprisonment (32%), and excessive travel times (31%).[211] (Figure 3.12.1)

---

[211] Total percentage exceeds 100% because categorical responses were not mutually exclusive.

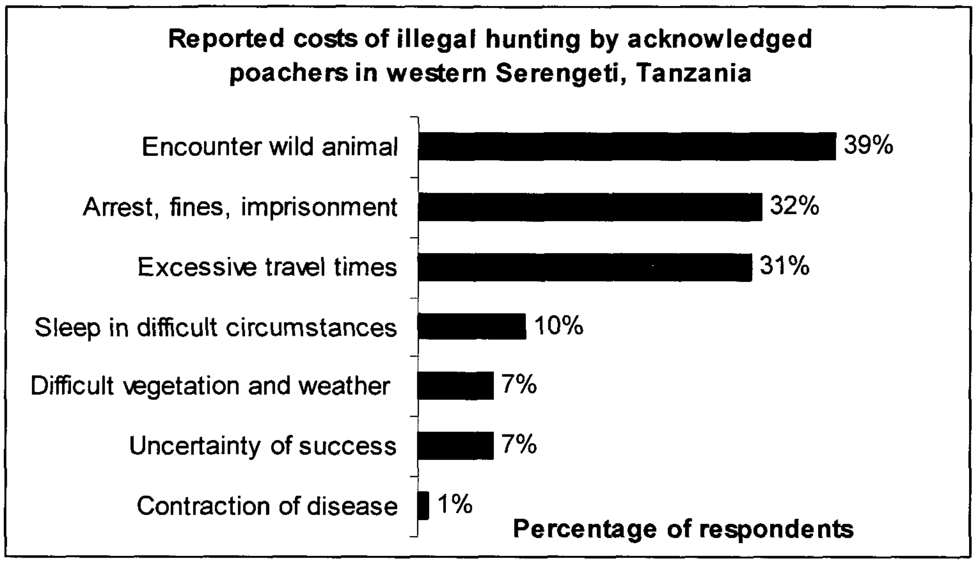

Figure 3.12.1 – Reported costs of illegal hunting by subset sample of acknowledged poachers (N = 104) in western Serengeti, Tanzania. The total percentage exceeds 100% because categorical responses were not mutually exclusive.

Some of the other leading reported costs included difficulty of sleeping in the bush (10%), harsh vegetation and weather (7%), and uncertainty of success (7%). In contrast to historical costs, just 1% of respondents listed the possibility of contracting disease.

Over four-fifths (83%) of the respondents perceived hunting as 'difficult' when asked to categorize the activity between "easy," "moderately difficult," or "difficult." Despite the fact that such a large percentage of poachers viewed the activity as difficult, they obviously still perceive that the benefits outweigh the costs or, according to theory, they would have chosen an alternative livelihood strategy. From preceding sections, it has become clear that primary benefits include added income (Section 3.8), protein (Section 3.10), and possible affiliative social and cultural values that are associated with the activity (Section 3.11). According to theory, these benefits must be sufficient to offset the costs incurred. Although sufficient, these benefits are not easy to obtain as just 9% of the respondents categorized hunting as easy or moderately difficult.

For the relatively few respondents who categorized hunting as easy or moderately difficult, half reported that they perceived it this way simply because they were used to the activity. The obvious implication here is that such individuals have been involved in the activity for quite some time. Such individuals, as will be argued shortly, should not be the target of anti-poaching programs that seek to mitigate illegal hunting levels. It appears that a certain percentage of poachers are simply more inclined to the activity because their paternal ancestors did it, or, simply because they enjoy the activity and the associative "thrill" involved with its associated costs and hardships. Poachers with such proclivities may be disinclined to give up the activity regardless of the presence of incentive schemes. Rather, this study makes the case that anti-poaching resources and energy should be directed toward individuals who gauge the activity as difficult and indicate that they are primarily hunting due to shortfalls in income or protein.

Approximately 36% of respondents who perceived hunting as easy or moderately difficult explained that hunting provides a fairly efficient means of obtaining income. Another 7% reported it is an easy means of supplementing existing protein sources. Until such perceptions change and all poachers view the craft as a difficult means of obtaining income or protein, poaching will likely continue to some degree in western Serengeti.

Two separate responses to the question of difficulty merit special attention here. One respondent reported that the existence of wire and the snaring method makes poaching an easy endeavor. This response highlights the fact that it is the methodology of poaching—snaring—that makes it easy. Although limiting access to wire in western Serengeti would be a formidable—if not impossible—task, it does suggest that anti-poaching enforcement agencies could benefit from a thorough investigation of how, when and where wire snares are used. Equipped with more detailed information about snaring procedures, enforcement effort could be channeled more effectively.

A second response similarly dealt with the methodology of poaching. Rather than mentioning wire, however, the respondent remarked that the use of cell phones and donkeys makes poaching easy. The mention of these two hunting aids is of particular interest here because it shows how poachers are incorporating technology, (e.g., cell phones), with more primitive means such as snaring and donkeys. Donkeys are advantageous over bicycles due to their capacity to carry large quantities of dried meat across uneven and difficult terrain.

Cell phones, on the other hand, are allowing poachers to alert one another of anti-poaching rangers and of key areas where animals are concentrated. This demonstrates that hunting strategies are ever evolving and syncretistic. If enforcement is going to be effective, therefore, it will have to counteract not only well-tested methods (e.g., donkeys and snaring), but also more recent technological developments such as cell phones (and someday soon, possibly Global Positioning Systems technologies).

3.13 – Fines, imprisonment, arrest, injury, & opportunity time

The principal costs of poaching can be discerned in two ways. One way is to determine the actual costs that poachers have incurred through such documents such as court records. A second way is to measure how poachers themselves perceive the costs that are associated with their activity. While the first method may be more objective, the second way might actually be more useful. As Shetler (2007) has pointed out, this might be because anti-poaching success depends to an equal measure on the psychological illusion of an effectual presence as much as it does on actual effort and force. In the sections to follow, each of these methods—objective records and poacher perceptions—will be compared and contrasted to most clearly portray the current costs that a western Serengeti poacher faces.

3.14 – Fines

Over half (59%) of the sample of the interviewed hunters had been arrested at least once for poaching-related offenses (Figure 3.14.1).

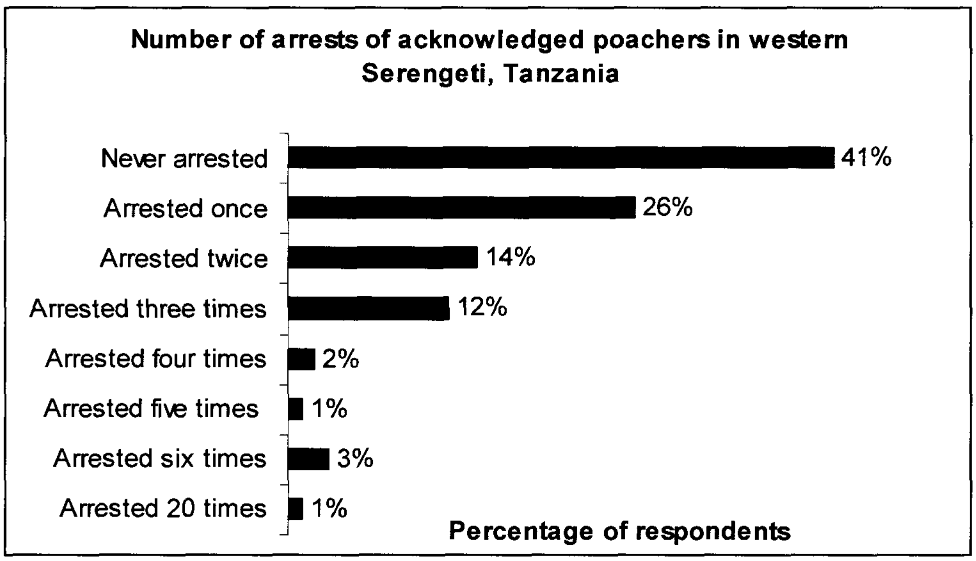

Figure 3.14.1 – Number of arrests of the subset sample of acknowledged poachers (N = 104)

Over one-tenth of these (14%) had been arrested twice while 12% had been arrested at least three times. Since research on these arrests did not include information concerning enforcement effort, little can be said regarding the probability of arrest. What is noteworthy, however, is that one-third of the arrested hunters had been arrested multiple times. There are two important implications to draw from this. One, it may imply that livelihood options are so limited in western Serengeti that hunting is necessary for basic survival, hence why individuals return to hunting even after being arrested. Or two, the penalties that are incurred after arrest may not be severe enough to deter hunters from reengaging with the activity (Section 3.16).

Over 95% of recorded offenses were meat-related (Figure 3.14.2).

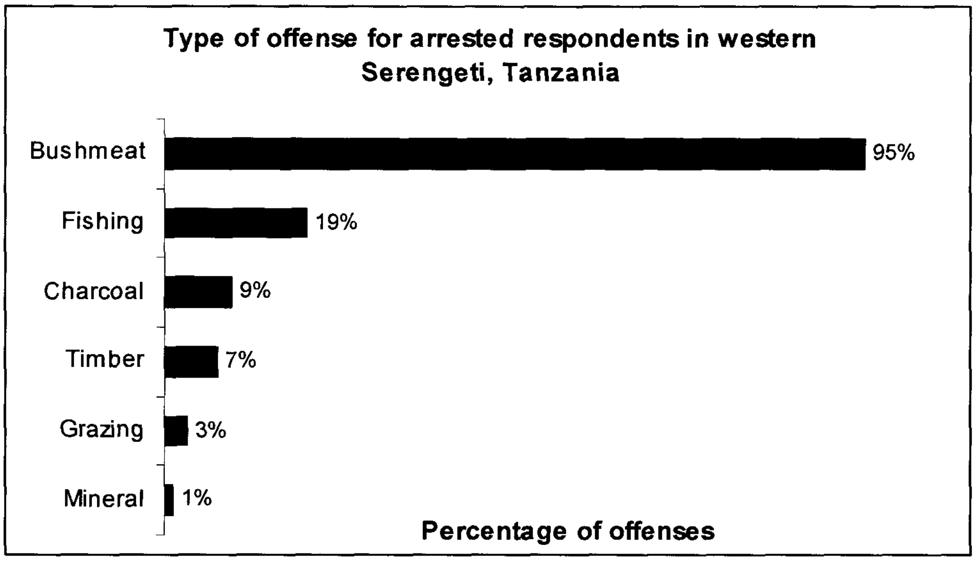

Figure 3.14.2 – Offense types for arrested respondents. Percentages exceed 100% because 22% of the subset sample (N = 108) were charged for multiple offenses at the time of arrest.

When arrested, however, over one-fifth (22%) of the respondents were charged with multiple offenses including fishing (19%), charcoal collection (9%), tree harvesting (7%), grazing (3%), or mineral extraction[212] (1%). Being arrested for multiple offenses is not uncommon due largely in part to the practice of snaring. Once snare or trap lines are set up, hunters often have time to partake in other activities, such as fishing or mineral extraction. One hunter reported that his group subsists largely on fish caught from the Grumeti River while they harvest bushmeat nearby. The passive dimension of snaring

[212] In western Serengeti, mineral extraction was largely for gold among arrested poachers. Other common mineral extraction in the region is for salt.

may also be connected to the higher consumption of beer among illegal hunters than the primary sample ($F = 55.130$, df = 1, $p < .001$).

Arrested hunters (N = 61) paid an average of 1.2 fines while one individual reported having paid five fines over his lifetime. When examined in light of the entire subset of 104 hunters, an individual paid an average of 0.7 fines despite poaching an average of 7.2 months for the last 14.5 years. This means that the average hunter paid .05 fines over his entire career. In terms of the total average months poached, a hunter paid .01 fines.

The actual amount that a hunter paid depended on several factors that included age, type of offense, number of animals harvested, who made the arrest,[213] and number in hunting party (Holmern et al. 2007). The average fine amounted to TZS 49,142[214] while the range spanned from TZS 5,000 to TZS 300,000. In the context of the preceding discussion, this implies that the average hunter has paid TZS 39,510 over the entire course of his hunting lifetime. Since a hunter generated TZS 482,094 for selling meat in the last 12 months alone, the amount of the fine is obviously extremely minor in comparison and therefore, unlikely has acted as much of a deterrent.

3.15 – Imprisonment

There are two types of prisons in Tanzania, a central prison and an "open farm" prison. Arrested hunters who have not yet been convicted are held in a central prison. Without procurement of sureties (Section 3.17), individuals cannot leave a central prison as all affairs are conducted within the facility. Although central prisons are largely

[213] Fines issued by TANAPA were often higher than those levied by villages.
[214] The average fine amount is likely a low estimate due to inflation.

reserved for holding unconvicted offenders, they also regularly serve as the location where convicted hunters carry out their respective sentences. The other type of Tanzanian prison, an Open Farm Prison, exists solely for hunters who have been convicted. In these facilities, convicts conduct revenue-generating work for the prison.

Two key informant interviews were conducted with the head prison officials at the central and open farm prisons in Serengeti District. At the central prison located in Mugumu, archival data for convicted hunters was obtained from prison officials for the years 2000-2006 (Figure 3.15.1).

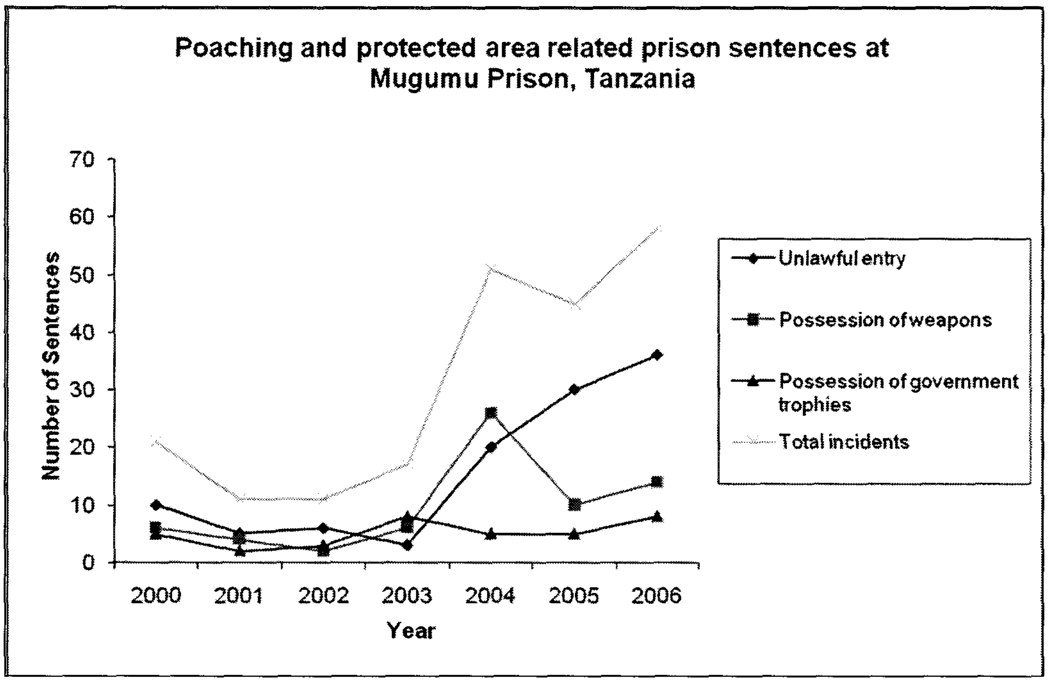

Figure 3.15.1 – Number of prison sentences levied at a central prison in Mugumu prison, Tanzania. Only includes individuals unable to pay the requisite fine.

Figure 3.15.1 shows that the number of total incidents (and resulting prison sentences) have increased nearly by nearly three times over the seven-year span. It is important to note that sentences in Figure 3.15.1 are only for convicted persons who were unable to pay the requisite fine.[215] The head prison official (S. Kata) remarked that roughly half of all prisoners leave the central prison before their sentence is up.

Since the amount of anti-poaching effort that went into making these arrests was not documented by enforcement personel, explanations for this increase in prison sentences can only be speculated. Four explanations—or a combination thereof—are possible. One, there may have been a greater presence of anti-poaching personel and greater enforcement effort in recent years. The establishment of local village game scouts and recent creation and prominence of the nongovernmental organization known as the Grumeti Fund for Conservation is a likely factor in this.

Two, the increase in convicted hunters may be due to in-migration. In this case, hunter effort may have remained steady but the number of hunters may have increased. As will be discussed in chapter four, survey results and district records support this conjecture. Three, hunters may have increased their hunting effort over the past seven years resulting in more arrests. If farm- and nonfarm-related livelihood opportunities are becoming more limited, local hunters may have had to increase their effort in recent years. Four, recalling that prison sentences here are only for individuals unable to pay a fine, it could be that poverty has increased in Serengeti District during the last seven years. If such is true, then it is likely linked with in-migration and general population growth that is resulting in less land and associated wealth per capita (Wittenemyer et al. 2008).

Regardless of anti-poaching effort, what Figure 3.15.1 does clearly show is that the total number of hunting-related cases in which the individual was unable to pay a fine

---

[215] Includes only those individuals who were unable to pay the requisite fine. Prison officials reported that many others are arrested but win their case or pay the necessary fine and get let off.

is remarkably small compared to the overall population living in the region. Recent estimates reveal that approximately 2 million people are currently living along the margins of SNP (Kaltenborn et al. 2008) and a fairly recent study (Campbell et al. 2001) suggested the presence of at least 60,000 poachers in and around SNP. Assuming that the number of poachers has not changed since 2001, and that approximately half of all convicted hunters (120) are kept at the Central Prison, then just 0.2% of all males over the age of 16 were arrested.

One scenario, of course, is that these data suggest that bushmeat hunting in western Serengeti is rare. Based on the analyses put forth in this chapter, however, this is unlikely. More plausible is exactly the opposite, namely that hunting has become a more common livelihood activity and has increased in scale and scope in western Serengeti (Section 3.25). Part of the reason may be tied to the results presented here. With such a low chance of actual arrest and conviction, hunting may be becoming more common and widespread in the region (Section 3.17).

An interview at the open farm prison was conducted with the head official, Mr. Steven Kato. Kato stated that 70% of transgressions of the individuals serving time at the open farm facility were hunting-related. According to Kato, a key question that needs to be asked is why prisoners who are released often return to hunting. Kato claimed the primary reasons for this are cultural and practical. In regards to cultural motivation, Kato remarked, "Their [the prisoners'] god is in the park. They go to worship at a tree." Although unstated as such, the implication here is that many people go to the park for the dual reasons of worship and poaching. Kato asserted that a need for protein comprised the primary practical reasons for hunters to return to hunting after arrest. He cited the high human population density of Serengeti District as a limiting factor which has taken away land required to support livestock. Not enough livestock necessitates that a fraction of the population turn to hunting to obtain protein.

Prison sentences at one of the two facilities were the second most common form of punishment for poaching after fines. Over one-third (35%) of the subset sample of hunters reported that they had spent time in prison. Total duration of jail time, however, amounted to just 0.7 years per arrested hunter. The maximum number of years in prison for any respondent was 10 years. Across the total subset, a hunter spent an average of 0.4 years in prison despite poaching for 14.5 years. If sentences of arrested hunters were spread across a hunter's total hunting career, the average respondent was imprisoned for an average of 10.1 days per year.

One of the reasons that jail sentences were short is because nearly two-thirds (61%) of arrested hunters posted bail sometime after being arrested. For half of the cases in which bail was posted, it was by nuclear—or extended—family members. In another 17% of the cases, bail was posted by an unrelated individual(s). In a scenario that was likely typical, one imprisoned hunter reported that his wife acquired the necessary money to bail him out of jail with income generated from selling beer. If the point of imprisonment is to remove hunters from the local population and thereby mitigate poaching, it is abundantly clear here that sentences are not long enough to effectively accomplish this end. Several contextual examples are presented in the following section to shed further light on this idea.

3.16 – Contextual examples

One example of the inefficacy of the penalties of enforcement involves a 44-year-old man of Ikoma descent, who is here referred to as "Juma." The first time Juma was arrested was in 1975 when he was 12-years-old. Although most kids of this age are beaten and released, Juma went to jail for six months. Three years later, he was arrested again. This time, he went to court, won his case, and was released. In 1981, he was arrested on two separate occasions and went to prison. Each time, however, he was released after posting TZS 10,000 for bail. The next year, he was arrested two more times. He won one case but lost the other, and served one year in prison as a result of being in possession of two wildebeest which he had killed. In 1985, he was also arrested twice. He won the first case but lost the second, and served a three-year prison sentence as a result of having killed a giraffe.[216] As soon as he was released in 1988, Juma was arrested again and served eight more months in prison, this time for being in possession of weapons in a protected area. He was arrested 11 more times with the final arrest coming in 2007, during the year of the interview for this study. In each of these subsequent arrests, however, Juma won his case.

In summary, Juma has spent five years and two months in jail and posted a total of TZS 20,000 as bail. He has never paid a fine and has subsisted primarily on the proceeds of hunting since he was 10-years-old. In the past, he has supplemented his hunting income by selling charcoal, selling beer, and mining for gold. Currently, he sells cotton, which provides him with the equivalent of one month's earnings from hunting

[216] Arrests that involve being in possession of larger mammals often carry longer prison sentences and larger fines. Sentences and fines vary with each species (Boma Cathbert, personal communication).

(TZS 60,000). Juma transfers about one-quarter of his earnings to his children for schooling, three of whom are currently in secondary school.

There are two reasons for outlining Juma's hunting account in detail. First, although he had been arrested more than any other interviewed hunter, his pattern of hunting and arrest was relatively common for all the respondents. From his narrative, it is clear that the threat of arrest, and even the completion of considerable prison sentences, temporarily removed a hunter from the local population, but did not cause the individual to choose an alternate lifestyle. Second, Juma's account outlines another pattern – that of being arrested without incurring subsequent penalties. Of the 20 times that Juma was arrested, he went to court and won his case 14 times. If Juma's case is at all representative, which subsequent sections will show that it is (Section 3.17), it means that a hunter can be arrested without incurring any form of penalty 70% of the time. This supports the argument presented here that the threat of arrest, arrest, and associated fines and/or prison sentences, do little to dissuade hunters from their craft.

The second contextual example highlights the inconsistency of penalties, which is perhaps an even more problematic aspect of enforcement than the severity. The account of this individual, here called "Boniface," illustrates the inconsistency. Boniface was interviewed at a Serengeti District prison (Tabora B) that borders SNP and occurred the very day he was being released from a six-year prison sentence. The 33-year-old man of Issenye ethnic descent was unmarried, childless, and still faced two more years of parole with community service.

Boniface had suffered the ill fortune of having been arrested the very first time he had hunted. After spending 15 days bushmeat hunting with six other people near

Banguesi Mountain in the Ikoma Game Reserve, he was arrested for three counts including unlawful entry into a protected area, possession of weapons without permission (a bow-and-arrow), and unlawful possession of government trophies without permission.[217]

Despite having journeyed on only one hunting excursion, Boniface was sentenced to six years of prison without the possibility of bail. This stands in sharp contrast to the aforementioned case involving Juma, who had hunted over 32 years and had never served a sentence over 3 years. Due to the sheer volume of illegal hunting cases, of course, the judicial system obviously cannot be expected to take each hunter's personal history into account when affixing prison sentences.

Based on the example given, this study argues that a records system which assigns graduated sentences to convicted offenders could be implemented without a great deal of cost and oversight. Sentences of reasonable length could be assigned to first-time offenders and be subsequently increased for repeat offenders. Until such a system exists, however, arrest penalties will remain inconsistent whereby first-time offenders may possibly suffer more severe penalties while repeat offenders face lighter ones. Furthermore, this uneven treatment of repeat offenders will not dissuade them from their practices. This idea will be reexamined in the following section (Section 3.17).

3.17 – Court reports

As mentioned in the methodology (Section 3.2), illegal hunting-related court records were obtained for Serengeti and Meatu districts. Despite repeated requests,

[217] The government trophies Boniface was arrested for included: four wildebeest (*Connachaetus taurinus*), three zebra (*Equus Burchelli*), two topi (*Damaliscus korrigum*), and two impala (*Aepyceros melampus*).

attempts to obtain similar records in Bunda district were disallowed by the acting judicial magistrate. Even without records from Bunda, however, comparisons between Serengeti and Meatu districts reveal some noteworthy findings.

For an individual to be arrested for illegal hunting and issued a court hearing, several steps must take place. First, the anti-poaching personel who made the arrest (e.g., TANAPA rangers, Tanzania Wildlife Division rangers, Village Game Scouts) must deliver arrested individuals to the local police department. The police then perform an interrogation and produce a statement of charges. Afterwards, the anti-poaching unit is issued a maximum of one week to procure witnesses while the defendants remain in custody. In nearly all cases, witnesses are other rangers who helped in the arrest (pers. comm. M. Mafwere).

If defendants plead not guilty, they are transferred to one of the district jails, where they remain from 14 to 28 days. Duration of jail time depends on whether or not the defendant is able to obtain "sureties." A surety is validation of another person who ensures local officials that the defendant will appear in court on his or her appointed day. If a surety is obtained, the defendant can be released after 14 days. If a surety is not obtained, the defendant must remain in jail for 28 days. During this time, police transfer the statement to the Tanzania Wildlife Division whose responsibility is to create a "certificate of value." This certificate is later used as evidence in court of the alleged monetary value of the wildlife species that were harvested.

All arrested hunters who plead "not guilty" must appear in court. Actual court appearances, however, depend on the court's calendar. In Serengeti District, poaching is the most common crime that is prosecuted. Due to this, the Serengeti District Court devotes the first and third weeks of hearings solely to illegal hunting cases.[218] During these weeks, rangers—or other witnesses—come to court. If witnesses fail to attend court for work- or home-related reasons, then the case is adjourned and rescheduled. If summoned witnesses fail to show up a third time, however, then the case is dismissed and the defendant is discharged. This phenomenon is actually quite common as anti-poaching rangers have work schedules that often preclude them from participating in court hearings (pers. comm. B. Cathbert).

If defendants plead guilty, they are often required to pay fines which vary according to the value of the wildlife species they were arrested with. If unable to pay requisite fines, defendants are transferred to district court where they are required to serve prison sentences (usually one year or less). If the defendant pleads guilty and is under the age of 18, they get beaten with strokes of cane (12 strokes maximum).

There are three hunting-related infractions (Wildlife Conservation Act #12 of 1974). The first count is unlawful entry into a protected area without a written permit. Although individuals are frequently arrested for this infraction, penalties are often much less severe—or ignored altogether—if this is the only count charged. One reason for this is that entering protected areas can be necessary for western Serengeti people during times of raids or theft. During cattle raids, for example, Maasai have historically raided at night and used the protected areas as an avenue of retreat as they returned to their villages with the stolen livestock. When livestock are realized to be missing, western Serengeti peoples have been documented as banding together to pursue their stolen property through the protected areas without taking the time to gain permits. Other reasons for entry can be cultural. Many respondents of Ikoma and Nata descent, for

[218] Research did not indicate how poaching compares to other crimes in Meatu District.

example, still recognize and pay homage to several sacred sites that now lie within protected area boundaries. These and many similar cases are often overlooked by the court and individuals who commit this infraction are rarely penalized.

The second count involves unlawful possession of weapons in a protected area without written permission. This includes all manner of weapons which are often: knives, spears, machete, and bow-and-arrow (Section 3.5). Like the first count, individuals are rarely charged for this second count in isolation of the other two counts. Several hunters mentioned anecdotally that this count is fairly easy to avoid as they are often able to cast off their weapons in the bush when pursued by anti-poaching units.

The third count is the most common hunting-related infraction. This involves unlawful possession of government trophies without written permission[219] One possible explanation for the prevalence of this charge is that it may be the most difficult infraction to conceal. To generate profit, bushmeat must necessarily be transported out of protected areas and distributed to buyers. Since greater quantities of meat generate greater profits, hunters have a fiscal incentive to obtain and distribute as much meat as possible. Greater quantities of meat, of course, are more difficult to conceal. Moreover, hunters may be arrested inside or outside of protected areas if they are in illegal possession of bushmeat or a government trophy (e.g., skins, horns, teeth). Values of government trophies vary depending on the wildlife species. Monetary values are often greater for carnivores, large-bodied species, and rarer animals (Wildlife Conservation Act #12 of 1974).

[219] This count was officially amended by Act #10 of 1984.

3.18 – Meatu District court records

A total of 170 hunting-related cases between the years 2003-2007 were obtained from the Meatu District courthouse. According to the Meatu District judge, these have constituted the only hunting-related cases presided over during this time period. Over nine-tenths (93%) of the sample was of Sukuma origin while the remaining ethnicities included Maasai (2%), Nyiramba (2%), Nyisanzu (2%), and Ndengeleko (1%). Although males of Sukuma descent are most represented here, it does not necessarily imply that Sukuma are more heavily involved in poaching activities than other ethnic groups. Rather, it is more likely due to the simple fact that Meatu District is largely dominated by the Sukuma ethnic group. Illegal hunting in other districts, like Serengeti (Section 3.19), appears to be similarly dominated by the ethnic group most firmly established. What is evident here, however, is that hunting in southwestern Serengeti is not limited to one ethnicity.

The majority of charges against arrested hunters involved the illegal possession of government trophies (98%). A smaller percentage of hunters were arrested for illegal possession of weapons in a protected area (33%), and unlawful entry into a protected area (5%). Although the majority of hunters (66%) were charged with one count, approximately one-third (31%) of hunters were charged for two counts while 3% were charged with all three counts. Conventional wisdom might suggest that the more counts charged to an individual would likely result in a greater likelihood of a prison sentence. This, however, did not bear out as none of the five individuals that were charged with all three counts were sentenced to prison. Rather, four of the individuals had their charges withdrawn while one was acquitted.

Two-thirds of all individuals charged with the first count of unlawful entry into a protected area had their cases withdrawn while 23% of the cases are still pending and 11% were acquitted ($X^2 = 25.294$, df = 5, $p < .001$) (Figure 3.18.1).

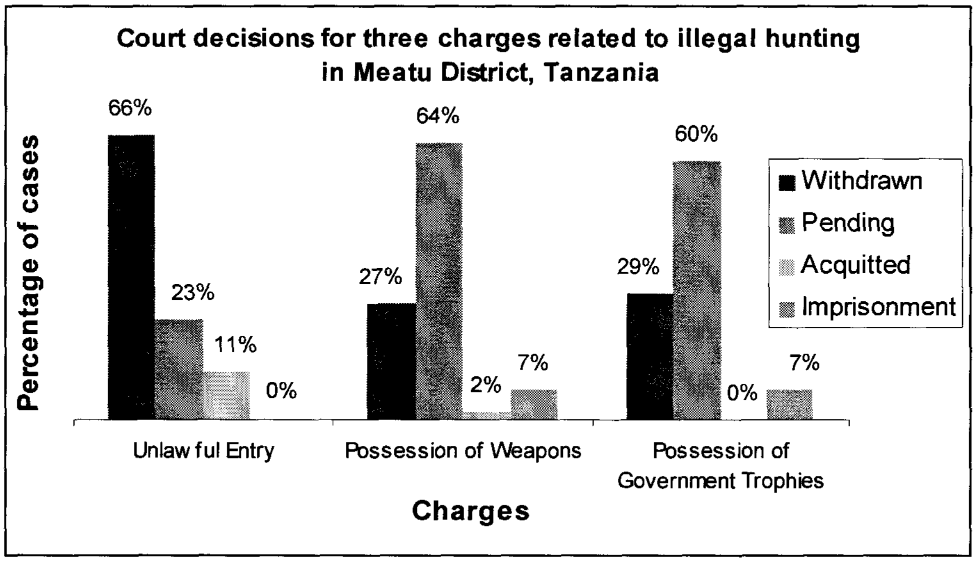

Figure 3.18.1 – Court decisions for three charges levied against arrested illegal hunters (N = ?) in Meatu District (2003-2007)

Regarding the second count of illegal possession of weapons in a protected area, 27% had their cases withdrawn while 64% had verdicts that were still pending. Approximately 7% of those charged with the second count were sentenced to prison while 2% were acquitted. Percentages for the third count of illegal possession of government trophies were similar those charged with the second count as 29% had charges withdrawn while 60% had verdicts pending and 7% were sentenced to prison.

These analyses reveal that individuals charged with the first count are more likely to have charges withdrawn and less likely to have pending verdicts. These realities, coupled with the fact that no individuals charged with the first count were sentenced to prison, may reveal that in Meatu District, the first count of unlawful entry into a protected area is not considered as serious as the latter two charges. Conversely, all 11 cases that resulted in prison sentences included individuals who had been charged with the third count, often in addition to other counts. This may suggest that the three charges are viewed on an ascending scale of severity with the third count being more serious than the first and second counts.

More than half (60%) of the cases have verdicts that are still pending. Over a quarter (29%) of the defendants have had their cases dismissed and been discharged without penalty. Under one-tenth (7%) were sentenced to prison, 3% had their cases transferred to other districts, 1% were acquitted.[220]. Unlike hunting-related cases in Serengeti District (Section 3.19), no individuals in Meatu were assessed fines. If all cases that are pending or were transferred to another district are eliminated from the analysis, the actual court verdicts resulted in four-fifths of the defendants being discharged with their cases dismissed. Under one-fifth (18%) were sentenced to prison terms while 2% were acquitted of wrongdoing.

Arrested hunters were 43-years-old on average. The youngest offender was 16 while the oldest was 80. Results from hunting cases showed that individuals sentenced to prison were older by an average of six years than those who had their case withdrawn ($F = 3.528$, df = 4, $p = .009$). Prison sentences averaged four-and-a-half years in length with a minimum sentence of one year and a maximum of seven years. The amount of time that individuals spent in prison did not depend on the number of charges or age of the individual.

[220] Not represented above is that 1% of the sample died while awaiting trial, which was considered anomalous.

3.19 – Serengeti District court records

A total of 916 total courts cases were collected in Serengeti District, over three times more than those collected in Meatu. In contrast to the court cases collected in Meatu, however, data from Serengeti District only represented a fraction of the hunting-related cases. Due to local restrictions by the presiding magistrate and time limitations for research, only one year—2003—included a full set of cases. Moreover, access was not granted to results from 2004 and only partial access was given to 2005-07. Even despite this, however, Serengeti District featured more than five times the number of hunting-related cases than Meatu District. Although this does not necessarily imply that poaching levels are higher in Serengeti than Meatu,[221] it does show that hunting-related court cases are much more common in northwestern Serengeti than southwestern Serengeti.

Of the 20 total ethnic groups recorded in the court registers for illegal hunting between 2003 and 2007, the three most common were Kuria (59%), Ikoma (12%), and Sukuma (8%). Of the three groups, the Ikoma have the greatest historical ties to hunting in the GSE (Shetler 2007). The Kuria, in contrast, are more historically tied to livestock husbandry (Fleisher 2000) while the Sukuma are known for a mix of agriculture and pastoralism (Coppolillo 2000). Echoing previous results described from the poacher subset questionnaire (Section 3.4), results here support the idea that hunting is a widespread activity in Serengeti District that is not limited to a few tribes and not strongly linked to ethnic background.

[221] Assertions cannot be made about the level of illegal hunting in each district because data concerning anti-poaching effort was not available.

Of the three hunting-related charges, a greater percentage of individuals were arrested for the first count of unlawful entry into a protected area (91%) than the second count of unlawful possession of weapons (87%) and unlawful possession of government trophies (67%). Over one-quarter (28%) of these cases are still pending.

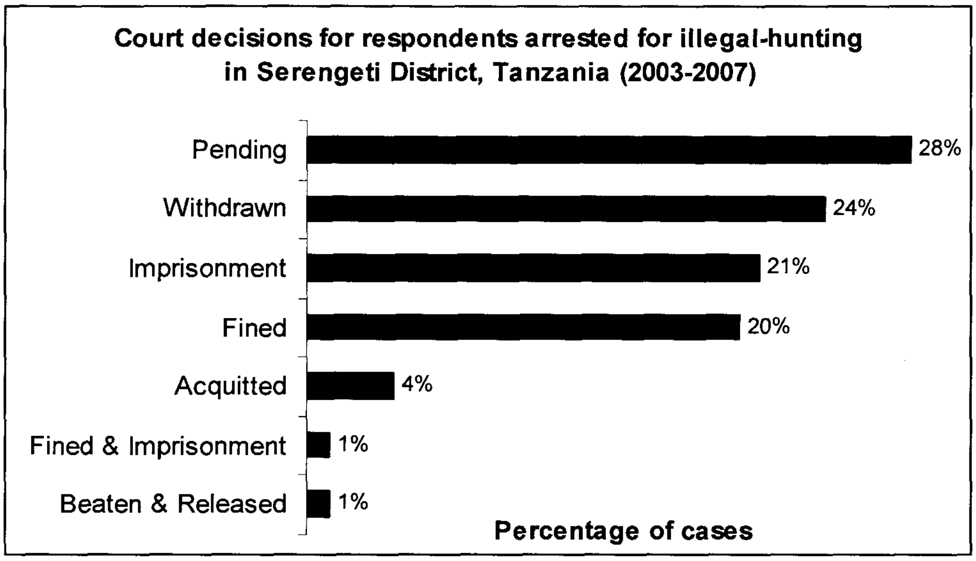

Figure 3.19.1 – Court decisions for respondents arrested for illegal-hunting in Serengeti District, Tanzania (2003-2007). Records presented here do not include all decisions presided over in illegal-hunting related cases.

For the other cases, approximately 24% of hunters had charges withdrawn, 21% were sentenced to prison terms, and 20% were ordered to pay a fine, and 4% were acquitted. In contrast to Meatu District that did not feature any fines, eight individuals in Serengeti District were subjected to a fine and imprisonment. Moreover, in Serengeti, nine individuals under the age of 16 were beaten with strokes of a cane and subsequently released.

3.20 – Game Reserve versus Serengeti National Park

In addition to forming a much larger sample size, the register of court cases in Serengeti District included information which was not available in Meatu District. Some information pertained to whether or not the illegal hunter was arrested in Serengeti National Park or in one of the park's three adjoining game reserves including Grumeti, Ikorongo, and Maswa game reserves.[222] Results here indicate that a far greater percentage of hunters were arrested in the national park (78%) than in a game reserve (23%). Assuming that the percentage of arrests is a valid measure of hunting activity and effort, several possible explanations may be put forth. One, it may be that wildlife are more abundant in the park than in the game reserves. This may be because the habitat of the park is better suited to wildlife, or, because the park offers wildlife a refuge that is further away from villages and human settlements. Two, vegetation in the park may better conceal hunters' activities than vegetation in the game reserves. This possibility might decrease a hunter's chances for detection. Three, it may be that hunters are hunting equally in the park and game reserves but anti-poaching enforcement is greater in the park.

Results from three other analyses add layers of complexity to the decision a hunter makes regarding hunting in a game reserve or the national park. Tests revealed that fines were higher for individuals arrested in the national park (TZS 13,696) than a game reserve (TZS 9,234) ($F = 7.050$, df = 1, $p = .009$). Similarly, hunters arrested in the national park served prison sentences (14.6 months) that were nearly double the length of those arrested in a game reserve (7.7 months) ($F = 9.732$, df = 1, $p = .007$). Due to the relatively lighter penalties incurred from hunting in a game reserve relative to the national park, it would seemingly be more judicious for hunters to hunt in game reserves

[222] The particular game reserve in which the individual was arrested in was not available in court documents.

rather than the national park. Since enforcement effort for the two protected area designations is unknown, however, such hypotheses cannot be tested.

Somewhat curiously, hunters arrested in a game reserve were slightly older (31.2 years) than those arrested in the national park (28.2 years) ($F = 8.744$, df = 1, $p = .003$). The majority of villages in western Serengeti are in closer proximity to game reserves than the national park. Noting the well-researched physical and financial costs of travel time in bushmeat hunting activities (Holmern et al. 2007, Nyahongo et al. 2006, Nyahongo 2005), these results may suggest that older hunters are traveling shorter distances to hunt than younger hunters.

What these results show more concretely, however, is the fact that many hunters are traveling through game reserves to access wildlife in the national park. This simple and seemingly obvious finding may suggest that game reserves offer an insufficient buffer zone in the prevention of illegal hunting from human populations west of Serengeti.

Court case results in Serengeti District suggest that a greater percentage of hunters arrested in a game reserve have their charges withdrawn (35%) than those arrested in the national park (22%) (Figure 3.20.1).

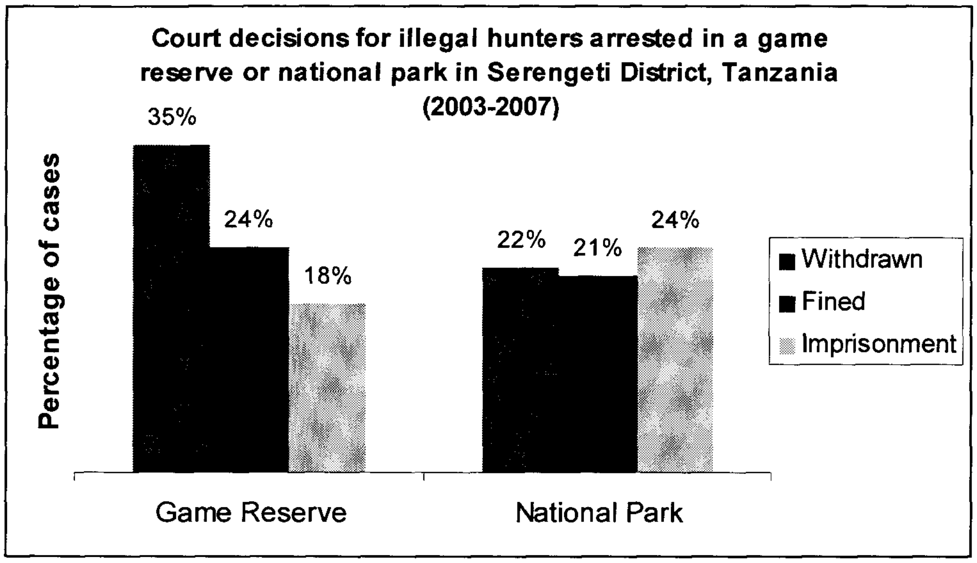

Figure 3.20.1 – Court decisions for illegal hunters (N = 916) arrested in a game reserve (Ikorongo, Maswa, or Grumeti) or Serengeti National Park in Serengeti District (2003-2007) ($X^2 = 23.147$, df = 7, $p = .002$). Decisions with pending, acquittals, and transfers were not included in this analysis. Results here do not include all illegal-hunting related court decisions for this time period.

Moreover, a lesser percentage of hunters arrested in a game reserve are imprisoned (18%) than those arrested in a national park (24%). Rather than prison sentences, it appears that fines are the more common form of punishment for individuals caught in a game reserve (24%) than for those caught in the national park (21%) ($X^2 = 23.147$, df = 7, $p = .002$). Considering that the average fine in Serengeti District was TZS 12,621, which is relatively low in comparison with average annual income, this is likely a less severe form of punishment than a prison sentence.

3.21 – Comparison of court records

A comparison of court records from Serengeti and Meatu districts for the years 2003-2007 reveals some interesting differences. The average age of hunters in Serengeti District was 29 years which was significantly lower than Meatu District in which hunters averaged 43 years old ($F = 160.102$, df = 1, $p < .001$). Assuming that hunters of all ages in both districts have relatively equivalent probabilities of being caught, results here suggest that a different demographic is hunting in each respective district. Since the average hunter is 14 years younger in Serengeti, it may be that a greater percentage of hunters in that district are hunting to obtain income for bridewealth (Shetler 2007) than in Meatu. For hunters not motivated by bridewealth, the older age of Meatu hunters may imply that hunting in that definitively more arid region is driven more by drought and related crop failures. The youngest arrested hunter in either district was 10-years-old while the oldest was 80. Such a large range between the youngest and oldest hunters suggests that motivations for hunting may be extremely different.

In addition to age, the three hunting-related counts charged to individuals in the two districts varied significantly. In Serengeti, 91% of hunters were charged with unlawful entry into a protected area compared to just 5% of hunters in Meatu (X^2 = 6.104, df = 1, $p < .001$) (Figure 3.21.1).

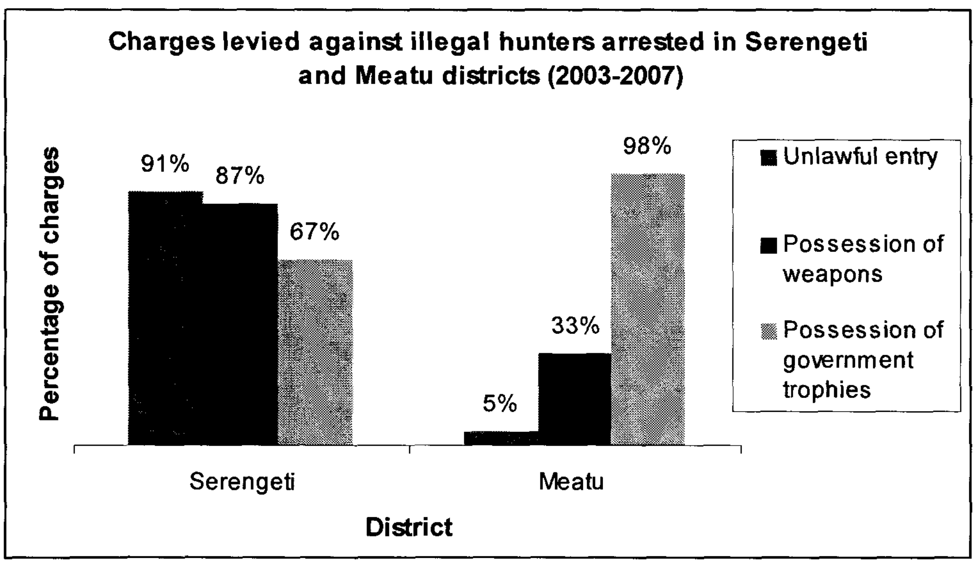

Figure 3.21.1 – Charges levied against illegal hunters arrested in Serengeti District (N = 916) and Meatu District (N = 170) between the years 2003-2007. Results were significant for the charges of unlawful entry (X^2 = 6.104, df = 1, $p < .001$), illegal possession of weapons in a protected area (X^2 = 2.414, df = 1, $p < .001$), and illegal possession of government trophies (X^2 = 67.754, df = 1, $p < .001$).

Similarly, a greater percentage of Serengeti hunters (87%) were arrested for unlawful possession of weapons than Meatu hunters (33%) ($X^2 = 2.414$, df = 1, $p < .001$). The trend is reversed, however, for the third count of unlawful possession of government trophies. For this count, nearly all hunters arrested in Meatu District (98%) were charged compared to two-thirds (67%) of hunters in Serengeti District ($X^2 = 67.754$, df = 1, $p < .001$).

Results from the court cases for the two districts also varied significantly. Disregarding the pending cases, a lesser percentage of individuals had their charges withdrawn in Serengeti District (33%) than Meatu District (70%).

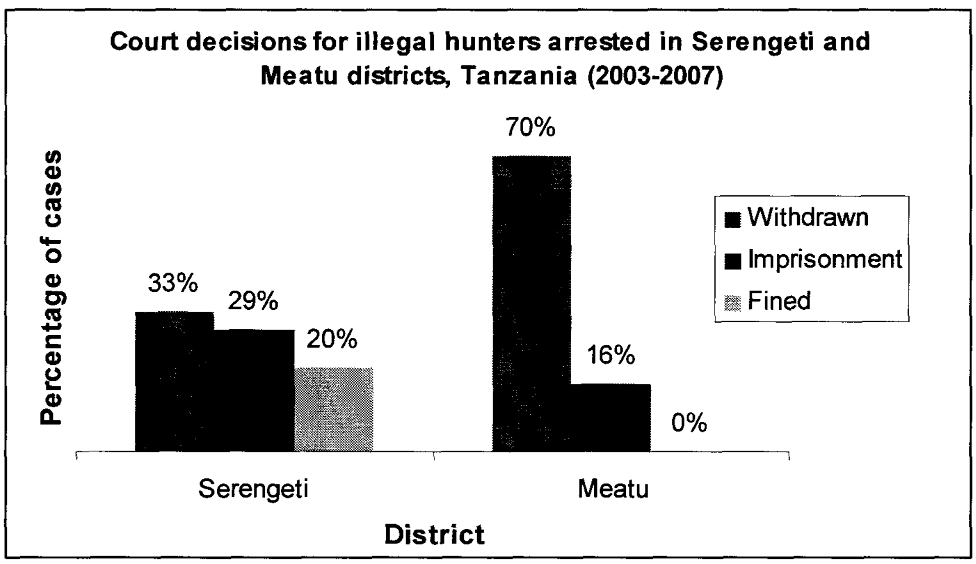

Figure 3.21.2 – Court decisions for illegal arrested hunters in Serengeti District (N = 916) and Meatu District (N = 170) from 2003-3007. Significant differences were found for court decisions pertaining to charges withdrawn, imprisonment, and fines ($X^2 = 72.210$, df = 6. $p < .001$).

As a result, a greater percentage of individuals in Serengeti District were sentenced to prison (29%) than Meatu District (16%) ($X^2 = 72.210$, df = 6. $p < .001$). Although a lesser percentage of arrested individuals were sentenced to prison in Meatu, prison sentences in were longer (4.5 years) than in Serengeti District (1.1 years) ($F = 79.183$, df

$= 1, p < .001$). Most noteworthy, of course, is the fact that one-fifth of individuals were fined in Serengeti District compared to no recorded fines in Meatu District. These collective differences may be indicative of different enforcement strategies between the two districts that ultimately stem from varying hunting pressures, enforcement efforts, enforcement jurisdictions, and other possible nuances in district-level politics.

For the five-years of data, approximately 90% of Serengeti District's 51 total villages had at least one hunter arrested. Recalling the fact that sample sizes are disproportionately larger for Serengeti District, it is still worth noting that 59% of Meatu district's total villages featured at least one hunter who was arrested during the same time span. Many villages that arrested hunters originated from suggest that poaching is not geographically restricted. This assertion is corroborated by statistics at a larger scale as well. Serengeti court records revealed that hunters originated from 43 separate villages outside the district. In other words, approximately half (48%) of the arrested hunters' home villages were outside of Serengeti District. In Meatu, records reveal that hunters originated from nine separate villages outside the district, which amounts to 21% of Meatu's implicated villages. Although court records did not reveal specific names of outside districts, results show that considerable percentages of hunters come from outlying districts.

Nearly half (48%) of the villages in Serengeti District that featured at least one arrested hunter did not directly border SNP or one of its protected areas.[223] The situation was similar in Meatu District where 46% did not directly border a protected area.[224] The

[223] This statistic only includes villages with locations verified by local maps. At the time of research, 37 villages of arrested hunters in Serengeti District had unknown locations.
[224] At the time of research, 18 villages of arrested hunters in Meatu District had unknown locations based on local maps and were not included in the analysis.

importance of these results cannot be overstated as they imply that the resources found in protected areas such as SNP and its game reserves are subject to exploitation not only from neighboring villages, but also from villages with which they do not directly share a border. Results here mirror a finding a by Holmern et al. (2007) that outlined that the catchment zone of illegal hunters is large, including a range of <41 km to the nearest protected area border. These findings suggest that if management plans are to successfully reduce illegal resource harvesting, they should be spatially far-reaching in the villages and settlements that they consider.

Perhaps the most important contribution that the preceding analysis of court records sheds on illegal hunting is that the penalties of arrest are of extremely limited severity. Prison sentences were rarely administered and when they were, averaged just 2.8 years in length. Fines, which were only used in Serengeti District, averaged TZS 12,621, which is only 3% of the yearly income that a hunter earns from bushmeat sales. A study by Leader-Williams (1992) points out that the probability of being caught and convicted are universally an effective deterrent to crime. At the same time, however, they caution that there is little consensus whether the severity of a sentence has a strong deterring effect at all (ibid).

A separate study in western Serengeti took these arguments a step further with the assertion that illegal hunters viewed arrest penalties as having minor importance because the probability of arrest was so low (Hofer et al. 2000). In light of these arguments, this study recommends that financial resources that are allocated to enforcement should be focused more on increasing detection rates (Holmern et al. 2007) and probabilities of arrest rather than ratcheting up penalties that will be exacted on such a small percentage of the illegal hunting population. Moreover, as argued previously, fines should be the primary form of punishment with prison reserved for repeating violators with longer track records of poaching. If the proceeds from fines are kept local, it could theoretically help sustain the cost of performing anti-poaching patrols. Moreover, the establishment of fines as the prominent form of punishment would eliminate costly transactions that often accompany prison sentences.

3.22 – Failed arrests

Much of the discussion so far has dealt with the inadequacy and inconsistencies of punishments and penalties after arrest has occurred. The subject of failed arrests, however, is worth mentioning as well. First, it can act as a surrogate measure for showing the skill level of western Serengeti hunters, which is notoriously difficult to assess. In other words, it can show how "adapted" hunters are to their craft. Second, failed arrests—or, poacher escapes—builds into the concept of a hunter's perception of arrest, which can be equally important to more objective measures (Shetler 2007). A hunter who has escaped multiple times from anti-poaching rangers, for example, may perceive the costs of poaching to be greater than a hunter who has never encountered rangers while hunting. The converse may also be true, however. A hunter who has escaped multiple times may have a greater sense of ease about anti-poaching rangers and therefore, perceive this as a negligible cost of poaching compared to hunters who have rarely fled from rangers. While the term escape can mean many things, here it is defined as any time in which an illegal hunter is positively sighted and actively chased by anti-poaching units. It also includes illegal hunters who manage to break free after an arrest has been made but before being delivered to the local police department.

The phenomenon of escape from anti-poaching rangers while hunting is not uncommon for western Serengeti hunters. Approximately 85% of hunters have escaped at least once while poaching (N = 92). According to the subset, the average hunter successfully escaped 9.3 times over the course of their hunting "careers." The fact that 85% of hunters have escaped an average of 9.3 times while 59% have been arrested for an average of 2.4 times shows that hunters evade arrest far more often than they actually get caught. Noteworthy here is the fact that these statistics are only for instances where hunters have been located and chased by rangers. Far more frequent, of course, are episodes where hunters sight rangers before detection and conceal themselves or leave the area thereby avoiding arrest. Such instances were so common, in fact, that the majority of hunters could not recall how many times they had avoided detection in this manner. As a result, this was not factored in and counted as failed arrests.

Although statistics here have shown that illegal hunters successfully escape far more often than they are arrested, the threat of anti-poaching rangers should not be too heavily downplayed. Hunters that do escape from rangers may face other costs, such as one individual who reported that he fell during a successful escape and needed one month to recover from the injuries he sustained. Furthermore, if a hunter fails to escape during an arrest, the results can be more severe than had he not attempted it. This is supported by the account of one individual who needed two months to recover from injuries he sustained after being beaten by rangers during a failed escape. Other escape narratives included more protracted escapes in which hunters ran for several hours, often taking refuge in rivers, thick vegetation, or rocky enclaves. Such episodes of escape are riddled with hazards of their own, however, as "hiding places" are often favored habitats of potentially dangerous game, such as hippos, crocodiles, poisonous snakes or in the case of rocky areas, leopards, lions, and buffalo. This seemingly minor reality has several sizable implications, and is therefore addressed in the following section (Section 3.23).

3.23 – Other costs of poaching

One of the rarely publicized costs of poaching concerns injuries that illegal hunters sustain during their hunting forays. Hunters themselves rarely mentioned injuries unless prodded by specific survey questions. Once asked, however, many hunters divulged detailed accounts of injuries received from specific animals they encountered while hunting. A few hunters even revealed bodily scars showing claw, teeth and horn wounds they received during such encounters.

Injuries are common for two primary reasons. One, many hunters travel through the bush at night to increase their chances for avoiding detection by rangers. Night travel reduces visibility for the hunters and increases the likelihood of encountering many of the nocturnal predators, such as lions and leopards. Two, snare hunting and pit traps are indiscriminate and as a result, predators, as well as ungulates, often get entangled and trapped. Since death by snaring is not often immediate, such animals are often alive—and severely wounded—when approached by the hunter. Several hunters described how wounded animals, especially the felids, immediately attacked upon sighting humans. Other hunters described episodes where animals they had assumed were dead, suddenly sprung to life and struck out at the hunter when approached. There were also reports that the snaring methodology often attracts carnivores that encounter the dead or dying carcasses in the field.

To lessen the likelihood of such injuries, hunters often slowly approach snare lines and use their bow-and-arrow, with arrow tips coated in poison, on the trapped animals to speed and/or ensure their death. Despite routinely employing these relatively effective methods, injuries were common. Nearly one-third (31%) of interviewed hunters had been injured while hunting (N = 90). Of these, 21% had been injured multiple times when hunting. Over half (56%) of the respondents reported that their injuries had been caused by buffalo (Figure 3.23.1).

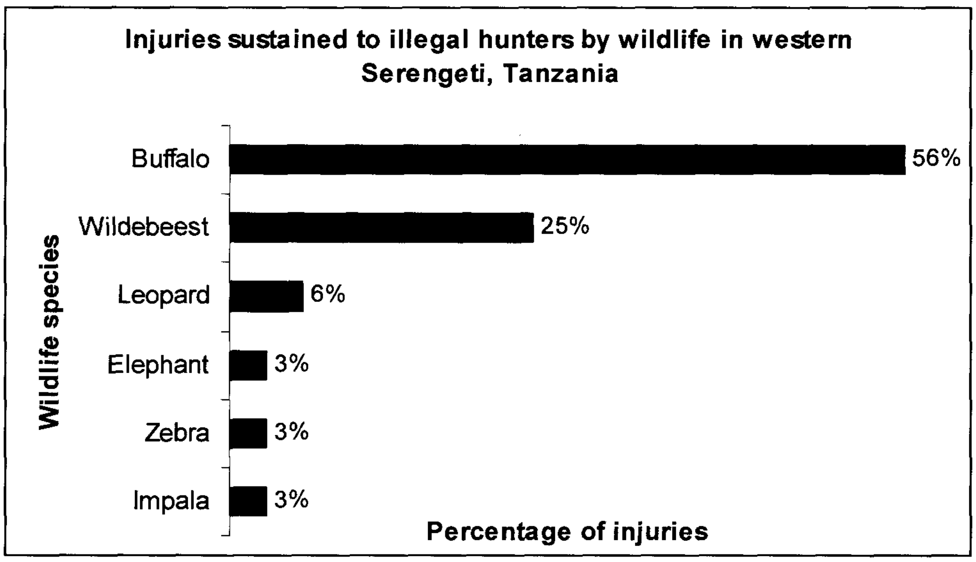

Figure 3.23.1 – Injuries sustained to illegal hunters (N = 28) by wildlife while hunting for bushmeat in western Serengeti, Tanzania

One quarter of respondents cited wildebeest while 6% mentioned leopards. An equal percentage of hunters (3%) were injured by elephant, impala, and zebra. Results here that show a considerable percentage of injuries stemming from ungulates validate the qualitative context received from key informants which asserted that injuries are commonly sustained from already ensnared animals. Although wildebeest readily flee at the sight of humans, one-quarter of illegal hunters reported being injured by them. This strongly suggests that these normally timorous animals can be provoked to attack if unable to escape from a snare.

In addition to physical and psychological pain, injuries can result in losses of opportunity time for both the hunter and his hunting party. One individual, for example, recounted how his friends had to abort a hunting trip to carry him home after he was wounded by a buffalo. Since distances between hunting grounds and home villages can be many kilometers, time lost for all members of the hunting trip may be significant. The same individual, of course, lost an even greater amount of time as he needed approximately three months to recover from his injuries. Time needed to recover is time that is lost to other potential income-generating activities, such as farming or wage labor. On average, injured hunters reported that their injuries required 52.5 days to recover from (N = 14). The cost of injuries can also include monetary losses. One respondent who had been injured by a wildebeest reported that in addition to his injury requiring two months of bed rest, he had to spend TZS 45,000 on hospital fees and medications.

The ultimate cost of hunting, of course, goes far beyond opportunity time or monetary losses. It is the possibility of being killed by animals while hunting. Two respondents had suffered the loss of a father to wildlife during their lifetimes.[225] Even in the face of such immeasurable loss, however, both respondents continued to hunt. This testifies to considerable courage, an underlying sense of fate, or a severe lack of another way to generate alternatives. While courage and fate are surely involved, this study

[225] One of the repondent's fathers died from injuries sustained from a buffalo while hunting in Grumeti Game Reserve in 2004. The specific cause of death of the other respondent's father in 1985 is unknown.

argues that the costs of poaching are primarily endured due to a lack of practical alternatives.

3.24 – Perceived costs of poaching

Discussion so far has focused on objectively measured costs such as those associated with arrest and injury. Equally important to the effort put into hunting, however, is how hunters themselves perceive the costs. To get a handle on perceptions, hunters were asked to list (Bernard 2006) all subjects they feared—or, the costs they perceived—while hunting. After freelisting, hunters then ranked what they had recorded.

Elephants were mentioned most frequently, by one-fifth of the sample. A disconnect exists here, however, between the actual threat of elephants and the perceived danger that they pose. We recall from the previous section (Section 3.23) that only 3% of respondents had been injured from elephants. Context provided by one hunter suggested that although elephants injure relatively few people, they frequently make physical threats to hunting parties when encountered by surprise. This behavior may explain why hunters perceive elephants as a greater threat than they actually pose. Another possible explanation may be tied to the crop destruction (Chapter Two). Elephants were responsible for a greater percentage of crop losses to households from the primary sample (N = 722) than any other species. Many respondents claimed that elephants could not be prevented from accessing their fields at night due to the danger involved in guarding crops from these animals. A fear of elephants while poaching may be associated with these losses.

The case with lions is similar. Lions were the next most frequently mentioned (18%) subjects of fear among hunters despite not accounting for any injuries. With lions, fear is not likely based on a realistic threat but rather, one that is more abject and imbued in local culture. Unlike the case with elephants, fear of lions cannot be associatively linked to livestock depredation as lions were minimally involved in overall depredation events (Chapter Two).

After elephants and lions, hunters listed anti-poaching rangers (17%) as a subject of fear. Again, this demonstrates that objective threats that face hunters do not match perceived fears. Survey results showed that hunters incurred a much greater number of fines and prison sentences than injuries sustained from wildlife. Based on reported costs, therefore, it was expected that rangers would constitute the most commonly reported cost. Explanations for this may include greater levels of familiarity that hunters have with rangers, or that actual penalties post-arrest are rarely significant (Section 3.17). Also possible is the explanation that wildlife may pose a different kind of threat, in which an encounter may be more stressful than one with rangers. Recalling that two of the interviewees had fathers who had died due to wildlife caused injuries, hunters may be cognizant that although wildlife threats are rarer, the magnitude of an encounter may be more severe, and possibly fatal.

Buffalo were mentioned by 14% of hunters as a subject of fear despite accounting for the majority of injuries (56%) sustained during poaching activities. Conversely, snakes were mentioned by 12% of hunters despite causing just ~3% of the injuries. Of the seven remaining threats that were reported, two were carnivores (leopard, hyena), two were herbivores (rhino, wildebeest), two were invertebrates (scorpion sp., tsetse fly), and one was other humans (Maasai).

While not responsible for any reported injuries, western Serengeti hunters still perceive Maasai as a threat. This threat is somewhat idiosyncratic as many individuals reported that they have hunted with Maasai and view them individually as friends. Since the late 18th Century, however, the Maasai as a collective whole have been regarded as enemies who are blamed for a series of disasters stemming from a surge of livestock raids (Shetler 2007). Oral testimonies have further categorized Maasai with the beasts of the wilderness which are considered dangerous but also respected (ibid). Although Maasai livelihoods are largely focused around pastoralism (Galvin et al. 2009), court records revealed that Maasai continue to be arrested for poaching as well. For these and other reasons, western Serengeti hunters reported it was not uncommon to encounter hunters of Maasai descent while on hunting trips.

When asked to rank perceived threats, a third of western Serengeti hunters listed anti-poaching rangers as the primary threat. This more accurately reflected the probable costs that a hunter faces than did the freelisting survey technique. Like with the aforementioned results, however, the ensuing ranks were largely disconnected from actual costs. Coalesced ranks included: lions (29%), elephants (24%), Maasai (7%), and snakes (5%). Of these, only elephants (3%) and snakes (3%) were linked to actual injuries. What this methodology did reveal, however, is that regardless of continued poaching pressure and the ineffectual penalties of Tanzania's district judicial system, a considerable percentage of hunters perceive fines and imprisonment as a primary cost. This suggests that rather than overhauling the entire system, anti-poaching enforcement may need just minor adjustments to more effectively curb illegal bushmeat hunting. The next section will explore a few possible options more fully.

Part III.

3.25 – To poach or not to poach

The preceding analyses of the costs and benefits of bushmeat hunting reveals that the need for income—especially continuous and reliable income—continues to drive hunting activities. Despite the potential for multifarious physical, financial, and opportunity costs, illegal hunting not only continues, but appears to be growing. Due to the nature of the activity, estimating the number of illegal hunters in western Serengeti has been problematic (Kaltenborn et al. 2008). To get a sense of its prevalence, however, ten individuals were chosen at random from the subset of acknowledged hunters to estimate the percentage of males over the age of 12 who hunt. Averaged together, these respondents estimated that over half (52%) of the male population in western Serengeti engage in hunting activities.

To get a sense of local perceptions on the trajectory of illegal hunting, 28 randomly selected individuals were asked whether hunting is increasing, decreasing, or remaining the same. Somewhat surprisingly, over half (57%) asserted that illegal hunting is decreasing. In contrast, over one-third (36%) claimed it was increasing and approximately 7% said it was remaining the same. When respondents were asked to explain why hunting was decreasing, 80% stated it was due to a greater presence of anti-poaching rangers in recent years and an increased threat of arrest. The unstated implication of such a response is that if anti-poaching enforcement subsides, then poaching will subsequently increase.

Despite one of this study's prior arguments concerning the ineffectuality of arrest and penalties, perceptions such as these support the idea that enforcement should remain not as the only component, but as *one* of the necessary tools in the regulation of bushmeat harvesting (Hilborn et al. 2006; Jachmann and Billiouw 1997; Leader-Williams and Albon 1988).

Somewhat more disconcerting to wildlife managers was that one-fifth of hunters claimed that hunting is decreasing because it is losing profitability as hunters have to travel increasing distances to poach animals that are no longer present at the peripheries of the game reserves. The implication here is that wildlife populations—at least those on the periphery of SNP—are decreasing. If illegal harvesting continues at the present rate, or increases, it could live up to its billing as the most serious threat to the Serengeti system (Sinclair 1995).

Two-thirds of hunters who asserted that hunting around the SNP is increasing cited a lack of income and employment as the primary reason. Similarly, the remaining hunters mentioned general livelihood difficulty. These explanations suggest that regardless of increased efficiency and presence of enforcement, hunters will hunt if they cannot procure any other viable livelihood. While it is unrealistic to assume that illegal hunting can ever be completely eliminated, several studies have mentioned the possible danger to local livelihoods that could result from a great reduction in the activity (Loibooki et al. 2002; Kaltenborn et al 2005). This study concurs with this finding. Until more employment opportunities emerge—especially park-related (Chapter Two)—the result of a significant upsurge in enforcement effort could be devastating for household economies. If enforcement levels are to increase in western Serengeti, so should the development of alternate employment opportunities.

3.26 – Possible steps forward

Two questions are central to poaching and its effects on the general resilience of the Greater Serengeti Ecosystem to change. The first involves the decision to hunt or not to hunt. The second involves the effort that a hunter chooses to invest in illegal hunting. To examine these two questions, multivariate logistic and linear regression analyses were conducted.

Several logistic regression models were constructed to predict known poaching households from nonpoaching households. Models were run with various combinations of relevant socio-demographic and socioeconomic variables. Due to their limited utility, however, socio-demographic variables such as age and ethnicity were largely replaced by socioeconomic variables that offered greater predictive capabilities. The model that predicted the most variance incorporated 12 independent variables which included: land owned, cattle owned, shoats owned, poultry owned, household size, income lost to crop destruction, income lost from wildlife depredation on livestock, income earned from livestock sales, income earned from crop sales, income earned from beer sales, income earned from year-round employment, and income earned from seasonal employment. Despite a relatively large sample size ($N = 640$), the Nagelkerke R^2 was .21, which explains relatively little of the variance (Table 3.16.1).

	Beta	df	SE	*p*-value
Constant	-2.165	1	.310	<.001
Land owned	-.082	1	.030	.006*
Shoats owned	-.030	1	.048	.030*
Poultry owned	.009	1	.011	.407
Agricultural sales	.000	1	.000	.029*
Livestock sales	.000	1	.000	.586
Seasonal wage labor	.000	1	.000	.069
Year-round employment	.000	1	.000	.116
Beer sales	.000	1	.000	.188
Household size	.143	1	.034	<.001*
Income lost to wildlife depredation	.000	1	.000	.171
Income lost to agricultural destruction	.000	1	.000	.105

Table 3.16.1 – Results from logistic regression model. Nagelkerke R2 = .21, N = 640. Dependent variable was "poaching household" or "nonpoaching household." Asterisk (*) denotes variables with statistical significance at the .05-level.

Perhaps the clearest message that emerged from these analyses is that predicting whether or not a household chooses to poach is not straightforward. Two factors may explain this. One, due to fear or general reluctance on the part of the respondents, the sample of nonpoaching households likely includes many that actually do, in fact, poach. If the poachers' assessment (Section 3.25) is correct that 52% of males poach, then the model is likely predicated on a biased selection of nonpoaching households. Another factor that may account for the limited utility of the model is that the socioeconomic variables only captured earnings from the last year. If earnings—or loss of earnings—were temporally variable, then they likely constrained the model's predictive capacity. Although the decision to poach appears to be too complex for utility as a reliable predictive agent, the model does suggest that socioeconomics play a larger relative role than demographic factors.

Once a household has decided to engage in illegal hunting activities, the people that make it up then must decide how much effort to invest. Effort has been measured in the number of wildlife killed, income earned from sales of wildlife products, time invested, and several other ways (Rist et al. 2008). While effort measured by time has several possible drawbacks (ibid), it was selected here as the most reliable indicator of effort because it correlated strongly with annual income generated from bushmeat sales (Pearson $R = .350, p = .002$), and monthly servings of bushmeat per household of the hunter (Pearson $R = .245, p = .030$). Moreover, hunters readily recalled the days per month and months per year that they had poached whereas recall of wildlife harvested proved more troublesome.

Much like the case with the logistic analyses, demographic variables did not significantly correlate with hunter effort. In contrast, socioeconomic variables were more strongly correlated with effort. Again, this supports the theory that poaching is driven primarily by poverty and its associated lack of protein and income (Ndibalema and Songorwa 2008; Kaltenborn et al. 2005; Hofer et al. 1995). The best performing linear regression model incorporated nine independent variables that included income generated from: cattle sales, shoat sales, poultry sales, agricultural sales, seasonal noncontract wage labor, beer sales, and income lost from livestock depredation by wildlife and crop destruction (Table 3.16.2).

	Beta	t	*p*-value
Constant		7.325	<.001
Cattle sold	-.078	-.604	.548
Shoats sold	.024	.163	.871
Poultry sold	-.102	-.768	.446
Seasonal wage labor	-.233	-1.955	.056*
Beer sales	.429	3.510	.001*
Income lost to wildlife depredation	.236	1.809	.076
Income lost to agricultural destruction	-.219	-1.723	.091

Table 3.16.2 – Results for linear regression model. R2 = .229, df = 7, F = 3.629, p = .003. Dependent variable was "days household poached in the last year." Asterisk (*) denotes statistical significance at the .05-level.

Mirroring the inherent complexity involved in a household's decision to poach, the effort a household invested in poaching—measured in days hunted in the last year—proved similarly difficult to predict ($R^2 = .229$, df = 7, $F = 3.629$, $p = .003$). Although relatively little variance was explained, the model succeeded in highlighting two variables that may have considerable import to poaching activities. These two factors were income earned from beer sales, which correlated positively with hunting effort ($\beta = .429$, df = 7, $p = .001$), and seasonal wage labor, which correlated negatively ($\beta = -.233$, df = 7, $p = .056$). Somewhat paradoxically, the households of hunters who hunted more days per year earned a greater amount of income from beer sales than did households who hunted fewer days. The explanation for this may lie in the nature and processes involved in local beer brewing.

In western Serengeti, local beer brewing requires minimal amounts of initial effort. If adequate amounts of maize, banana, millet, or other crop are in supply, then the process of beer production involves little more than fermentation and distribution. If distribution and sales are carried out by other members of the household (e.g., women and children), hunters are afforded significant amounts of time that can be devoted to hunting. Because beer brewing is a relatively passive activity, a household can earn sizable amounts of income from a combination of hunting and beer sales.

In contrast, income generated from seasonal noncontract wage labor requires a significant time investment on the part of the hunter. This likely explains why this factor correlated negatively with the number of days that an individual hunted. Although causality cannot be determined by this correlation, the simple fact remains that hunters who hunted a greater number of days earned lesser amounts of income from seasonal labor. If hunters expend larger amounts of time poaching, then they necessarily have less time to earn income from labor opportunities. Testimonies from key informants suggest that two factors are integral here. One, there are annual shortages of seasonal wage labor opportunities. This shortage may in turn cause hunters to invest more time in poaching. Two, seasonal noncontract wage labor is often strenuous work, subject to unexpected termination, and is notoriously low paying. Several hunters remarked that they opted to hunt illegally even though they could have procured this less desirable form of employment.

Viewed in parallel, the two variables may add insight into the GSE's general resilience to changes wrought by illegal hunting. Effort that is committed to poaching allows a household to simultaneously invest in some forms of passive income generation (beer sales) yet necessarily precludes others that require greater onsite time investments (wage labor). These findings suggest that if one of the two primary forms of poaching mitigation strategies is enacted—incentive schemes such as Integrated Conservation

Development Projects (Section 3.7)—to reduce bushmeat harvesting, then they need to be aimed at making long-term demands on an individual's time (Knapp 2007). Incentive schemes that promote more passively oriented projects such as infrastructure development, reduced bushmeat prices, or poverty alleviation are less likely to succeed. While incentives may change conservation attitudes (Infield and Namara 2001), the desired effects they have on changing human behavior remain uncertain (Holmern et al. 2007).

A total of 82 hunters were asked on the subset questionnaire about what factors would cause them to stop hunting. Most (69%) claimed that they would stop hunting if they had year-round employment (Figure 3.26.1).

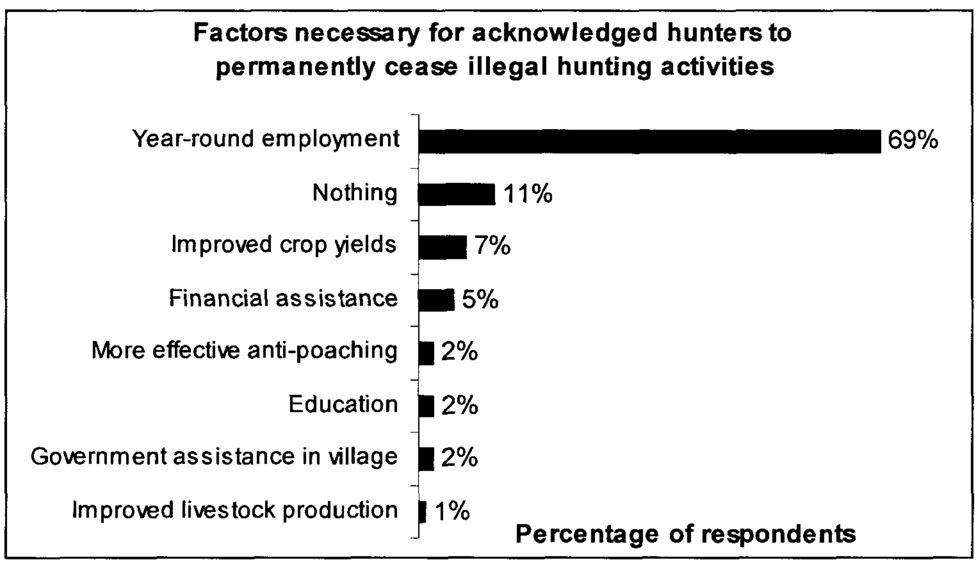

Figure 3.26.1 – Factors necessary for acknowledged hunters (N = 85) to permanently cease illegal hunting activities in western Serengeti, Tanzania

Over a tenth (11%), however, claimed that nothing would cause them to cease poaching activities. These responses lead me to conclude that if poaching is to be reduced and the GSE's resilience enhanced, it must proceed by two primary avenues. Most importantly, employment opportunities must be created in the region. As argued in Chapter Two, employment, especially park-related jobs, should be targeted toward resident households living closer to the park. As a study by Milner-Gulland and Leader-Williams (1992) has pointed out, regulation is an expensive enterprise and it may be more practical to increase the opportunity costs of hunting by improving wages elsewhere.

Secondarily, anti-poaching enforcement must maintain a continued presence in western Serengeti. The most pragmatic approach to this is to involve local people and promote the incipient formation of village game scouts (VGS). While local VGS systems are not immune to corruption, the expansion of the VGS system—and monitoring of the VGS—will concomitantly increase local participation in conservation and create year-round employment opportunities for needy households. At the same time, and as the analysis of Serengeti and Meatu District court cases has clearly showed, sentencing of illegal hunters should occur in the villages and fines that are levied should be retained at the village level. This will provide a faster and more cost-effective processing system (Holmern et al. 2007) and eliminate the costly and highly ineffectual transportation and drawn-out prosecution that occurs at the district level.

Chapter Four

Cumulative effects of primary impacts on households with implications for adaptive capacity and resilience

Part I.

4.1 – Introduction

As the previous three chapters have shown, humans cannot be considered external to the Greater Serengeti Ecosystem in which they live (Galvin et al. 2009). What has also become clear is that human-wildlife interactions are many and diverse (Thirgood et al. 2005) and can be positive or negative (Riley et al. 2002). The four primary interactions focused on thus far—crop damage, livestock depredation, park-related employment, and poaching—have demonstrated some of the principal impacts that protected areas have on humans, and vice versa. For clarity, these interactions have been treated separately. In reality, however, these interactions need to be considered together as a single force that affects the park and its future (Galvin et al. 2009). But the net result of these forces, or, scaling up, cannot be done, therefore, without a systems approach.

As Chapter One revealed, the resilience framework is a systems approach and an appropriate lens by which to view the coupled human-natural system of western Serengeti (Chapter One – Section 1.17). Up until this point, however, resilience has been applied loosely in the two proceeding chapters, being defined simply as the capacity of a social and ecological system to withstand disturbances and buffer change (Galvin et al. 2009). While a resilience framework is widely accepted as a meaningful way to view systems (Berkes et al. 2003; Gunderson & Holling 2002; Folke et al. 2002), its utility as a practical measure has proven more difficult (Carpenter et al. 2001). This can be attributed partially perhaps to the fact that the framework is relatively recent approach (Holling 1973) and partially to the fact that few workable surrogates of resilience have emerged (Carpenter et al. 2005). This final chapter attempts to meet these challenges by using household food security as a proxy for measuring household resilience to change. While other measures might prove useful, food security is used here because it is clearly affected—both directly and indirectly—by the four forces of crop raiding, livestock depredation, park-related employment, and poaching that have been focused on in the preceding chapters.

Household food security is defined as the ability of a household to procure sufficient food year-round and maintain healthy and sustainable lives (FAO/UNESCO 1984). Food security is foundational to households as it represents the most extreme manifestation of poverty and human deprivation (ibid). In addition to its strong association with poverty, food security is also related to adaptive capacity. In short, if households are food insecure due to poverty, they lack adaptive capacity (Nelson et al. 2007). Understanding a household's adaptive capacity, which can be approximated by food security, is essential as it represents a set of mechanisms or preconditions that allows a household to respond to crisis or change (ibid).

Some of these crises or changes may come through interactions with wildlife. In some cases, households may become more food secure through interactions with wildlife that contribute positively. In Chapter Two, this was demonstrated via park-related employment that contributes income to households with which food may be purchased. In Chapter Three, poaching—albeit viewed negative from a human or wildlife perspective—represented another means that households in western Serengeti have used to become more food secure.

In contrast, however, households can become food *in*secure through interactions with wildlife that negatively affect the household (Thirgood et al. 2005). Chapter Two outlined two of the most common interactions which included crop raiding and predation on livestock. Using this set of simplified—but critical—interactions, this chapter has two primary objectives.

First, it will assess household food security apart from the four aforementioned human-wildlife interactions. The objective is to better understand household food security *without* the various forces exerted by the presence of SNP. Essentially, this objective speculates the economic well-being of households if SNP (and its wildlife and park-related jobs) did not exist. This allows for an unobstructed assessment of the park's effects.

Second, each layer of park-related interactions will be sequentially added in to determine how household food security is affected in the context of the Greater Serengeti Ecosystem.

As a final caveat, the use of household food security is a measure of specific household resilience to change or disturbance (Chapter One – Section 1.17). Although this chapter is focused on the human component of the coupled system, it argues that the general resilience of the Greater Serengeti Ecosystem ultimately hinges on the well-being of the many households, villages, and districts within it. If households lack resilience due to food insecurity, then the resilience of the Greater Serengeti Ecosystem is likely to be threatened.

To clarify, this chapter is organized into three parts. Part I, the bulk of the chapter, focuses on the aggregated effects of the human-wildlife interactions on household income and food security. Part II discusses in-migration and how it can amplify deleterious interactions by accelerating natural resource use and land-use change. Part III concludes with a summary of the important findings from the previous chapters and a discussion of how the resilience may be enhanced in the GSE.

4.2 – Methods

Methods for the analysis presented in this chapter utilized semi-structured household interviews from the primary sample (N = 722). Interviews from this sample were conducted orally in Kiswahili and administered in 15 villages selected from Serengeti, Bunda, and Meatu districts. Households were chosen in a stratified-random format dependent upon their proximity to Serengeti National Park or the Ikoma, Grumeti, or Maswa game reserves. Each household was located within 18 km of one of these designated areas. For simplicity, the study area encompassed by these specifications is referred to hereafter as "western Serengeti."

To ensure adequate spatial heterogeneity, 1-3 sub-villages were selected from each village and 20-25% of selected sub-villages were sampled.[226] Due to logistical constraints (e.g., inaccessible roads, excessive walking distances), sub-villages were selected using judgment sampling (Bernard 2006) based upon the feasibility of administering interviews. A total of 46 sub-villages were selected across the 15 villages. Interviews were administered with the male head of the household. If unavailable,

[226] Two exceptions with sub-village selection occurred in Nyakitono and Robanda village. In Nyakitono, data collection was limited to one sub-village due to the relatively large size (N = 48) of the randomly selected sub-village. In Robanda, all sub-villages were selected for the purposes of completing an exhaustive assessment crop destruction and wildlife depredation on livestock (Chapter Two).

interviews were carried out with the household head's spouse.[227] All respondents were 17-years-old or older.

Interviews with the primary sample were integrated with subset samples obtained during the same timeframe of the primary sample. One subset sample consisted of in-depth interviews conducted with 104 acknowledged poachers in western Serengeti. Since poaching is a sensitive issue that carries penalties if arrested (Chapter Three), respondents were selected with "snowball sampling" techniques (Bernard 2006). Interviews were organized with the help of trust-based relationships developed with three key informants. Respondents remained anonymous and interviews were conducted in remote areas to ensure full confidentiality.

The second subset sample consisted of 50 interviews conducted with individuals who were actively employed in year-round jobs that were park-related (Chapter Two). Like the case with acknowledged poachers, interviews here involved sensitive issues dealing with exact amounts of income generated through several years of employment. As a result, respondents were chosen with judgment sampling techniques (Bernard 2006) and predicated upon trust-based relationships developed over several years.

Though "food security" has been defined several ways, in this study it is parsimoniously defined as a household having harvested sufficient quantities of maize (*Zea maize*) for a calendar year (12 months) (Kaswamila et al. 2007). While households consume a variety of crops, livestock, and wildlife species in western Serengeti, maize was selected due to its preference among respondents, dominance in the local diet, and general recognition as the staple food crop of Tanzania (Msoffe et al. 2002). Assessment

[227] In several cases, interviews were conducted with a coalition of respondents of respondents who corporately demonstrated knowledge of household affairs.

of dietary recall revealed that maize constituted the primary grain crop in 43% the afternoon meals and 46% of the evening meals.[228] Due to the primacy of maize consumption in western Serengeti, it serves here as a surrogate for measuring overall food security for a household.

Although analyses of food security were limited to maize, its relationship with the consumption of the other staple grain crops and livestock species is examined in Section 4.12. Maize consumption was based on an adult person's average consumption of 90 kg per annum (URT 1999). Households were designated as "insecure" if they failed to harvest enough maize to feed the household adjusted according to a scale of adult equivalence devised by Martin (1985). This scale assigns values to individuals of a household according to age.[229] Martin's scale was selected primarily because it assigns gender-neutral values to individuals. Although males and females are differentially capable in terms of work, females were purposely considered equal to males in this study because they tend to do a greater share of the work in most rural western Serengeti households (Shetler 2007).

In several sections (4.5, 4.6, 4.8, 4.9, 4.11, 4.13), income was separated into income generated from non-park and park sources. Income that was designated as coming from non-park sources[230] included that which came from seasonal wage labor, year-round employment, remittances, and agriculture (maize, millet, sorghum, beans, potatoes, cotton, cassava), livestock (cattle, "shoats,"[231] poultry[232]), and beer sales.

---

[228] The four other grain crops consumed during the afternoon meal included cassava (26%), sorghum (16%), potatoes (14%), and millet (1%). Percentages consumed during the evening meal included cassava (29%), sorghum (17%), potatoes (6%), and millet (1%).
[229] Values assigned to members of a household in Martin's scale are according to age and designated as follows: < 2-years-old = 0.1; 2-5-years-old = 0.3; 6-14-years-old = 0.6; > 15-years-old = 1.0.
[230] 14 total non-park sources were examined in this study.
[231] 'Shoats' refers to sheep and goats considered here as one species for matters of simplicity.

Seasonal and year-round employment was *not* included as a non-park source if it was in any way related to SNP, Ikoma, Grumeti, or Maswa game reserves. Park sources of income included bushmeat sales and park-related employment (seasonal and year-round). In sections 4.6, 4.9, and 4.11, the term "potential income" was used to designate all revenue lost to crop destruction or wildlife depredation on livestock.

In section 4.6 and throughout subsequent sections, it was assumed that 52% of households located in western Serengeti generate income from illegal bushmeat sales. This assumption was based on a subset of interviews in which ten key informants were asked to hypothesize what percentage of households participated in poaching and the sale of bushmeat. The average of these values was calculated and substantiated by two separate studies conducted in western Serengeti. A study by Loibooki et al. (2002) found that 32% of people volunteered to hunting bushmeat while 89% reported that people in their area did. In group discussions, 57% of respondents admitted to being active poachers. Another study by Kaltenborn et al. (2005) found that 85% of males reported using wildlife products in the last year.

From these studies, the percentage used here (52%) seems a reasonable estimate—and if anything, likely represents an underestimate—of the actual number of households that engaged in poaching activities during the last year. These studies also demonstrate that results on sensitive issues such as illegal hunting can be influenced by survey methods (Loibooki et al. 2002). Due to the sensitivity that surrounds poaching, subsequent analyses here used the value (52%) obtained from a subset of acknowledged poachers rather than placing reliance on data obtained from the primary sample.

---

[232] Poultry included chickens and domesticated ducks.

At the time that this study was conducted, one thousand Tanzanian Shillings (hereafter, "TZS") was equivalent to approximately one U.S. dollar. In the analyses to follow, all percentages are rounded to the nearest whole number.

4.3 - Food security

As outlined in the Methods (Section 4.2), food security was determined in two primary steps. First, sums were computed of a household's four income sources, crop production (converted to Tanzanian Shillings), and livestock sales. Second, these sums were divided by the adult equivalent of each household to determine the purchasing power of the the household. Third, household purchasing power was compared to the cost of purchasing enough maize (90kg per person) for an entire year. If households lacked funds to purchase sufficient annual quantities of maize, they were deemed insecure. If total household funds exceeded the annual cost of maize, they were considered food secure. To gain a more nuanced understanding, food security was examined for all western Serengeti, and then subsequently at the district, village, and household levels. The sections to follow describe these findings.

4.4 – Food security in western Serengeti

As stated in the introduction (Section 4.1), food security is the physical and economic access to food for all people indefinitely (Hoskins 1990). Here, households are considered secure if they were self-sufficient in producing enough maize to last for 12 months' duration (Section 4.2). While households in western Serengeti diversify their holdings and grow several crops, maize was clearly the dominant crop relied on by the majority (Section 4.2). At the risk of oversimplification, however, limiting this analysis to maize enables two important exercises. One, it allows for comparison to other studies of food security in Tanzania (Kaswamila et al. 2007; Emerton & Mfunda 1999). Two, it clearly shows the link between household food security and protected areas while also potentially foreshadowing why households choose to engage in exploitative activities such as illegal hunting.

Western Serengeti households need to harvest an average of 581 kg of maize[233] annually to be self-sufficient and attain the minimal level of food security (Table 4.4.1).

Food Security Variables	Serengeti	Bunda	Meatu	Western Serengeti
Average Adult Equivalent	6.22	6.90	6.26	6.46
Average maize yield for consumption (kg)	205	297	383	295
Household food requirements (kg/household/yr)	560	621	563	581
Surplus (+) or deficit (-) in months	-7.5	-6.2	-3.8	-6.1
Average maize yield destroyed (kg)	442	29	6	159
Additional months possible	9.4	0.6	0.1	3.3

Table 4.4.1 – Food security as measured by maize yields for Serengeti, Bunda, and Meatu districts in western Serengeti, Tanzania. Average adult equivalent based on Martin (1985). Household food requirements based on an adult person's consumption of maize (90 kg) per annum (URT 1999). Average maize yield destroyed determined by destruction by all wildlife species.

In reality, however, the average household produced 295 kg for consumption and therefore fell short of self-sufficient food production by 286 kg. In other words, western Serengeti households faced a maize deficit for 6.1 months of the year. This means that for approximately half of the year, the average household is forced to rely on other crops or other income sources to make up for the shortfall. In years of adequate rainfall, this is unlikely to pose much difficulty as households can sell cash crops (e.g., cotton) and buy grain. In poor rainfall years, however, households face decisions that might include

233 This number was computed by multiplying an average adult person's consumption of 90 kg per annum by the average adult equivalent value for western Serengeti (6.46).

selling off livestock, searching for employment, or engaging in illegal hunting (Chapter One – Figure 1.34.2).

A shortfall of maize for 6.1 months in western Serengeti is considerably greater than a study by Kaswamila et al. (2007) which found one-month shortfalls for villages adjacent to Lake Manyara National Park and Mkomazi Game Reserve in northern Tanzania. Household income generated from crop sales in western Serengeti amounted to TZS 167,751 (Table 4.5.1) which was a considerably lower estimate than the Tanzania government official estimate of TAS 250,000 (URT 2001) and less than similar studies conducted in different parts of Tanzania[234] (Kaswamila et al. 2007; Ngailo et al. 2002).

Households in western Serengeti could undoubtedly generate more income from crop sales and face fewer months of food insecurity if they suffered less crop raiding by wildlife. The average household lost an average of 159 kg of maize in the last year (Table 4.4.1). Such an amount would provide 3.3 additional months of food per household. In western Serengeti, therefore, one (of several possible) metrics for gauging crop destruction is that it causes food insecurity for approximately 25% of a household's average year. While eliminating crop destruction is unrealistic for households living near the border SNP, any degree of reduction would significantly contribute to bolstering a household's food security.

4.5 – Household income

The average revenue of a western Serengeti household's annual resources amounted to TZS 371,337 when considered apart from the effects of SNP (Table 4.5.1; Figure 4.5.1).

[234] The range found in the studies mentioned above was TZS 180,000-200,000.

Income Source	Western Serengeti
Agricultural sales	
Cotton	154,221
Maize	6,697
Millet	1,369
Sorghum	1,172
Cassava	1,014
Potatoes	927
Beans	2,350
Total	167,751
Livestock sales	
Cattle	59,386
Goats	7,605
Sheep	840
Poultry	3,569
Total	71,400
Employment	
Seasonal noncontract wage labor	21,920
Year-round contractual work	36,929
Other	
Trade / Small business	49,865
Beer sales	23,472
Remittances	17,873
Total (all sources combined)	371,337

Table 4.5.1 – Sources of income generated by households in Serengeti (N = 422), Bunda (N = 102), and Meatu (N = 198) districts in western Serengeti, Tanzania

The greatest contribution came from agriculture which amounted to TZS 167,751. This was followed by livestock sales (TZS 71,400), trade/small business (TZS 49,865), year-round contractual employment (TZS 36,929), beer sales (TZS 23,472), seasonal noncontract wage labor (TZS 21,920) and remittances (TZS 17,873). Findings here are well supported by other studies in western Serengeti that depict household economies as being heavily based on agriculture and livestock (Kaltenborn et al. 2005; Loibooki et al. 2002). One other likely source of household income that was not captured in the questionnaire is prostitution.[235]

[235] Near the end of fieldwork, several key informants revealed that prostitution is a considerable enterprise in western Serengeti and features importantly in household economies. Due to the sensitive nature of prostitution, however, accurate monetary estimates of this practice would likely have been difficult.

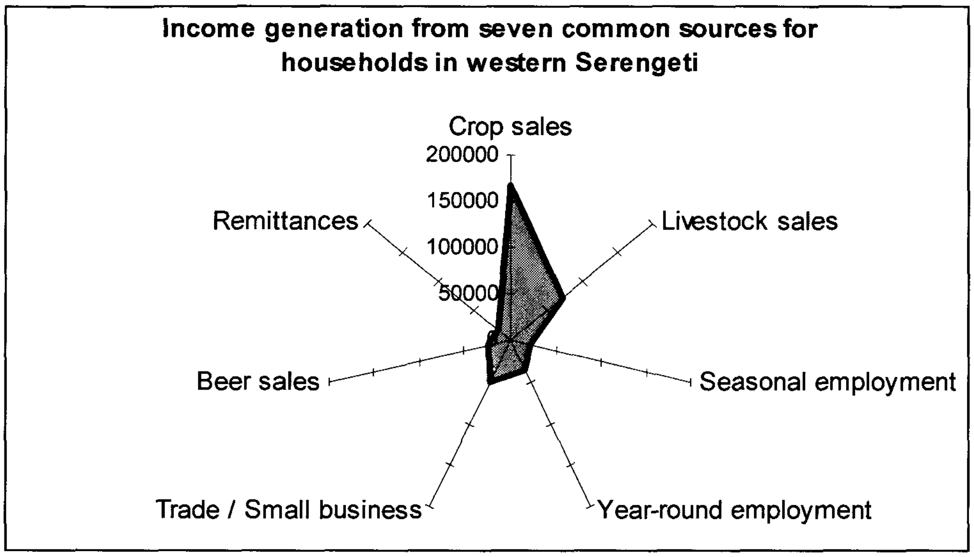

Figure 4.5.1 – Income generation from seven sources for households on the western side of Serengeti National Park (N = 722). Monetary values given in Tanzanian Shillings.

4.6 – Park-related effects on household income

The effect of SNP on western Serengeti contribute both positively and negatively on households (Figure 4.6.1). Negative contributions[236]—or losses of potential revenue—came most heavily from crop raiding by wildlife. The average household lost an average of TZS 110,427 in the last year from crop raids. Wildlife depredation on livestock also exerted considerable losses as households lost an average of TZS 50,992. Positive contributions, however, came from park-related employment and illegal sales of bushmeat, wood, and charcoal. Bushmeat sales netted the average household TZS 149,995 which was much higher than income earned from park-related employment (TZS 24,800), wood sales (TZS 1,023) and charcoal sales (TZS 1,424).[237]

[236] Injuries and death to humans were not considered due to their rarity and to the difficulty of attaching a monetary value on such a phenomenon. One death had occurred in the previous 12 months. A hyena had killed a young girl in Robanda village.
[237] Wood and charcoal sales were not examined further because data was not collected in Serengeti District. Data that was collected reveal that their singular and collective contributions to household economies appear to be negligible.

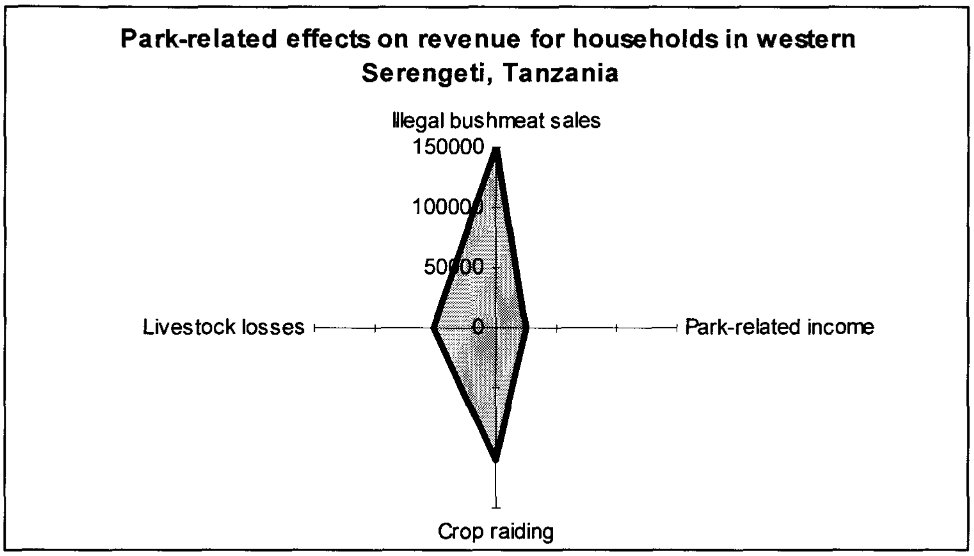

Figure 4.6.1 – Economic gains (park-related income and bushmeat sales) and losses (crop raiding losses and livestock losses to wildlife depredation for households in western Serengeti (N = 722)

A summation of the aforementioned economic losses and gains concluded that the average household from the primary sample had a net gain of TZS 13,376 from park-related influences (Figure 4.6.2).

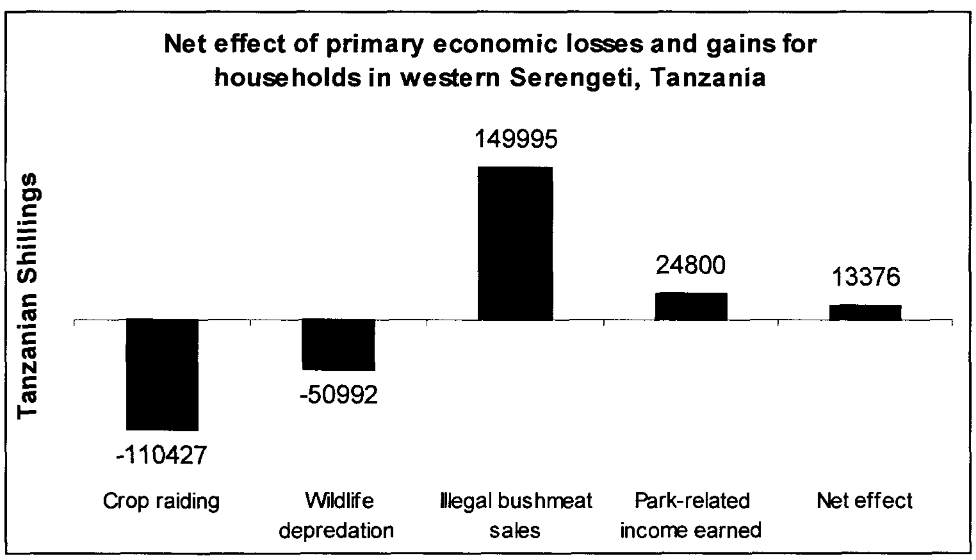

Figure 4.6.2 – Income generation and loss for households in western Serengeti (N = 722). Overall income increased by TZS 13,376 for the average household.

In other words, the influence of SNP and its affiliated protected areas slightly increased income (and its correlate of food security). Until this point, there have been few broad-level empirical studies concerning the economic effects that parks have on people (Wilkie et al. 2006; Schmidt-Soltau & Brockington 2004). Moreover, findings here contradict the few studies that have been done on this subject (Colchester 2004; Ghimire & Pimbert 1997) which have asserted that protected areas generally have negative impacts on human well-being.

Evidence here may have ramifications for household resilience in western Serengeti and similar locations whereby people are living adjacent to large protected areas. One, it may show how households buffer park-related losses (e.g., crop raiding) by legal (park-related employment) or illegal (bushmeat sales) means. And two, it may help explain why in-migration continues to occur at high rates to the west of Serengeti National Park. This idea will be discussed in depth at the conclusion of this chapter (Section 4.16).

This counter-intuitive finding, however, has several important caveats. First, it is based on the assumption that 52% of households (that include at least one adult male) engage in illegal hunting activities (Section 4.2). If this percentage is significantly lower, which is unlikely, the average household would benefit less—or even incur costs—from living near SNP. If the percentage of households that hunt is higher, however, the average household may be benefitting even more than the TZS 13,376 profit margin.

Two other factors that may have had an effect on this finding relate to the methods chosen here. One, a selection of households from three of the six total districts that border SNP was sampled. While the chosen districts are thought to be representative, it could be that the other three districts are quite different and therefore present an alternate view of western Serengeti. To further examine this possibility, a district-level analysis is discussed subsequently. Two, the 0-18 kilometer distance from SNP might not have adequately captured the majority of households that affect, and are affected by, the national park. The fact that most park-related interactions appeared to significantly drop off after a distance of 10km, however, refutes this possible exception (Chapter Two – Section 2.12). Even so, the "average" western Serengeti household would likely have had a differing profit margin had ranges of 10 or 25km been chosen instead of the distance range selected here. Because distance that households are located from SNP has such a large effect on income and food security, this idea will be examined subsequently (Section 4.7).

4.7 – Food security at the district level

While getting a sense of food security at the broad level of western Serengeti is valuable, it obscures important facets that emerge at finer levels. At the district level, for example, food security differences have significant ramifications on household well-being. Considering maize, it becomes apparent that households in each district do not grow sufficient quantities to last the year (Table 4.4.1). Households in Serengeti District have the greatest deficit, as the average household faced a deficit of 7.5 months. The shortfall in Bunda District was also considerable with households lacking maize for 6.2 months and Meatu households lacking sufficient supplies of the crop for 3.8 months.

As will be discussed shortly, households in Serengeti District earned the largest amount of income from illegal bushmeat sales, followed by households in Bunda and Meatu districts (Table 4.7.1).

Income sources	Districts			*F*	df	*p-value*
	Serengeti	Bunda	Meatu			
Illegal bushmeat sales	280,450	148,909	20,627	NA	NA	NA
Park-related employment	74,400	0	0	11.672	2	< .001
Wood sales	NA	1,450	596	4.551	2	.011
Charcoal sales	NA	2,000	848	.823	2	.365
Total	354,850	152,359	22,071			

Table 4.7.1 – Income earned from activities related to the presence of Serengeti National Park. Illegal bushmeat sales taken from subset survey (N = 104). Park-related employment taken from primary survey (N = 722). Wood and charcoal sales taken from primary survey (N = 300) but not conducted in Serengeti District. Monetary values in Tanzanian Shillings.

While data here cannot prove the linkage, it is not likely coincidental that the households facing the largest deficit of maize production are engaged to the greatest extent in illegal hunting activities. Moreover, as evidenced in Meatu District, households that face lesser degrees of food insecurity are also less actively involved in poaching. In an overarching study of wildlife's effects on food security in sub-Saharan Africa, Ntiamoa-Baidu (1997) asserts that even in communities dominated by farming, income from hunting often represents a substantial proportion of the household income. Results presented here, however, take Ntiamoa-Baidu's claims one step further. What is suggested here is that the proportion of income that a household earns from bushmeat sales is inversely correlated with their level of food security (Figure 4.7.1).

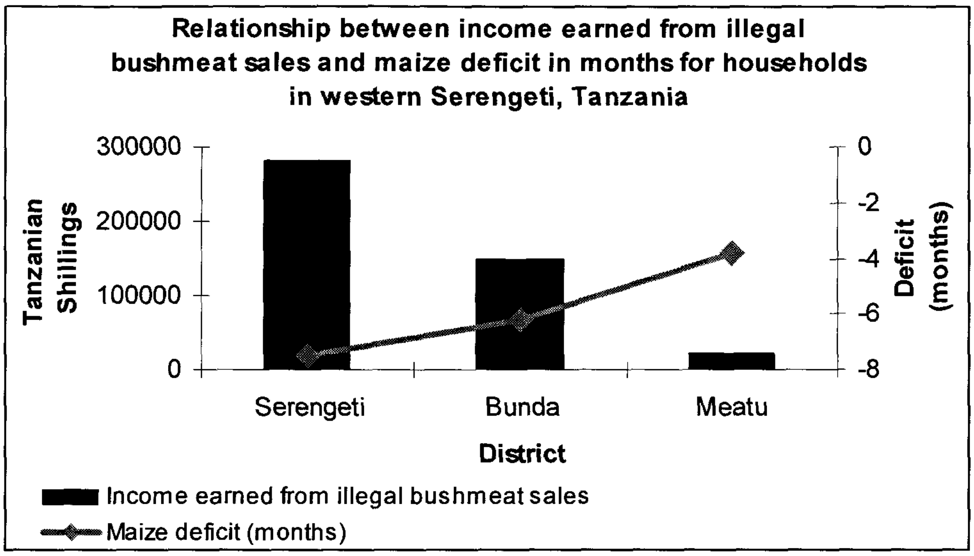

Figure 4.7.1 – Relationship between income earned from illegal bushmeat sales and maize deficit for households in Serengeti, Bunda and Meatu districts. Bushmeat sales based on subset survey of acknowledged poachers (N = 104). Maize deficit based on primary survey (N = 722).

Perhaps the most important finding of an analysis of food security at the district level is in regards to crop raiding of maize. We recall from earlier that households in Serengeti District consumed an average of 205 kg of maize which was sufficient for the family for an average of 4.5 months. Results from crop raiding, however, revealed that Serengeti District households lost an average of 442 kg in the last year. In terms of food security, this amount could potentially have provided sufficient food for 9.4 months. If crop damage did not occur, therefore, the average Serengeti household would be food secure and generate a surplus of maize for an additional 1.9 months. This is a critical finding as it shows that households do not face food deficits for a lack of land or a lack of effort. Rather, shortfalls in this district are directly caused by wildlife. This is not the case for Bunda and Meatu districts, however. In these districts, crop raiding amounted to 29 kg and 6 kg, respectively, which would have afforded each district less than a month of additional food. In these districts, food deficits cannot be significantly ameliorated by a reduction in crop raiding. With Bunda and Meatu districts, the shortfalls in maize are likely because households put a greater emphasis on cash crops (Table 4.8.1) or that they suffer from land shortages.

4.8 – Household income at the district level

Much like food security, important income-related nuances emerged at the district level. As the analysis of western Serengeti revealed, the greatest contribution of income to households came from agricultural sales (Section 4.5). Sales of cotton were the most important. Households in Bunda earned considerably more from cotton sales (TZS 240,251) than did households in Meatu (TZS 176,775) and Serengeti (TZS 45,637) (F = 35.862, df = 2, p <.001) (Table 4.8.1).

	Districts					
	Serengeti	Bunda	Meatu	*F*	df	*p*-value
Agricultural sales						
Cotton	45,637	240,251	176,775	35.862	2	<.001
Maize	17,813	0	2,278	4.556	2	.011
Millet	4,048	0	60	3.590	2	.028
Sorghum	3,517	0	0	1.502	2	.223
Cassava	3,043	0	0	4.528	2	.011
Potatoes	2,456	0	325	0.617	2	.540
Beans	7,049	0	0	2.651	2	.071
Total	83,563	240,251	179,438			
Livestock sales						
Cattle	88,662	47,215	42,281	1.054	2	.349
Goats	8,720	12,074	2,020	5.786	2	.003
Sheep	1,226	917	377	0.667	2	.514
Poultry	7,948	1,397	1,362	1.543	2	.215
Total	106,556	61,603	46,040			
Employment						
Seasonal noncontract wage labor	15,374	23,206	27,181	1.630	2	.197
Year-round contractual work	85,662	20,882	4,242	6.750	2	.001
Other						
Trade / Small business	88,617	51,863	9,114	8.682	2	<.001
Beer sales	59,998	1,176	9,242	15.972	2	<.001
Total (all sources combined)	439,815	398,981	275,257			

Table 4.8.1 – Non-park-related income sources for households in Serengeti, Bunda, and Meatu districts in western Serengeti, Tanzania (N = 722). Monetary values in Tanzanian Shillings.

Significant differences were also observed for maize ($F = 4.556$, df = 1, $p = .011$), millet ($F = 3.590$, df = 2, $p = .028$), and cassava ($F = 4.528$, df = 2, $p = .011$).

Fewer differences between the districts were observed for income generated from livestock sales. Although households in Serengeti District earned considerably more total income from livestock sales (TZS 106,556) than did those in Bunda (TZS 61,603) or Meatu (TZS 46,040), differences were only significant for the sale of goats ($F = 5.786$, df = 2, $p = .003$) (Figure 4.8.1).

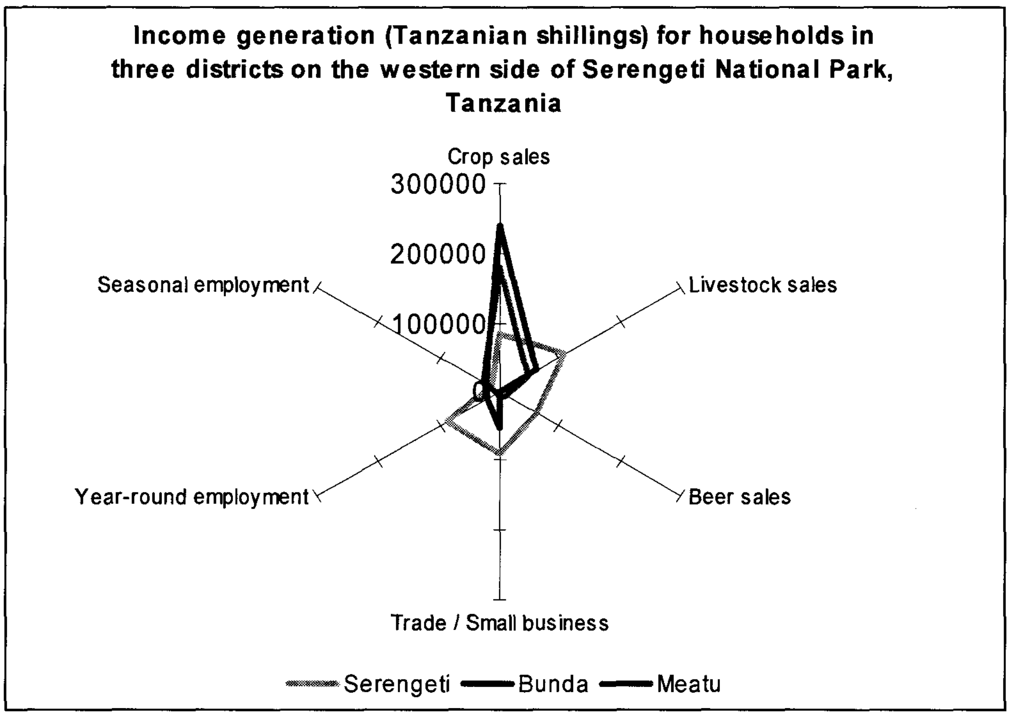

Figure 4.8.1 – Income generation for six primary sources of income for households in Serengeti (N = 422), Bunda (N = 102), and Meatu (N = 198) districts in western Serengeti, Tanzania. Remittances were not included because data was unavailable in Serengeti District.

Differences in income were observed for nonfarm-related activities as well. These included beer sales ($F = 15.972$, df = 2, $p < .001$), trade or small business ($F = 8.682$, df = 2, $p < .001$), and year-round employment ($F = 6.750$, df = 2, $p = .001$). Of these, year-round employment is of special import to this dissertation's central thesis as it represents a smooth income source that is decoupled from the vagaries of rainfall (Chapter Three).

In terms of overall income, households in Serengeti District earned the greatest amount (TZS 439,815) followed by Bunda (TZS 398,981) and Meatu (TZS 275,257). Viewed in isolation, these findings might suggest that households in Serengeti District are economically better off than the other two surveyed districts and therefore, are more food secure and earn lesser amounts from illegal bushmeat sales. Due to the effects of SNP, however, this is not the case. As shown in Section 4.5, households in Serengeti District were actually more food insecure than the other two districts. As a result, households in Serengeti need to earn more income to meet their food shortages. Section 4.9 explores this further.

4.9 – Park-related effects on households at the district level

The economic losses of each district's aggregated crops echo the trend witnessed for maize. Serengeti District lost 18 times more income to crop raiding than Bunda and 46 times more than Meatu. When income losses for all crops were computed, Serengeti District reported an annual loss of TZS 308,216, compared to TZS 16,479 for Bunda, and TZS 6,585 for Meatu (Table 4.9.1).

Potential income lost	Districts			F	df	p-value
	Serengeti	Bunda	Meatu			
Crop raiding						
Cotton	8,854	4,565	352	4.694	2	.009
Maize	93,465	5,885	1,194	12.234	2	< .001
Millet	53,627	714	0	30.830	2	< .001
Sorghum	25,752	1,775	3,550	7.314	2	.001
Cassava	92,052	0	0	28.574	2	< .001
Potatoes	17,604	3,347	1,489	5.647	2	.004
Beans	16,862	193	0	5.604	2	.004
Total	308,216	16,479	6,585			
Wildlife depredation on livestock						
Cattle	65,416	14,401	1,863	4.406	2	.013
Goats	20,662	12,873	2,257	6.083	2	.002
Sheep	2,218	4,198	251	2.373	2	.094
Poultry	23,707	3,873	1,257	4.400	2	.013
Total	112,003	35,345	5,628			
Total (crop raiding & wildlife depredation)	420,219	51,824	12,213			

Table 4.9.1 – Potential income lost to households in Serengeti (N = 422), Bunda (N = 102), and Meatu (N = 198) districts in western Serengeti, Tanzania. Monetary values given in Tanzanian Shillings.

Significant differences between the districts were observed for each of the seven most commonly planted crops that were considered here. The three largest discrepancies, however, occurred for millet ($F = 30.830$, df = 2, $p < .001$), cassava ($F = 28.574$, df = 2, $p < .001$), and maize ($F = 12.234$, df = 2, $p < .001$).

Analyses of wildlife depredation on livestock show a similar trend to crop raiding in that Serengeti District lost a much larger amount (TZS 112,003) than Bunda (TZS 35,345) or Meatu (TZS 5,628). The largest difference in income lost was for goats ($F = 6.083$, df = 2, $p = .002$), followed by cattle ($F = 4.406$, df = 2, $p = .013$), and poultry ($F = 4.400$, df = 2, $p = .013$).

While households in Serengeti District suffer the largest losses in crop raiding and wildlife depredation, they appear to buffer these losses in income generated from bushmeat hunting and park-related employment. Following the methodology outlined previously (Section 4.2), households in Serengeti District earned TZS 280,450 from bushmeat sales compared to TZS 148,909 for households in Bunda, and TZS 20,627 for households in Meatu. Similarly, households in Serengeti District earned an average of TZS 74,400 for park-related employment compared to TZS 0 for households in Bunda and Meatu districts ($F = 11.672$, df = 2, $p < .001$).[238] Income from wood and charcoal sales were not collected in Serengeti District but based on the low figures from the other two districts, the effects of this potentially positive source of revenue were negligible on overall income.[239]

A synthesis of the aforementioned results shows important properties that emerge at the district level. This agrees with the western Serengeti analysis that the average household living from 0 to 18 km from SNP earned a net profit of TZS 13,376. At the district level, however, it quickly becomes apparent that this profit margin is not uniform. Moreover, each district tells a decidedly different story about economic benefits of living near a large protected area.

Despite their disproportionately larger amounts of revenue generated from bushmeat sales and park-related employment (Figure 4.9.1), households in Serengeti District faced an overall financial loss of TZS 65,369 over the last year (Figure 4.9.2).

---

[238] The lack of any income earned by households in Bunda and Meatu Districts from park-related employment is due to the fact that not one respondent (or the respondent's household) had that form of employment.

[239] Wood sales over the last 12 months in Bunda and Meatu amounted to TZS 1,450 and TZS 596, repectively. Charcoal sales amounted to TZS 2,000 in Bunda and TZS 848 in Meatu (Table 4.7.1).

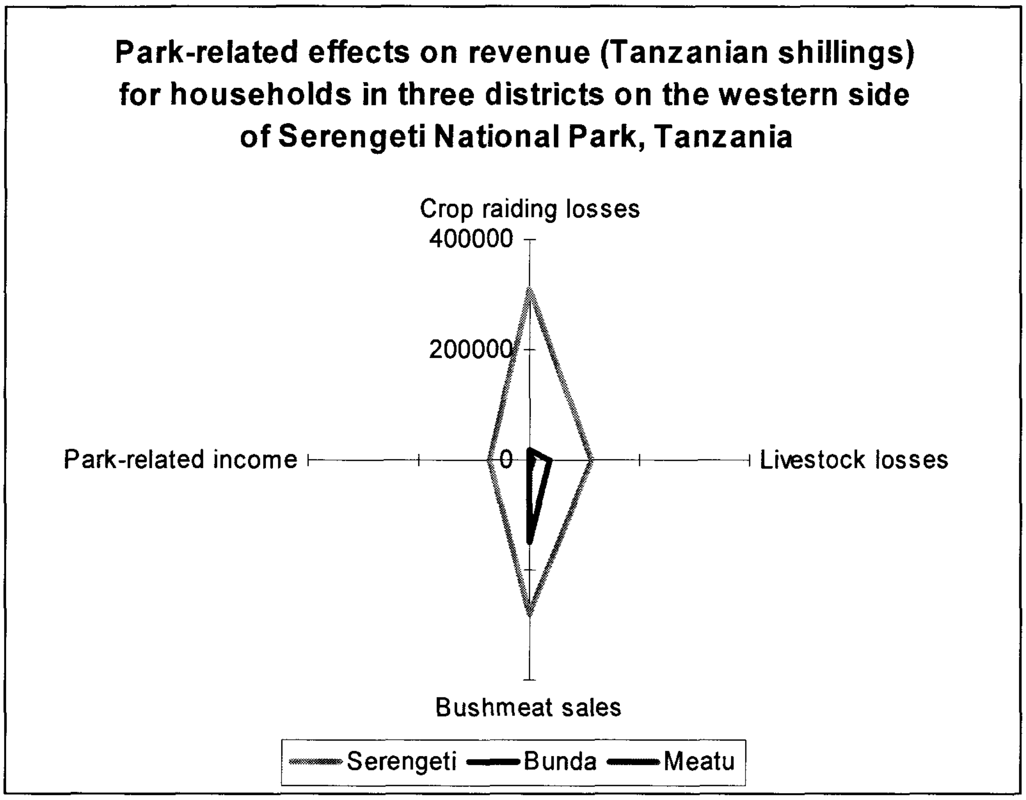

Figure 4.9.1 – Park-related effects on revenue for households in Serengeti (N = 422), Bunda (N = 102), and Meatu (N = 198) districts in western Serengeti, Tanzania. Crop raiding and livestock losses were due to wildlife.

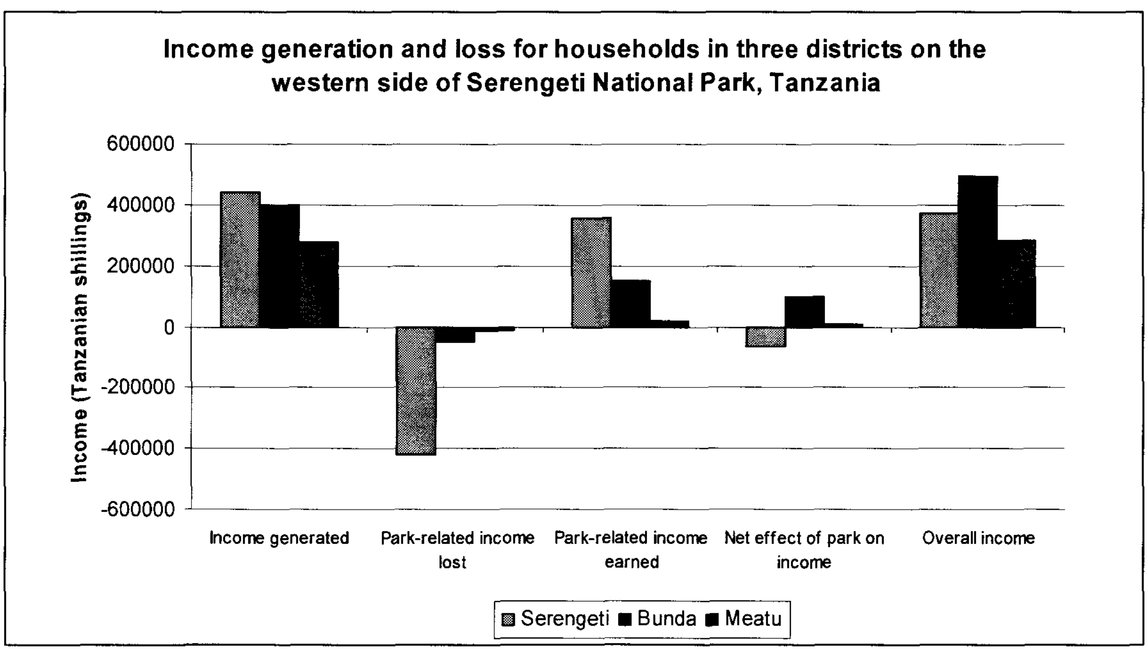

Figure 4.9.2 – Income generation and loss for households in Serengeti (N = 422), Bunda (N = 102), and Meatu (N = 198) districts in western Serengeti, Tanzania.

This is due to the inordinate amount of crop damage and wildlife depredation of livestock that Serengeti households suffered from. Although speculative, it is likely that the higher amounts of crop damage and wildlife depredation instigate some households to hunt that otherwise would abstain. Noting the omission of important features such as infrastructure and access to markets (Barrett et al. 2000), this analysis concludes that it is not economically beneficial for households to live within 18 kilometers of SNP in Serengeti District.

The story was the exact opposite in Bunda District, however. In Bunda, households generated a profit margin of TZS 97,085 (Figure 4.9.2). As Figure 4.9.2 shows, households in Bunda profit because they suffer comparatively little crop damage and livestock loss while earning significant amounts of income from bushmeat sales. A possible explanation for this may stem from geographic features that characterize Bunda. The presence of the Grumeti River, which separates all of the villages in Bunda District from the park, acts as a barrier for wildlife thereby limiting crop raiding and wildlife depredation. The river does not, however, present a barrier to locals whom are privy to bridges and crossing points. Such a geographical setting may underscore why the average household in Bunda profits significantly from living near SNP.

In contrast to the deleterious effects of SNP to Serengeti households and the positive effects to Bunda households, households in Meatu appear to have a comparatively neutral relationship with SNP. This is likely due to a minimal amount of interactions with wildlife. When park-related losses were subtracted from gains, Meatu households had a profit margin of TZS 8,414. Although the profit is small, it bears mentioning that for households living at the edge of poverty, even small incomes can determine whether or not a child goes to school (Ntiamoa-Baidu 1997), or, in this case, makes households more food secure. But, unlike the large profit reaped by households in Bunda District, the relatively small profit margin in Meatu is unlikely to entice households to immigrate into that district. Immigration of people into Meatu, explored shortly (Section 4.16), is therefore likely driven by other factors.

Perhaps most noteworthy from this district-level analysis is the relationship between food security measured by maize (Table 4.4.1) and the income loss or profit margins just discussed (Figure 4.9.2). Households in Serengeti District faced the greatest food deficit and an income loss due to the park (Figure 4.9.3).

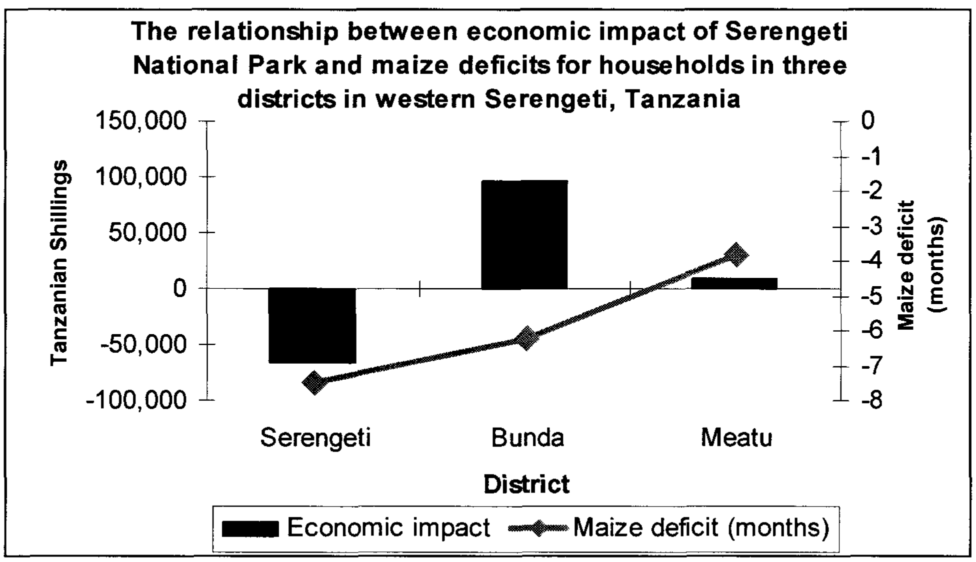

Figure 4.9.3 – The relationship between economic impact of Serengeti National Park and maize deficits for households in Serengeti (N = 422), Bunda (N = 102), and Meatu (N = 198) districts. Economic impacts shown here included the sum of illegal bushmeat sales, park-related employment, crop raiding, and wildlife depredation on livestock (Table 4.9.1).

Overall, it is significant to note that Serengeti households were unable to buffer their losses because they were apparently unable to limit crop destruction and wildlife depredation. Households in Bunda also incurred a food deficit but appeared to buffer these losses because they were less, and additional income was obtained through moderate levels of illegal hunting. In Meatu, households were much more self-sufficient in food production and incurred almost no crop or livestock losses from wildlife. Although conjecture, this scenario may explain why they did not engage very heavily in illegal hunting.

4.10 – Food security as assessed by distance from a protected area

The effect of distance on food security offers interesting insights. Somewhat unsurprisingly, households located closest to SNP faced larger maize deficits (9.2 months) than households in the other two distance categories (Table 4.10.1).

Food Security Variables	0-3,000	3,001-6,000	6,001-18,000
Average Adult Equivalent	5.41	6.49	6.33
Average maize yield for consumption (kg)	109	270	196
Household food requirements (kg/household/yr)	487	584	570
Surplus (+) or deficit (-) in months	-9.2	-6.4	-7.8
Average maize yield destroyed (kg)	824	351	233
Additional months possible	20.1	7.2	4.9

Table 4.10.1 – Food security measured by maize yields for households located at 0-3,000m (N = 109), 3,001-6,000m (N = 186), and 6,001-18,000m (N = 121) from a protected area border in western Serengeti, Tanzania.

What is surprising, however, is that households located at an intermediate distance from SNP had a smaller food deficit (6.4 months) than households located further away (7.8 months). Households at an intermediate distance had the greatest food requirements (584 kg) but also consumed a much larger quantity of their own maize (270 kg) than households closer to SNP (109 kg) and those further away (196 kg). This suggests that households located at a moderate distance from the park have greater food security than households located closer or further from SNP. As will be discussed shortly (Section 4.11), the important implication here is that households do not uniformly suffer from close proximity to protected areas. Rather, there exists an advantageous distance by which people may settle and profit from a protected area. One reason for this might be that households in this intermediate range (3,000-6,000m) are buffered somewhat from crop damage and wildlife depredation on livestock yet they are still able to take advantage of infrastructure, illegal exploitation of resources, and park-related employment opportunities. This finding builds on previous sections (Sections 4.7 & 4.8) which found that significant differences in food security and income exist between the districts that border SNP.

Not surprisingly, the average maize yield destroyed by wildlife decreased as distance from SNP increased. What is noteworthy, however, is the magnitude by which it decreased between the three distance categories ($F = 4.404$, df = 2, $p = .013$). Households located closest to SNP reported an average loss of 824 kg per household, which is over seven times more than an average household consumed. This amount could potentially provide an additional 20.1 months of food for the household. In the intermediate distance category, households lost 351 kg which could potentially provision the household for an additional 7.2 months. Households in the third distance category lost an average of 233 kg of maize which could allow for 4.9 additional months.

In sum, the difference of maize (kg) destroyed between households in the two closer distance categories was 473 kg, while the difference between the intermediate and furthest households was 118 kg. In other words, households that were furthest away from the park did not suffer much less than households at an intermediate distance. Households at an intermediate distance, however, suffered much less than households closest to the park. What is of interest here is that households at an intermediate distance not only suffered less crop damage than households closest to the park, but also appeared equally able to take advantage of park resources and job opportunities. The next section shows this more fully (Section 4.11).

4.11 - Income earnings and distance from a protected area

When income between the three distance categories is assessed without regard for SNP, then all households in western Serengeti earned roughly equivalent amounts of total income and did not vary significantly in their number of income sources. Moreover, households in each distance category took advantage of the six most common sources of income in western Serengeti (Figure 4.11.1).

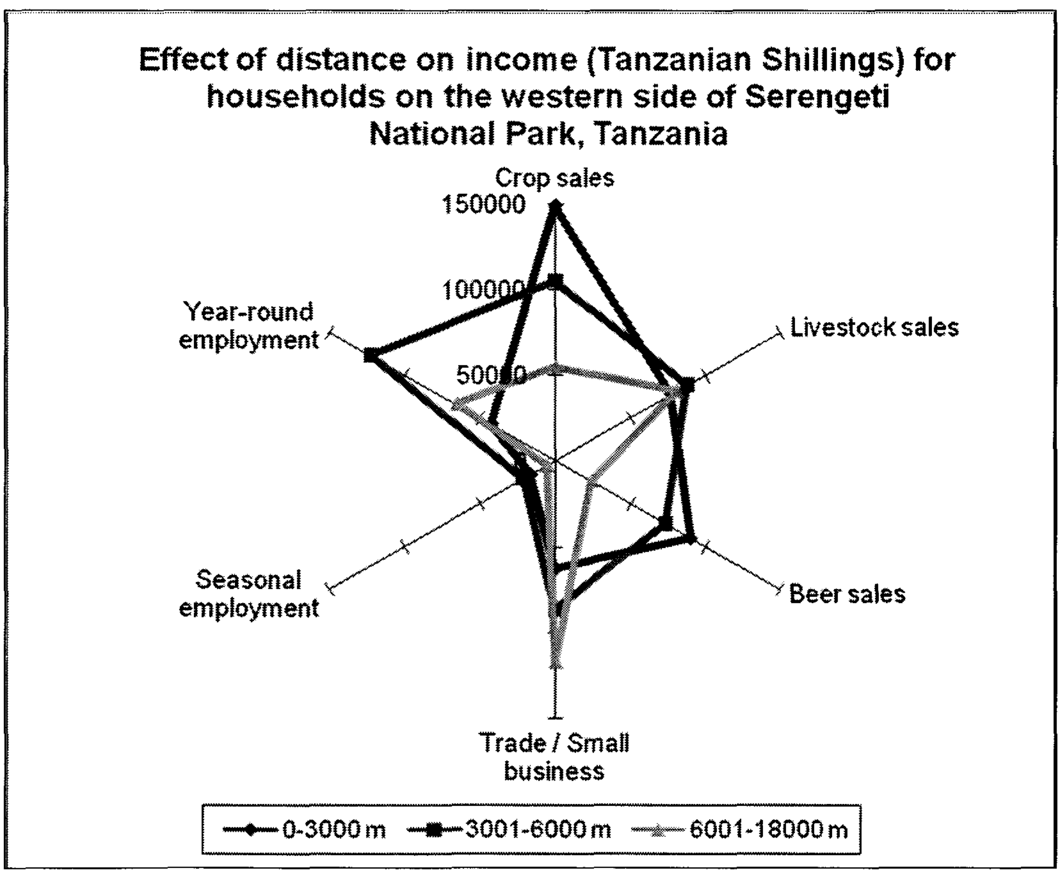

Figure 4.11.1 – Income generated from six income sources for households located 0-3,000m (N = 109), 3,001-6,000m (N = 186), and 6,001-18,000 (N = 121) from a protected area boundary in western Serengeti, Tanzania. Income from park employment is not considered here.

As predicted in rural agropastoral environments (Reardon 1997), households earned large percentages of their income from agriculture (24%; TZS 102,571) and livestock (19%; TZS 82,165). Of the six income sources, seasonal noncontractual employment contributed the smallest amount (6%; TZS 14,542). Significant differences were found for crop sales ($F = 2.902$, df = 2, $p = .056$) and beer sales ($F = 3.962$, df = 2, $p = .020$). In each case, households closer to the park earned the greatest amount of income from these sources, followed by households at intermediate distances and then those furthest away.

Arguably the most notable income source between the three distance categories, however, is earnings from year-round employment. Although not statistically significant ($F = 1.958$, df =2, $p = .142$), households from the intermediate distance category earned TZS 122,221, which was nearly double what households further from the park earned (TZS 65,538) and nearly triple what households closest to the park earned (TZS 42,264). As this study has consistently argued, year-round employment income is the most critical of all income sources because it is decoupled from vagaries of weather and rainfall and therefore smoother and more reliable for households. From the viewpoint of wildlife managers, year-round employment is also beneficial because it more consistently occupies an individual's time thereby reducing the opportunities to hunt (Knapp 2007).

In addition to earning more average income from year-round employment, households at an intermediate distance from SNP also earned more overall income than households at the other distances. This amounted to 12% more than households closer to the park and 30% more than households further away.[240] Since the income totals presented here are independent of park-related effects, this suggests that households

[240] This difference was statistically significantly at the .15-level ($F = 2.109$, df = 2, $p = .123$). Interview #280 was removed from the analysis due to exceptionally high total income (TZS 106,240,000).

located at an intermediate distance from the park may simply have a greater amount of income-generating opportunities than other households.

The advantages of living at an intermediate distance from the park become even more clear when examined in light of park-related effects.[241] As Figure 4.11.2 depicts, households that live closest to SNP are much more adversely affected than households located further away.

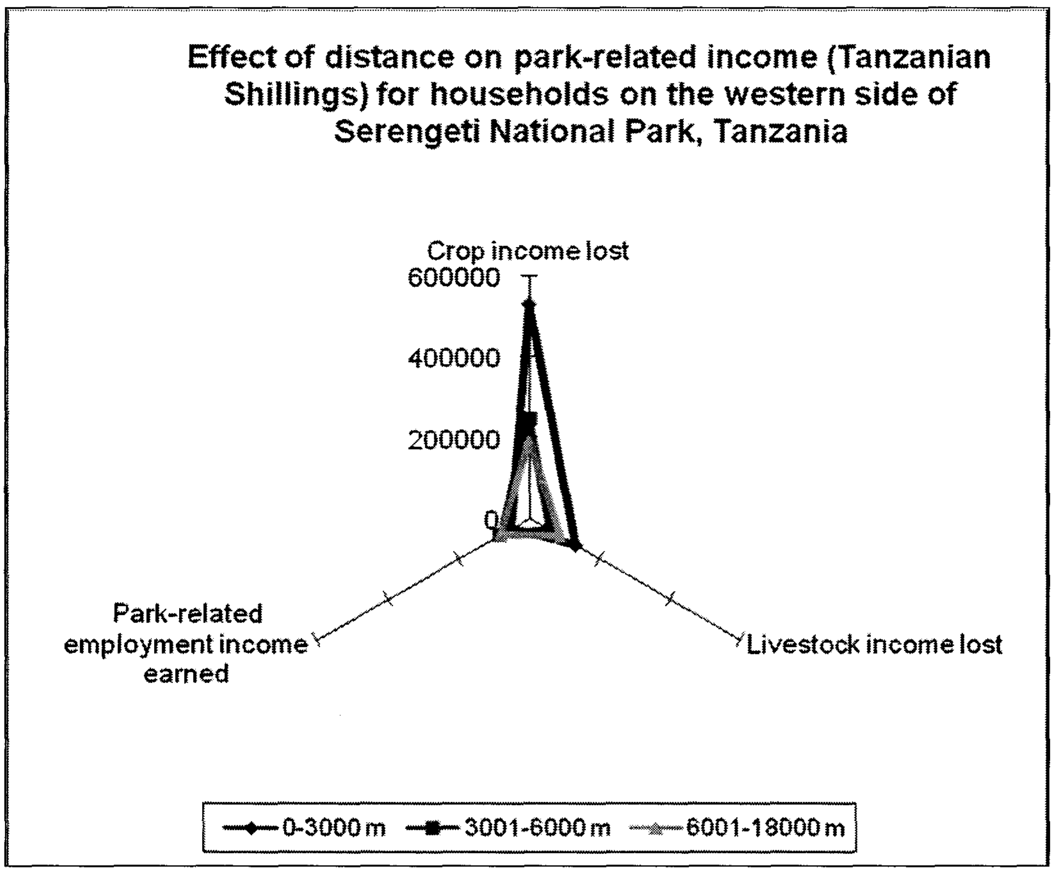

Figure 4.11.2 – Relationship between distance and park-related revenue impacts for households located 0-3,000m (N = 109), 3,001-6,000m (N = 186), and 6,001-18,000m (N = 121) from a protected area boundary in western Serengeti, Tanzania.

[241] Amounts of income generated from illegal bushmeat sales are not included in this analysis of distance (as they were in the analysis at the district-level). This is because distances were not recorded for the subset survey of acknowledged poachers due to reasons of confidentiality.

While the closest households suffer far more than the other two distance catagories, the differences between the intermediate and furthest categories appear to far less significant. In sum, households closest to the park lose a total of TZS 662,111 in potential revenue due to crop raiding and wildlife depredation on livestock (Figure 4.11.3).

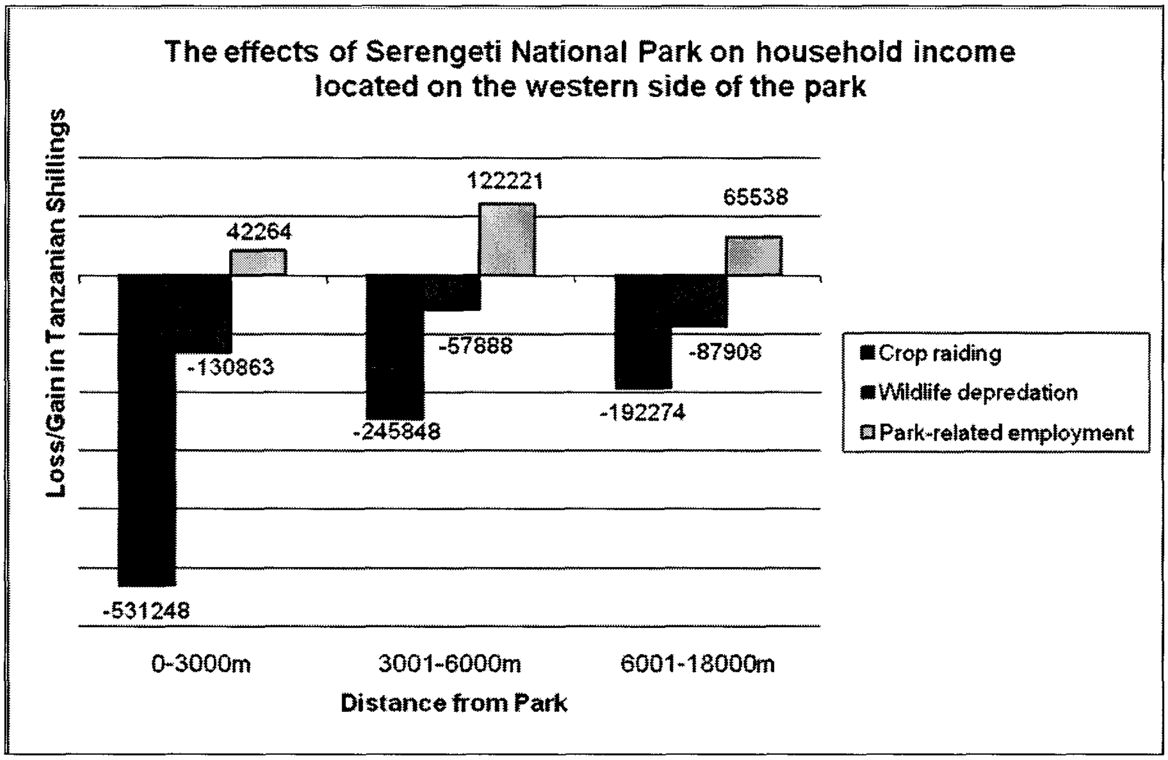

Figure 4.11.3 – Economic losses and gains caused by three park-related impacts for households located 0-3,000m (N = 109), 3,001-6,000m (N = 186), and 6,001-18,000m (N = 121) from a protected area boundary in western Serengeti, Tanzania.

This is more than double the amount lost by households at intermediate distances (TZS 303,736). Households furthest away from SNP, however, lost TZS 280,182, which is only 8% less than households at the intermediate category. The most significant losses came from crop raiding where the closest households lost TZS 531,248 compared to TZS 245,848 and TZS 192,274 for the intermediate and furthest categories, repectively (F = 12.274, df = 2, $p < .001$). Compounding matters more, households closest to SNP earn the least amount of income (TZS 42,264) from park-related employment which is lower than what households at an intermediate distance earn (TZS 122,221) and households at the furthest distance (TZS 65,538).

When general income and park-related losses and gains are considered jointly, it becomes clear that households in the intermediate distance category fared better than households closer to, and further from, SNP. As section 4.18 examines further, this implies that all else equal, immigrants will profit most by moving into intermediate zones around SNP. Intermediate zones appeared to confer advantages to households because they buffered them from crop damage and wildlife destruction (due to the presence of other households) yet were not so far from SNP that they limited the array of possible year-round and park-related employment opportunities. At present, studies that have examined the effects of distance have not recorded this important nuance (Parker & Osborn 2001; Bhima 1998; Naughton-Treves 1997), possibly because they were based on distance scales that were either too small or too large. Due to the potentially large ramifications this has for development projects and in-migration (Section 4.15), however, this study is worth duplicating on the margins of other protected areas in the developing world.

4.12 – Household food security in-depth

As to the household scale, it was found that 601 households, or 84%, were food insecure for maize during the three-year timeframe by which this study was conducted. In contrast, just 13% produced a surplus of maize and 3% produced exactly enough to meet consumption needs. Statistics here, however, do not imply that the majority of households went hungry. Rather, they only show that 84% of households did not grow enough of the primary maize crop and were there therefore relegated into partaking in any number of other possible options to make up the shortfall. Of the myriad choices, three are thought to be undertaken most heavily. One, households with maize shortfalls may switch to consumption of other crops (e.g., cassava, millet, sorghum, etc.). Two, households may slaughter their livestock to procure an additional food source. And three, households can use income earned from other activities to purchase additional maize from the local market to meet their requirement.

Regarding the first option, households generally do not favour consumption of other crop varieties over maize. As a result, there is a general cultural reluctance to switch to other crops, often pejoratively called “drought” or “starvation” crops. Even so, many households are forced to resort to eating other crops. Doing so generally does not necessarily mean households lack food security.

Households are generally disinclined to slaughter livestock, too, as livestock are viewed as long-term insurance to be kept in the face of particularly severe droughts. In contrast to the first option, slaughtering livestock is more likely to reduce food security and adaptive capacity because households lose their only assets that are able to multiply wealth and add security.

Of the three options, the third, by which households are forced to purchase food crops to make up for shortfalls, likely makes households food insecure to the greatest degree. While such households procure food for the short-term, they may become food insecure over the long-term. Purchasing food crops directly depletes household funds that could hypothetically be used for investing in long-term assets (e.g., cattle, land, education, etc.). To examine how households may deal with food insecurity in western Serengeti, these three options are explored subsequently.

Results showed that households that were insecure in maize production did not consume greater amounts of the other five other staple crops. Rather, when adult equivalence was accounted for, all households with maize deficits actually harvested and consumed less of the other crops than did households with maize surpluses. Of the crops considered, however, only potatoes yielded statistically significant results. Regarding potatoes, households with maize surpluses consumed 1.2 sacks per adult compared to households with maize deficits that consumed 0.3 sacks per adult ($F = 24.554$, df = 2. $p < .001$). Bivariate correlations supported these trends for sorghum (Pearson $R = .104$, $p = .005$) and potatoes (Pearson $R = .240$, $p < .001$) as consumption of self-produced maize correlated positively with the consumption of these two crops.[242]

Regarding the second option, one might intuitively expect that households with maize deficits would be forced to slaughter (for consumption) greater numbers of livestock to account for their shortfalls. This, however, was not the case. Differences in the number of livestock slaughtered between households with deficits and surpluses were not significant for cattle, sheep, and poultry. But for goats, it was actually households with surpluses that slaughtered more (0.16 per adult) than households with deficits (0.08 per adult) and households that broke even in maize production (0.05 per adult) ($F = 3.774$, df = 2, $p = .023$). This somewhat counterintuitive finding was supported since the amount of maize consumed by a household was positively correlated with the number of cattle slaughtered (Pearson $R = .079$, $p = .034$), goats slaughtered (Pearson $R = .157$, $p <$

[242] Results for consumption of beans (Pearson $R = .065$, $p = .083$), millet (Pearson $R = .052$, $p = .164$), and cassava (Pearson $R = .253$, $p = .253$) all correlated positively with consumption of maize but results were not statistically significant.

.001), sheep slaughtered (Pearson $R = .092, p = .014$) and poultry slaughtered (Pearson $R = .127, p = .001$).

What these results collectively show is that households that were insecure in maize production were generally unable to make up for this shortfall by switching to consumption of other crops and/or livestock products. Rather, the opposite phenomenon occurred whereby such maize-strapped households actually consumed less of the other crops per adult and slaughtered fewer of their livestock than did households with maize surpluses. The likely explanation for this is that households that have maize deficits tend to have similar deficits with the other five staple crops and various livestock species. Such households face shortfalls across the board and do not appear to be readily able to make up deficits in one crop by harvesting a surplus of another. Rather, such households are likely forced into a different livelihood strategy to deal with food insecurity.

Since 84% of the surveyed households had deficits in maize production, this implies that most households in western Serengeti must rely on obtaining food from external sources to gain adequate provisions for the duration of a calendar year. In contrast, the 13% of households with maize surpluses were able to consume greater quantities of the other crop varieties and slaughter more of their livestock. In addition to likely enjoying a higher standard of living, this small percentage of households is thought to be less dependent on other food sources. Since most households in western Serengeti with maize deficits appear unable to buffer their deficits with other self-produced food, it stands to reason that they must use income to purchase food. To see if this is the case, we now turn to the effect of income on food security.

4.13 – Household income and food security

Analyses presented thus far have suggested that household income and food security in western Serengeti appear to be linked. As the previous section showed (Section 4.12), most households did not produce sufficient food to meet consumption needs. Likewise, most households (78%) were over-budget, meaning that they spent more money in the last year than they had generated in an equal amount of time. The 563 households that were over-budget spent an average of TZS 538,585 more than they earned. In contrast, the 158 households (22%) that were under-budget earned TZS 436,528 more than they spent ($F = 231.032$, df = 1, $p < .001$).[243] The simple fact that the average household reportedly spent more than they earned[244] implies the existence of several possible scenarios, or, more likely, a combination thereof.

One, it may simply be that households underreported income and over-reported expenditures. While possible, this seems unlikely since the small number of income sources per household (1.8) which should not have posed too much strain on recall faculties.

Two, it may have been due to the timing of the fieldwork. In other words, households may have uncharacteristically drawn heavily on savings during the time of year the interviews were conducted. This, however, is unlikely as interviews were conducted during every month of the year (Section 4.2). Moreover, there exists a general cultural reluctance on the part of rural Tanzanians to save. This is because if rural Tanzanians have a surplus of money, the presiding culture dictates that they dispense of their surplus to those who ask. Because of this cultural obligation, many rural

---

[243] Interview #280 was left out of the analysis due to its outlier status. The household reportedly earned TZS 106,240,000 and spent TZS 1,706,000.

[244] The average household reportedly spent TZS 324,898 more than they earned.

Tanzanians immediately spend surplus on indivisible assets, such as housing materials or livestock (Fleisher 2000). Due to this tendency for quick reinvestment, it is unlikely that so many households would have had sufficient savings to draw from during the time of these interviews. Lastly, no evidence was obtained suggesting that the previous years had been agriculturally auspicious enough to generate excess income.

Far more plausible is a third possibility suggesting that households did not report *all* of their sources of income due to possible fear or embarrassment. As this chapter has shown, households earn large amounts of income from illegal hunting (Section 4.6). This source may make up a significant percentage of the shortfall recorded here (Chapter Three).

As mentioned earlier, another likely source that was not recorded was prostitution. Remittances may also play a larger role than is indicated by results here. Although the average income that a household received through remittances was TZS 17,873 (Section 4.5), the subset survey of households with park-related employment revealed that those households gave TZS 182,800 to other family members during the last 12 months. Since figures for remittances were not recorded in Serengeti District, which included over 10% of households with park-related employment, it is likely that remittances are actually higher than they appear in this dataset.

Sources such as remittances, illegal hunting, and even prostitution all likely contributed large amounts to household income. Assertions presented here are supported in work by Schneider (2002) who documented that Tanzania has the second largest informal economy in Africa (58.3%), which is much higher than the average for developing countries (41.0%). Most important to the research here, however, is the idea that the pronounced budgetary shortfalls that are apparent here are subsidized in large part through illegal exploitation of wildlife in SNP. The fact that 78% of households in western Serengeti spent more than they allegedly earned in the last year strongly suggests the existence of a thriving informal economy that is highly dependent on products obtained from SNP. Although this can only be inferred from the data here, if true, it has major ramifications for management of the GSE. If management efforts are to be effective, for example, they will undoubtedly have to address the supply, demand and extent of the informal economy.[245]

The dependence of local households likely on wildlife is further borne out by an examination of how households use income to purchase food. For many parts of rural sub-Saharan Africa, theory holds that pastoralists and agropastoralists with food deficits often resort to selling cows for money to buy grains (Coast 2002). In western Serengeti, the opposite phenomenon occurred whereby households with surpluses sold significantly more cattle (0.3) per adult than did households with food deficits (0.1) ($F = 7.747$, df = 2, $p < .001$). The same pattern occurred for sales of goats ($F = 4.259$, df = 2, $p = .014$).

A similar trend was observed for food expenditures. Contrary to what was expected, households with maize deficits actually spent less money on food (TZS 45,999) than did households with maize surpluses (TZS 82,584) ($F = 23.294$, df = 2, $p < .001$). Moreover, households with maize deficits had a smaller amount of total expenses per adult (TZS 128,495) than did households with surpluses (TZS 232,551) ($F = 17.533$, df = 2, $p < .001$). While it is true that households with maize deficits spent a larger percentage

[245] Such a discussion is complex and outside the scope of this study.

of their expenditures on food (38%) than households with surpluses (36%), this difference was not significant.[246]

Findings here suggest that households with food deficits—which comprise at least three-fourths of the study sample living within 18 kilometers of SNP—are not shoring up their shortages with livestock sales or by allocating significantly more of their income to grain purchases. We recall from earlier (Section 4.4) that the average household in western Serengeti faced 6.1 months of maize shortage. Here, we see that households with maize deficits spent an average of TZS 45,999 on supplemental food. Assuming that households purchased only maize (TZS 18,189 per sack), they would have procured 2.53 sacks, or 227.7 kg. This would create an additional 4.4 months of additional food for the family. This, however, still leaves a span of 1.7 months in which households are without sufficient supplies of the staple maize crop and are thus characterized by food insecurity. Although 1.7 months of annual food insecurity poses a threat to local livelihoods, such a shortage is not insurmountable.

One possible means of making up this 1.7-month shortfall is through greater emphasis on livelihood diversification. At the time of this research, western Serengeti households generated income from an average of 1.8 sources. Households that were able to procure additional sources of income incurred smaller budgetary shortfalls than households that were not able to (Table 4.13.1).

[246] ($F = .568$, df = 2, $p = .567$)

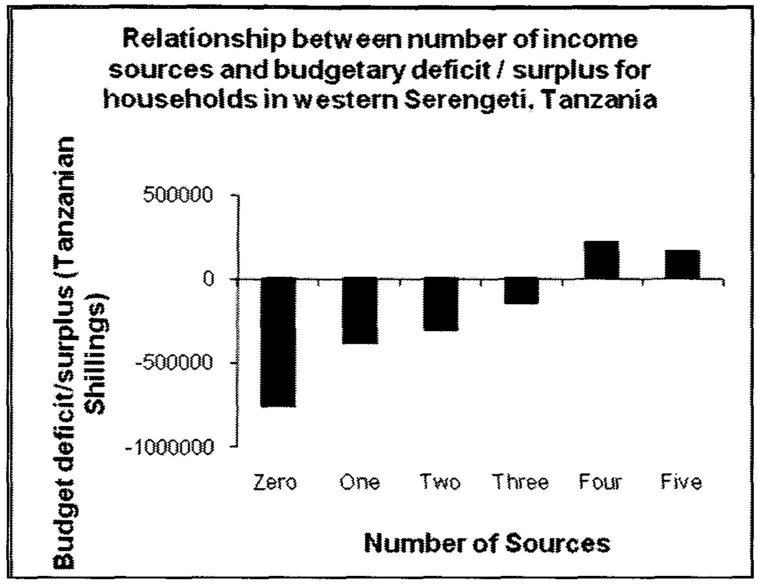

Figure 4.13.1 – Relationship between the number of income sources and budgetary deficit or surplus for households (N = 722) in western Serengeti, Tanzania. Households with budget deficits spent more than they earned while those with surpluses earned more than they spent.

Households with 0-3 income sources averaged budgetary shortfalls while those with four and up averaged surpluses ($F = 6.437$, df = 5, $p < .001$). As expected, the number of income sources was strongly correlated with the total amount of income earned (Pearson $R = .419$, $p < .001$). Analysis of Variance (ANOVA) tests revealed that households that had budgetary deficits had an average of 1.6 income sources while those with surpluses drew from 2.3 sources ($F = 85.558$, df = 1, $p < .001$). For the majority of households, the main income sources included a combination of agriculture and/or livestock. Since these sources are linked to rainfall and subject to perturbations from SNP, both have the potential to undermine a household's resilience, and the GSE at large.

Part II.

4.15 – In-migration

It's appropriate here to introduce and consider the effects of in-migration. A strong case can be made, in fact, that in-migration—or immigration—affects all of the human-wildlife interactions mentioned thus far. This topic has been postponed until now, however, due to the potentially severe implications it likely exerts on household economies, food security, and the ultimate resilience of the coupled human-natural system in western Serengeti.

The process of moving into sparsely populated areas from more congested areas is a common coping mechanism found in many Tanzanian semi-arid locales (Madulu 1996). In regards to protected areas, in-migration to frontier and buffer zones—such as the western Serengeti study area—is arguably the single largest demographic dilemma in the developing world (Sherbinin & Freudenberger 1998). A study by Wittemyer et al. (2008) found that annual growth rates were higher in protected area buffer zones than in ecologically equivalent rural areas in 245 out of 306 sampled locations (80%). A similar trend appears to be occurring in western Serengeti whereby villages located near SNP are experiencing a high level of in-migration (Holmern et al. 2007). Both push and pull factors are thought to be at work. The obvious push factors are that regions further to the north and west of SNP have higher populations, thereby reducing the number of livelihood opportunities and available land for agriculture and grazing (Mwamfupe 1998). Pull factors are less substantiated but may include an attraction to better infrastructure (e.g., roads, dispensaries, etc.), employment opportunities, and access to ecosystem services (Wittemyer et al. 2008, Scholte 2003).

The central importance of in-migration is the effect that settlers have on land conversion, land availability, livestock, and native wildlife populations, and resource extraction. Negative impacts on biodiversity that have been linked to high human populations around protected areas include high rates of timber and mineral extraction (Karanth & Curran 2006), intensifying land use (Reid et al. 2008), habitat conversion (Bulte & Horan 2003; Balmford et al. 2001), bushmeat hunting (Brashares et al. 2001; Campbell & Hofer 1995), and species extinctions (Brashares et al. 2001).

Ultimately, this list of negative impacts can be linked to population growth, both intrinsic and extrinsic. Here, in-migration is defined as extrinsic and separated from intrinsic population growth so as to clarify its effect on SNP and household economies. One of the initial challenges in an analysis such as this, however, is the development of a satisfactory definition of in-migration and accurately assessing who is local and who is not (Scholte 2003). To resolve this, several slightly varied definitions have been chosen and will be presented in the sections to follow.

4.16 – In-migration into western Serengeti

Most respondents (73%) from the overall sample were currently residing in a different village than the one they were born in. Similarly, many respondents (44%) were not living in the district of their birth. Although alarming, these statistics do not necessarily imply that all of these respondents (and their respective households) have in-migrated to be closer to SNP. Rather, it merely enforces the idea that people are moving—or shuffling—extensively within the study area. Some households (4%), in fact, were forcibly moved *out* of one of SNP's protected areas and relocated to villages along the border. Although the effects of such forced relocations are important, the households of special interest here are those that have in-migrated from a district that does not border SNP (17%) and those that have in-migrated relatively recently. Approximately 21% of respondents not living in their birth village had in-migrated in the last 10 years while 10% had done so in the last five years.

For population growth to be slowed, and its negative impacts curtailed, it is essential to determine why households originally decided to immigrate into the study region. In other words, push and pull factors need to be assessed. Such factors are notoriously difficult to validate because they often act in tandem on a household's decision. Fortunately, however, the available dataset allows these factors to be teased apart.

An examination of the reasons that people moved into their current location provides a simplified overview allowing educated speculation on the interplay of push and pull factors. As depicted in Figure 4.16.1, nearly half of the sample (47%) currently living in a village other than their birth village moved in order to acquire more—or more productive—land.

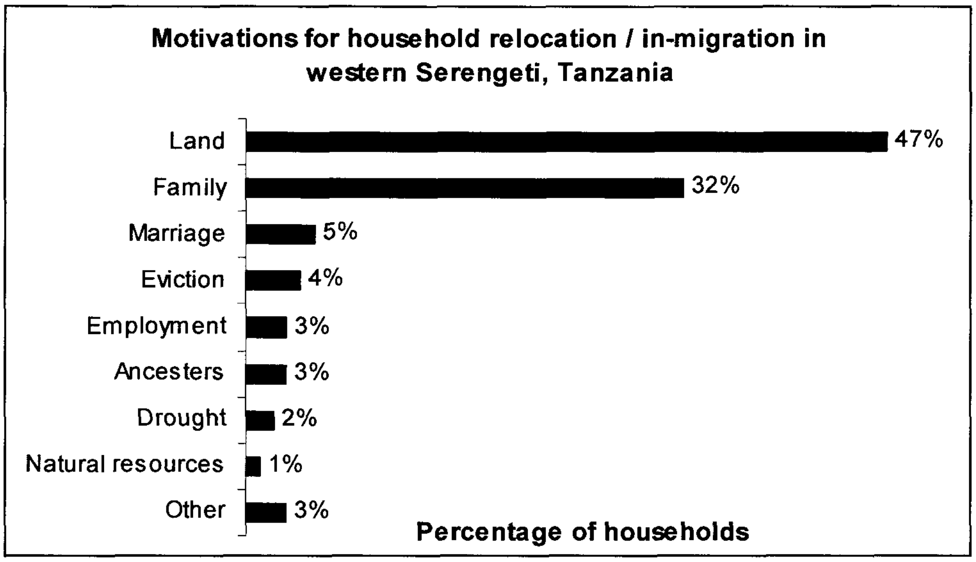

Figure 4.16.1 – Motivations for relocation / in-migration for households (N = 521) in western Serengeti, Tanzania

Moving for the primary purpose of acquiring land is more likely indicative of a pull factor than a push factor. Regarding the push factor, it is true that people's home villages may have offered little acreage by which the respondent could expand agricultural or pastoral activities. But, it is plainly evident that respondents specifically chose to move into—or alter their locale within—the study area lying adjacent SNP. Such respondents moved because land within 18 kilometers of SNP was available. Land availability, therefore, likely pulled respondents to this region.

Following land, figure 4.16.1 shows that 32% of people moved for family reasons. This group—comprising roughly one-third of the households—moved to join family members already living in the western Serengeti region. Since close cultural and familial ties that exist in rural Tanzania, it is more difficult to conjecture about the interplay of push or pull factors. Several respondents who cited this reason, for example, reported that they moved into a household of relatives following the death of a father or mother. Similarly, it is difficult to infer motivations behind the 5% of respondents (all female) who moved in order to join a husband already living in the western Serengeti study area.

Educated inferences can be made, however, for the smaller percentages of households that moved for other reasons. It is likely, for example, that the households that moved for employment opportunities (3%), better access to natural resources and wildlife (1%), and those wanting to live in the land of their ancestry (3%) were more affected by pull factors. Conversely, the households that were forcibly evicted (4%) and those that moved because of drought (2%) were more likely affected by push factors exerted by the region they were living previously.

From these results, that appear to emphasize the primacy of pull factors, one might reasonably predict that more respondents who in-migrated would report that they receive benefits from SNP than those who have not. This was not the case, however. For those respondents currently living in their birth village, 41% reported that they received benefits compared to 27% of those who had moved ($X^2 = 11.453$, df = 1, $p = .001$). Similarly, a greater percentage of respondents currently living in the district of their birth (38%) reported benefits compared to 23% of those born in a different district ($X^2 = 17.881$, df = 1, $p < .001$). What this possibly suggests is that respondents who originally moved to gain easier access to land, resources, or employment may no longer perceive these pull factors as current benefits of living relatively close to SNP.

As stated earlier, however, the households of interest here are not those that have made small-scale local relocations within the study area, but rather, the households that have in-migrated from districts not bordering SNP and those that have in-migrated recently. Such households that have moved in from faraway regions are of interest because they substantially accelerate the intrinsic population growth of the study area (with subsequent effects on human-wildlife interactions) and may more clearly explain why rural peoples choose to resettle near large protected areas such as SNP. On the other hand, recent immigrants are of interest because they more clearly reflect the current milieu. Understanding recent motivations for in-migration may better inform managers and policymakers seeking effective policies for reducing this source of extrinsic population growth. These groups of immigrants are examined in the two sections to follow.

4.17 – In-migration from non-bordering districts

It was stated earlier that 17% of the overall sample in-migrated from a district that did not directly border SNP or its affiliated protected areas. Although the importance of push or pull factors cannot be decisively concluded, two findings suggest that push factors were possibly responsible for causing these households to immigrate closer to SNP.

With regard to land holdings, the desire to acquire adequate land was the primary reason that these households moved. Based on this, one might predict that more immigrants coming from other districts would report that they have since acquired sufficient land holdings. But this was not the case. Just 30% of those from other districts reported having enough land compared to 40% of the general sample ($X^2 = 5.259$, df = 1, $p = .022$). This finding is surprising considering the fact that the actual amount of land owned by the two groups was equivalent. It may be, of course, that households which in-migrated from other districts did so with the intent of acquiring land but were relatively unsuccessful in this pursuit. But this scenario seems unlikely, however, because households generally do not go to the trouble of uprooting long-established ties without foreknowledge of the opportunities offered by the place they will settle.

A second finding that suggests the importance of push factors is the associated benefits that a household gains from the presence of SNP. Just 16% of households that in-migrated from districts that do not border SNP reported that they receive benefits from SNP compared to 35% of households from the general sample ($X^2 = 17.980$, df = 1, $p < .001$). If pull factors (e.g., better access to natural resources, better infrastructure, etc.) were responsible, then it would be reasonable to predict that immigrants would be more cognizant of benefits and more likely to report them. Since this was not the case, push factors are more likely accountable for the immigrants' decision to move closer to the park.

Two generalized patterns emerge here. The first concerns overall movement and relocation of western Serengeti households. Pull factors seem implicated in most responses given by households that made local—or small scale—migrations (e.g., one village to another within Meatu Distict). On the positive side, the existence of pull factors suggests that land and natural resources have been relatively available in the recent past. More negatively, however, it implies that households have actively—and likely continue to—moved within the western Serengeti study area with the specific intent on using land and harvesting resources. A more thorough analysis of small-scale movement patterns is essential if existing tracts of land and resources are to be conserved and managed sustainably.

Second, the responses of households that have in-migrated from districts not bordering SNP more strongly imply the presence of push factors. These households have likely moved due to limited possibilities in their previous district. The existence of push factors in other districts and parts of Tanzania is important to agencies and wildlife managers in SNP because it suggests that the human population near the park will increase at a rate that is greater than the current intrinsic rate of growth. As population growth in the study area continues, so too will the instances, and magnitude, of human-wildlife conflict (Burgess et al. 2007).

An examination of movement patterns between the three districts did not reveal significant differences at the local level (e.g., from village to village). At a larger scale, however, Meatu District had a greater percentage of households (54%) that had moved in from another district than did Serengeti (40%) or Bunda (39%) ($X^2 = 11.346$, df = 2, $p = .003$). The difference between the districts was even greater for respondents who had in-migrated from districts that did not border SNP. Nearly half (46%) of respondents who immigrated into Meatu were from nonbordering districts compared to 10% of respondents in Serengeti District and 6% in Bunda District ($X^2 = 120.500$, df = 2, $p < .001$).

If it is true that push factors played out more prominently for households that immigrated from non-bordering districts, then this implies that non-bordering districts in southwestern Serengeti are more heavily populated and devoid of opportunities than those in northwestern Serengeti.[247] Incidentally, however, each district had

[247] Unfortunately, comparative studies of population density by district have not been completed for Tanzania. The 2002 Population & Housing Census reveals the following population densities for the three regions in this study: Mara: 70 people/km^2; Shinyanga: 55 people/km^2; Mwanza: 150 people/km^2.

approximately equal numbers of recent immigrants[248] suggesting that population growth rates in southwestern and northwestern Serengeti are likely occurring at equivalent rates, with current differences between the regions dictated more by intrinsic growth rates than in-migration.[249]

4.18 – Recent in-migration

Management policies seeking to slow population growth by curbing in-migration cannot be effectively implemented without understanding the underlying motivations of recent movement patterns. For simplicity, "recent immigrants" are those that have lived in their current domicile less than, or equal to, ten years from the date of the interview. This definition included over one-fifth (21%) of the total number of households that had moved, or 15% of the total households sampled.

Reasons for immigration among recent immigrants mirrored overall statistics as the largest percentage moved to obtain land (41%), followed by roughly one-third (34%) who moved to live with, or closer to, family, and equivalent percentages who moved for reasons pertaining to employment, ancestry, and marriage (5%, respectively). No significant differences were found between recent immigrants and the general sample of immigrants for reported benefits from SNP, amount of land owned, general income earned, or park-related income earned. The ostensible lack of differences shown here suggests that the same factors that lured respondents into western Serengeti a long time ago are still at work today. Clearly, the dualistic pull of land and family continue to act

[248] Recent immigrants are defined as households that have moved into the study region within the last decade.
[249] Northwestern Serengeti (represented by Mara and Mwanza Regions) was growing at 2.5% and 3.2%, respectively. Southwestern Serengeti (represented by Shinyanga Region) was growing at 3.3%, slightly higher than northwestern Serengeti. Source: 2002 Population & Housing Census, Tanzania.

as the primary magnets for rural peoples in western Serengeti. The fact that recent immigrants and the general sample owned equivalent amounts of land implies that land is still available, yet likely subject to ever greater levels of subdivision. Since displacement of already settled peoples is politically and ethically difficult (Woodroffe et al. 2005; Scholte 2003), this study recommends that if the human population near SNP is to be slowed, in-migration must be controlled via preventative rather than reactionary measures.

Analyses here point to two workable strategies. One calls for local villages to conserve remaining tracts of local land and set them aside for communal pasture, wood lots, fish farms, or other sustainable resource-based activities. If land continues to be parceled out to immigrants and subdivided among their offspring, there may soon be few feasible agricultural or grazing locations. The second strategy would be to put a moratorium on non-employment-related development activities near SNP. This aligns with recommendations put forth by others (Hart & Hart 1997; Sinclair & Arcese 1995) that Integrated Conservation Development Projects (ICDPs) have been largely unsuccessful due to their dependency on funding agencies, general failure to conserve, and inherent risks of overexploitation.

Rather, this study argues that caution should be used in SNP regarding future road development and improvement of infrastructure. In so doing, development activities should be selected and administered carefully (Scholte 2003) so as to minimize pull factors. Development initiatives that are incorporated should seek to directly benefit the livelihoods of long-established residents (Leader-Williams & Milner-Gulland 1993)—

especially through employment—and be based on non-exploitative park-related activities (e.g., tourism).

With 17% of all interviewed households having immigrated from a district not bordering SNP and 15% having arrived in the last 10 years, it is clear that in-migration continues to contribute significantly to overall population growth in western Serengeti.[250] While this threat appears more future-oriented, many interviewees have acknowledged its growing importance as 62% reported that their current land holdings are insufficient largely because their current allotments were not large enough to divide among their offspring.

With fewer parcels available, it is not unreasonable to conclude that future immigrants will be forced into settling ever closer to SNP with the resultant buffer zone becoming a "harder" edge between protected and unprotected lands (Harcourt et al. 2001). This is particularly unfavorable as it has been repeatedly documented that human-wildlife conflicts are most severe in areas where game reserves abut cultivated areas with high human densities (Knickerbocker & Waithaka 2005; Naughton-Treves & Treves 2005). Moreover, existing households will likely have to intensify the use of current land holdings (deFries et al. 2007; Burnsilver 2007), which can drain existing cash supplies making it more difficult for them to purchase food to make up agricultural shortfalls.

To conclude this section is a brief discussion of two tangential, but noteworthy, findings. One, immigrants who arrived from districts not bordering SNP earned a much lower amount of income (TZS 12,950) from park-related employment than those who immigrated from nearby areas (TZS 50,708) ($F = 3.738$, df $= 1$, $p = .054$). From this, it seems unlikely that most immigrants are coming to take advantage of desirable economic

[250] At present, emigration statistics are not known for the study area or the region at large.

opportunities as shown by Scholte (2003). At the same time, however, a significantly greater percentage of respondents from non-neighboring districts had achieved food security (24%) by growing a surplus of maize than did those from nearby areas (11%) ($X^2 = 15.374$, df = 2, $p <.001$).

What this latter finding shows is that households coming from more distant areas already possess—or quickly attain—adequate knowledge of local growing conditions and farming practices. Positively, this reveals an enterprising characteristic of immigrants. More negatively, however, greater rates of livelihood success among immigrants may attract even more outsiders, thereby increasing pressures on SNP. This could prove to undermine resilience because land and employment opportunities that are subsumed by immigrants are necessarily removed from the population that is more historically and culturally rooted in western Serengeti.

Part III.

4.19 – Implications for adaptive capacity and resilience

Household resilience and the general resilience of the Greater Serengeti Ecosystem to change is predicated on the compatibility—or coexistence—of humans and wildlife. The question of this compatibility is not a recent one, however. In the 1920s, for example, the Tanzanian Game Department made consistent efforts to remove western Serengeti peoples who were building, cultivating, and grazing within the newly established game reserves. Although subtle and not fully recognized at the time, this made the case that humans and wildlife were incompatible and that coexistence would not be possible (Shetler 2007). Varying arguments about coexistence and compatibility in western Serengeti have periodically arisen since this time. As discussed in Chapter One, Bernard Grzimek favored separating people from wildlife in the 1960s, calling Serengeti, "an island teeming in a sea of humanity." Protectionist arguments were countered in the 1980s and early 90s as proponents around the world advocated community- and incentive-based approaches. After multiple reported failures in these approaches, however, momentum seems to be swinging the other way again, or meeting in the middle (Riley et al. 2002).

The question of compatibility as revealed by the analysis of the current human-wildlife milieu suggests two overarching themes. One, there now appears to be an ephemeral window of opportunity in western Serengeti for both fostering conservation and enhancing the resilience of the coupled human-natural system. And two, rather than an either-or approach, resilience will likely depend on a combination of approaches—or one heavily nuanced approach—to be successful. This first theme will be discussed later (Section 4.20). The second theme, which was explored in-depth in the first three chapters, will conclude this study by serving as a summary of the possible steps forward to heightened household resilience to change (Section 4.21).

4.20 – Window of opportunity in western Serengeti

The window of opportunity alluded to previously is rooted in the well-established idea that conservation awareness arises precisely when use pressures exerted by humans reach a given threshold (Lu Holt 2005). This threshold is marked by a switch to overexploitation in which individuals use local resources so as not to lose them to the harvesting rates of others (Banana & Gombya-Ssembajjwe 1996) as frequently illustrated in tragedy of the commons scenarios (Hardin 1968). Such scenarios, like what is now happening in western Serengeti, often run concurrently with population growth, adoption of Western technologies, and a greater degree of market production (Lu Holt 2005).

A seminal study by Hames (1987) outlined three necessary factors for conservation-promoting—or resilience enhancing—institutions to emerge. These include stress on the resource base, mechanisms for dealing with cheaters, and territoriality. These three requirements are now in place in western Serengeti, but this study strongly suggests that two of them—mechanisms for dealing with cheaters and territoriality—are lacking effectiveness and therefore, even worse, are undermining the entire system's resilience.

As evidenced by the limited food security of the sample (Section 4.4) and limited incomes from agropastoral activities (Section 4.5), western Serengeti households appear to have stressed the resource base to a point where production has become limited. At the same time, however, mechanisms for dealing with cheaters (e.g., poachers) appear inchoate and ineffectual. As revealed by court reports in Chapter Three (Section 3.17), there are insufficient disincentives to keep individuals from engaging in illegal exploitation of resources. This leaves little for households that might wish to preserve resources and play by the rules (Holmern et al. 2007). As will be argued shortly, this may potentially be remedied through increased involvement and expansion of local game scouts and environmental protection committees.

Also lacking is the idea of territoriality which is defined as the defense of land and resources against outsiders or newcomers (Hames 1987). Territoriality, which is essentially a land tenure issue, is predicated on the idea that land-use patterns are like investments in that households are more likely to engage in resilience-enhancing activities (e.g., cultivate wood lots, hold land in long fallow, etc.) provided they are operating under long-term use rights that are relatively immune from the arrival of newcomers (Clay et al. 1994). So far, however, such sustainable practices have not been encouraged, possibly due to historically based local fears regarding land insecurity (Shetler 2007), coupled with a high steady influx of outsiders (Section 4.16) and high rates of intrinsic population growth (Kaltenborn et al. 2008).

Before possible steps are put forth for building resilience in western Serengeti, it is worth mentioning that conservation and resilience are not a state of being (Lu Holt 2005). Rather, they are often more concerned with specific responses from a person's perceptions about the changing state of their environment and resources (ibid). Because resilience is not a static goal, it can often be achieved incrementally through small-scale behavioral changes brought about through relatively simple modifications to existing resource-based institutions. This study will conclude with a summary of what some of these resilience-enhancing modifications might be.

4.21 – Possible steps for enhancing resilience: a review

4.21a – Chapter One

Chapter One laid the groundwork for this discussion by providing the context for human-wildlife conflict. In so doing, two findings emerged that have significant import for possible steps of enhancing resilience. These are dependence on natural resources and education.

Heavy dependence on natural resources for crops and livestock is of critical importance due to the region's propensity for periodic drought. Long-term rainfall trends corroborated household interviews showing that region-wide droughts occur approximately every ten years. Consequences may be especially severe for households lacking adaptive capacity and without assets and wealth to fall back on. As Chapter One revealed, 94% of households changed livelihood strategies during a drought. In terms of resilience, the fact that one-fifth of households switched to collecting and selling firewood and charcoal accelerates background rates of deforestation and habitat destruction in the GSE. Coupled with this, 7% of the sample reported that one or several household members turned to poaching wildlife or illegal fishing in past droughts. In light of increasing human population growth (Section 4.19), accelerated habitat destruction and biodiversity loss during droughts may result in local extinctions and threaten key migration routes.

There are three potential ways to build resilience based on these analyses. One is the accumulation of fall-back assets. As explained in Chapter Three, these might include increasing poultry production by enhancing survival of young chickens and improving livestock husbandry practices. Two, local villages need to take steps to curb in-migration into villages bordering protected areas. This could occur by village councils capping the amount of land available to outsiders and creating sizable disincentives for households seeking to subdivide existing parcels. Three, national (and international) agencies need to anticipate severe droughts and be ready to intervene with temporary relief in times large crop failures. Although droughts may be difficult to predict year-to-year, rainfall records and household surveys show a definite periodicity, with large-scale changes in livelihood strategies. Although this study does not advocate outside intervention as a long-term solution to building resilience, failure to do so in the short-term may have irreparable consequences for the biodiversity of the GSE.

Chapter One revealed that education is the foundation for higher levels of income. Secondary education levels for males were positively correlated with total income (Pearson $R = .266$, $p < .001$) and total income per adult equivalent (Pearson $R = .184$, $p < .001$). The same applied for females for total income per adult equivalent (Pearson $R = .182$, $p < .001$). Regression analyses showed that a female's primary education had a greater impact on household income than male's level of primary or secondary education ($\beta = .206$, $p < .001$).

Education spills into other park-related arenas as well. Females who completed greater amounts of primary education had smaller household sizes (Pearson $R = -.134$, $p < .001$). Hypothetically, this implies that increasing female education in western Serengeti may slow down intrinsic rates of population growth. Other analyses showed that a greater percentage of educated individuals recognize benefits from SNP ($X^2 = 11.286$, df = 1, $p < .001$). This is critical as theory laid out in Chapter Two suggests that individuals who recognize benefits are more likely to conserve the resource than those who do not.

Education had two other important ties to concepts in the second and third chapters. In the second chapter, individuals with park-related employment were more highly educated than those without. Simply put, it is critical for individuals living close to SNP to become more educated if they are going to compete with people from other areas for the limited number of park-related jobs.

In the third chapter, it was shown that acknowledged poachers had attained a lower level of secondary education than the primary sample ($F = 11.23$, df = 1, $p < .001$) and far fewer had completed secondary ($X^2 = 5.105$, df = 1, $p = .024$). These findings go hand-in-hand with those from chapters one and two. Households with lower levels of education had lower incomes and fewer jobs. As a result, many of them lacked food security and had to poach wildlife to make up shortfalls.

4.21b – Chapter Two

Perhaps the most significant finding of Chapter Two is that crop damage and wildlife depredation on livestock for households in western Serengeti are heavily localized and distributed unevenly. Despite the fact that all three districts directly bordered SNP or one of its protected areas, households in Serengeti District lost 4.9 sacks (441 kg) of maize compared to households in Bunda Distict that lost 0.3 sacks (27 kg) and households in Meatu District that lost 0.1 sacks (9 kg) ($F = 11.961$, df = 2, $p < .001$) (Section 2.9).

Similar trends were observed at finer scales. Within Serengeti District, for example, despite being located at equivalent distances from a protected area boundary, households in Bonchugu village lost 20.6 sacks (1,854 kg) of maize compared to 10.2 sacks (918 kg) per household in Park Nyigoti village and 1.1 sacks (99 kg) per household in Robanda village ($F = 7.103$, df = 2, $p = .001$) (Section 2.10). Within Robanda village, highly localized damage was even observable at the sub-village level. Households in Mereshi sub-village averaged losses of 3.2 sacks (288 kg) per household compared to households in a neighboring sub-village, Machengere, losing just 0.5 sacks (45 kg) ($F =$

2.702, df = 1, $p = .112$).[251] (Section 2.11) Similar idiosyncratic patterns were observed for wildlife destruction of all seven of the staple food crops and for cattle, sheep, goats, and poultry.

Such findings, never before recorded in western Serengeti, reflect patterns in other parts of Africa showing that conflicts are not evenly distributed (Treves et al. 2004; Sitati et al. 2003). Patchy human-wildlife conflicts can cause negative attitudes toward wildlife among local peoples. Although the distribution implies that many households suffer relatively little, negative attitudes can occur simply because costs can be inordinately high if a household is unlucky enough to be affected. The flipside of the argument, however, can have positive implications (Woodroffe et al. 2005).

In essence, conflicts that are highly localized can be mitigated through solutions that are highly focused on small—or specific—areas. Improving crop guarding or upgrading animal husbandry practices, for example, can be focused more tightly on households, sub-villages, villages, or even districts that suffer repeatedly or disproportionately. In the case of maize, analyses put forth in Chapter Two indicate that efforts to reduce wildlife destruction at the district level might be much more cost-effective if they are focused in Serengeti District rather than Bunda or Meatu districts. Effort may be channeled even more effectively if Bonchugu is targeted at the village level and Mereshi at the level of the sub-village. More focused effort at finer scales would decrease the tendency for management agencies to waste limited financial resources and ultimately make conflict mitigation more effective.

[251] Result is not significant at the .05-confidence level likely due to small sample sizes for sub-villages. Mereshi sub-village had a sample of 10 households while Machengere sub-village had 19 households.

Another seemingly minor step to build resilience among western Serengeti households calls for improving poultry-keeping practices. In contrast to much smaller losses of cattle, goats and sheep, annual losses of poultry were disproportionately large. Households, for example, lost over half (55%) of their poultry holdings to wildlife or disease over a year. As a result, potential income from poultry losses (TZS 14,717) was nearly three times larger than reported earnings (TZS 5,207). With food insecurity so high in the region (Section 4.4), this loss of potential protein and income undoubtedly lowers the adaptive capacity of households and ultimately, the general resilience of the GSE to change.

While respondents recognized that losses to adult chickens could be minimized if chickens were enclosed, many reported that they could not afford the price of poultry feed. Due to this, one possible step forward might be improving the survival rates of chicks.[252] Predation on chicks is extremely high as households lost 93% over the course of a year. Unlike adult chickens that consume greater quantities of feed, chicks may be enclosed and reared to breeding age relatively inexpensively. While increasing survival rates of chicks may seem trivial, each loss represents a potential source of protein or income, capable of earning upwards of TZS 5,000, which is more than double the average daily earnings of typical seasonal wage labor.

Park-related employment constitutes a third potential step by which resilience may be enhanced in western Serengeti. In terms of the overall sample, just 6% of households had attained park-related employment. In addition to adding a significant amount of income to households (TZS 1,722,426), park-related employment provided a benefit over general employment in that it appears to give households positive feelings

[252] Chicks are defined here as chickens not yet capable of egg-laying.

toward the SNP as it was strongly correlated with reported benefits from SNP (Pearson $R = .376, p < .001$). This is in line with theoretical predictions suggesting that households with more positive feelings toward protected areas will be more likely to protect them (Charnley 2005). Households with park-related employment become invested—and partially dependent—on the maintenance of the park and its biodiversity. In a sense, therefore, they can effectively become custodians of the wildlife and natural resources. By contrast, installing and improving community programs and infrastructure does little to resolve human-wildlife conflicts (Walpole & Thouless 2005; Leader-Williams & Hutton 2005) because the link between more generalized conservation activities and benefits recognized at the household level is weak (Woodroffe et al. 2005).

More pragmatically, income from tourism effectively decouples households from the vagaries of rainfall, disease, and other park-related costs of living near wildlife. This makes households more resilient to environmental perturbations and likely decreases their likelihood to poach. Moreover, 90% of households with park-related employment gave large sums of money to various kin and non-kin constituents, thereby increasing their economic resources and ability to buffer periods of food insecurity. Most importantly, nearly one-third (32%) of respondents with park-related employment dispersed an average of TZS 225,395 to dependents or siblings to assist them with fees associated with secondary school. In this way, park-related employment contributes not only to the present, but also the future—and multigenerational—resilience of western Serengeti.

Although park-related employment cannot be expected to act as the sole driver of conservation and development (de Toit et al. 2004), its ability to generate revenue is well documented (Nyhus et al. 2005) and not nearly as susceptible as compensation programs to corruption (Western & Waithaka 2005). The benefits of creating more park-related ecotourism opportunities are also considerable from a macroeconomic perspective. Research has suggested that land used for wildlife production and tourism purposes offers the highest potential return per unit area (Ntiamoa-Baidu 1997).

4.21c – Chapter Three

As Chapter Three revealed, the primary challenge of poaching is that it acts as a threat to biodiversity while simultaneously sustaining some of the world's poorest people (Bennett et al. 2006; Robinson 2005). Somewhat ironically, however, maintenance of biodiversity in the GSE is likely essential for many poachers who depend on the ecosystem services the system provides. This is because the structure and function of the GSE is upheld by the wildebeest migration (Sinclair et al. 1995). Illegal killing of the wildebeest, which has been dubbed the greatest threat to the system (ibid), possesses the capacity to weaken the resilience of the ecosystem which would ultimately undermine the resilience of the dependent western Serengeti human population. While there are obviously no simple solutions to such a complex dilemma, two potentially resilience-enhancing findings were discussed in Chapter Three. One involves employment while the other concerns enforcement. But the two objectives presented here are interlinked.

The simple fact that over two-thirds (69%) of acknowledged poachers responded that they would discontinue poaching if they procured year-round employment is enough to conclude that employment—with its steady wages—is an essential element to curbing poaching. Since the case for park-related employment has already been made due to the vested interest it creates in biodiversity, suffice it to add that existing park-related employment opportunities should be targeted toward households that have long-standing histories of residence along SNP's boundaries. Moreover, improving steady wage opportunities are a practical means of increasing the opportunity costs of hunting which can be more economical than increasing expensive enforcement operations (Milner-Gulland & Leader-Williams 1992).

Despite its costs, the other essential element for reducing poaching rates is through enforcement and regulation (Hilborn et al. 2006). It was mentioned in Chapter Three that over one-tenth (11%) of acknowledged poachers asserted that no amount of incentives or employment would cause them to stop their illegal hunting. For this group—and those that fail to procure other income-generating activities—enforcement is the only viable means of curbing poaching.

Enforcement is usually viewed as a top-down strategy that contributes little to household economies. In reality, however, enforcement—through the expansion of local village game scout (VGS) operations—could potentially function to maintain an effective regulatory presence while also creating year-round park-related employment. While VGS systems are not immune to internal corruption (Holmern et al. 2007), partnerships with higher level agencies (e.g., Tanzania Wildlife Division, Tanzania National Parks) could build capacity (Bennett et al. 2009) by forging greater levels of inter-organizational accountability and by increasing transparency.

Funding for such a system could be created by levying payable fines rather than costly prison sentences for offenders arrested for poaching. Moreover, if fines for poaching are retained by the home villages of the VGS, this could provide revenue for maintenance of daily operations and provide a faster and more cost-effective processing system (Holmern et al. 2007). Collaborative initiatives such as the one just described are recommended here for the primary reason that they have the dualistic aim of protecting biodiversity while also lifting households out of poverty (Bennet et al. 2009). Initiatives that fail to address one of these two fundamental objectives will not likely achieve long-term success.

4.21d – Chapter Four

The overarching message of Chapter Four is that most households (84%) in western Serengeti are not food secure. General food insecurity, coupled with the finding that the majority of households (78%) were reportedly well over-budget, suggests that households in the study region are generally impoverished. Although rural poverty is not uncommon in Tanzania (Madulu 2003), a clear assessment of poverty in western Serengeti is especially important due to the severe effects that impoverished households can potentially exert on the GSE's world renowned wildlife and natural resources. As this final chapter has shown, negative effects on the ecosystem are indeed occurring as many impoverished households in western Serengeti are subsidizing their protein and budgetary shortfalls through illegal exploitation of natural resources from SNP.

With these critical findings in mind, it becomes clear that the long-term resilience of western Serengeti people and the GSE ecosystem that supports them hinges on forging a robust linkage between the impoverished local people and SNP. Despite over three decades of acknowledging that people and parks need to be brought together, the IUCN stated recently[253] that the conservation community is still beleaguered by "a current of acrimony and conflict over the impact of protected areas on local peoples."

This study, however, has aimed to aid in resolving this conflict by concretely assessing the impacts of the park on household economies. While broad-level studies such as the one here run the risk of oversimplification, they are vital for recognizing the overarching tradeoffs between positive and negative effects that stem from human interactions with wildlife (Riley et al. 2002). Moreover, studies such as these have been dubbed "the functional approach to wildlife management for the twenty-first century" (Decker et al. 2009) in that they are conducted with the aim of making the most positive impacts on human-wildlife interactions (Enck et al. 2006).

Like other protected areas around the world, SNP exists as a cornerstone of conservation, but one that is fraught with human-wildlife conflicts (Woodroffe et al. 2005). This is because humans and wildlife are daily competing for space, food, and life. Although tradeoffs between these constituents may arise, they need to be addressed in a way that does not disproportionately disadvantage either one (IUCN 2004). For this to happen, and as this study has consistently argued, the first step forward is acknowledgement that humans are an integral part of the system (Galvin et al. 2009). Only widespread acceptance of this foundational tenet on the part of all vested stakeholders can reasonably ensure that the GSE system will remain resilient in the face of ever-changing conditions. And ultimately, it is the only way to ensure that western Serengeti people—like the park itself—shall not die.

---

[253] The statement by the IUCN was made in 2004.

References[254]

Chapter One

Adams, A. M., Evans, T. G., Mohammed, R., & J. Farnsworth. (1997). Socioeconomic Stratification by Wealth Ranking: Is it Valid? *World Development*, 25(7):1165-1172.

Adger, N. W., and K. Vincent. (2004). Uncertainty in adaptive capacity. *Geoscience*, 334:399-410.

Adler, P. S., and Kwon, S. W. (2002). Social Capital: Prospects for a New Concept. *Academy of Management Review*, 27(1):17-40.

Ayalew, W., King, J. M., Bruns, E., & B. Rischkowsky. (2003). Economic Evaluation of Small-holder Subsistence Livestock Production: Lessons from an Ethiopian Goat Development Program. *Ecological Economics*, 45:473-485.

Bahiigwa, G., N. Mdoe, and F. Ellis. (2005). Livelihoods Research Findings and Agriculture-Led Growth. *IDS Bulletin* 36 (2): 115-20.

Barrett, C. B., Reardon, T., and P. Webb. (2001). Nonfarm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics, and Policy Implications. *Food Policy*, 26(4):315-331.

Berkes, F., and N. J. Turner. (2006). Knowledge, Learning and the Evolution of Conservation Practice for Social-Ecological System Resilience. *Human Ecology*, 34(4):479-494.

Berkes, F. and C. Folke. (1998). Back to the Future: Ecosystem Dynamics and Local Knowledge. *In* Gunderson, L.H. and C.S. Holling, editors. Panarchy: Understanding Transformations in Human and Natural Systems. Washington (DC): Island Press.

Bernard, H.R. (2006). Research Methods in Anthropology: Qualitative and Quantitative Approaches, Fourth Edition. Rowman Altamira, Lanham: Maryland.

[254] References for each chapter are delineated for convenience. Many sources were used in multiple chapters and are listed in each corresponding chapter, respectively.

Biran, A., Abbot, J. and R. Mace. (2004). Families and Firewood: A Comparative Analysis of the Costs and Benefits of Children in Firewood Collection and Use in Two Rural Communities in Sub-Saharan Africa. *Human Ecology*, 32(1):1-25.

Boone, R.B., Thirgood, S.J., Hopcraft, J.G.C. (2006). Serengeti Wildebeest Migratory Patterns Modeled from Rainfall and New Vegetation Growth. *Ecology*, 87(8):1987-1994.

Brockington, D. and K. Schmidt-Soltan. (2004). The Social and Environmental Impacts of Wilderness and Development. *Oryx* 38(2):140-142.

Brosius, P. J. (2004). Indigenous Peoples and Protected Areas at the World Parks Congress. *Conservation Biology*, 18(3):609-612.

Campbell, K. L. I., Nelson, V., Loibooki, M. (2001). Sustainable Use of Wildland Resources, Ecological, Economic, and Social Interactions: An Analysis of Illegal Hunting in Serengeti National Park, Tanzania. Department for International Development (DFID) Animal Health Programme, and Livestock Production Programmes. Final Technical Report. Project R7050. Natural Resources Institute, Chatham, Kent, UK.

Carpenter, S.R., Walker, B.H., Anderies, J.M. & Abel, N. (2001). From Metaphor to Measurement: Resilience of What to What? *Ecosystems*, 4:765-781.

Chambers, R. (1987). Poverty and Livelihoods: Whose Reality Counts? *Environment and Urbanization*, 7(1):173-204.

Clay, D. C., Guizlo, M., and S. Wallace. (1994). Population and Land Degradation. Working Paper No. 14, pp. 1-24.

Cleaveland, S. Mlengeya, T., Kazwala, R. R., Kaare, M. T., Jones, S. L., Eblate, E., Shirima, G. M., and C. Packer. (2005). Tuberculosis in Tanzanian Wildlife. *Journal of Wildlife Diseases*, 41(2):446-453.

Cleaveland, S., Laurenson, M. K., and L. H. Taylor. (2001). Diseases of Humans and their Domestic Mammals: Pathogen Characteristics, Host Range and the Risk of Emergence. *Biological Sciences*, pp. 991-999.

Coughenour, M. B., McNaughton, S. J., and Wallace, L. L. (1984b). Modelling Primary Production of Perennial Graminoids – Uniting Physiological Processes and Morphometric Traits. *Ecological Modeling*, 23: 101-134.

Ellis, F. (1998). Household strategies and rural livelihood diversification. *Journal of Development Studies*, 35(1):1-38.

Ellis, F., and Mdoe, N. (2003). Livelihoods and Rural Poverty Reduction in Tanzania. *World Development*, 31(8):1367-1384.

Epaphras, A. M., Gereta, E., Lejora, I. A., Ole Meing'taki, G. E., Ng'umbi, G., Kiwango, Y., Mwangomo, E., Semananini, F., Vitalis, L., Balozi, J., and M. G. G. Mtahiko. (2008). Wildlife Water Utilization and Importance of Artificial Waterholes during Dry Season at Ruaha National Park, Tanzania. *Wetlands Ecology and Management*, 16(3):183-188.

Fleisher, M.L. (2000). Kuria Cattle Raiders: Violence and Vigilantism on the Tanzania-Kenya Frontier. Michigan University Press, Ann Arbor, MI.

Friedman, M. (1957). A Theory of the Consumption Function. Princeton, New Jersey: Princeton University Press.

Fryxell, J. M., Wilmshurst, J. F., and Sinclair, A. R. E. (2004). Predictive Models of Movement by Serengeti Grazers. *Ecology*, 85(9):2429-2435.

Galvin, K. A., Thornton, P. K., and Boone, R. B. (2004). Climate Variability and Impacts on East African Livestock Herders: The Maasai of Ngorongoro Conservation Area, Tanzania. *African Journal of Range and Forage Science*, 21(3):183-189.

Galvin, K. A., Ellis, J., Boone, R. B., Magennis, A. L., Smith, N. M., Lynn, S. J., and Thornton, P. K. (2002). Compatibility of Pastoralism and Conservation? A Test Case using Integrated Assessment in the Ngorongoro Conservation Area, Tanzania. *In* Displacement, Forced Settlement, and Conservation. Chatty D. and Colester (eds). Berghahn, Oxford, UK. pp.36-60.

Garmestani, A. S., Allen, C. R., and L. Gunderson. (2009). Panarchy: Discontinuities Reveal Similarities in the Dynamic System Structure of Ecological and Social Systems. *Ecology and Society*, 14(1):15.

Garmestani, A. S., Allen, C. R., Gallagher, C. M., and J. D. Mittelstaedt. (2007). Departures from Gibrat's Law, Discontinuities and City Size Distributions. *Urban Studies*, 44:1997-2007.

Githiru, M. (2007). Conservation in Africa: But for Whom? *Oryx*, 41(2):119-120.

Gjertsen, H. (2005). Can Habitat Protection Lead to Improvements in Human Well-being? Evidence from Marine Protected Areas in the Philippines. *World Development*, 33(2):199-217.

Glewwe, P. & van der Gaag, J. (1990). Identifying the poor in developing countries: Do different definitions matter? *World Development*, 18(6):803-814.

Grzimek, M. and Grzimek, B. (1960). A Study of the Game of the Serengeti Plains. Berlin.

Gunderson, L. H., and C. S. Holling (eds.). (2001). Panarchy: Understanding Transformations in Human and Natural Systems. Island Press, Washington, D.C.

Hardin, G. (1968). The Tragedy of the Commons. *Science,* 162 (3859): 1243-1248.

Hella, J. P., van Huylenbroeck, G. & M. E. Mlambiti. (2001). Small Farmers' Adaptive Efforts to Rainfall Variability and Soil Erosion Problems in Semiarid Tanzania. *Journal of Sustainable Agriculture*, 22(1):19-38.

Hilborn, R. A., Borner, M., Hando, J., Hopcraft, G., Loibooki, M., Mduma, S., and Sinclair, A. R. E. (2006). Effective Enforcement in a Conservation Area. *Science*, 314:1266.

Himmelfarb, D. (2006). Moving People, Moving Boundaries: The Socio-economic Effects of Protectionist Conservation, Involuntary Resettlement and Tenure Insecurity on the Edge of Mt. Elgon National Park, Uganda. *Agroforestry in Landscape Mosaics Working Paper Series*. World Agroforestry Center, Tropical Resources Institute of Yale University, and the University of Georgia.

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, 4:1-23.

Houghton, J. T., Ding, Y., Griggs, D. J., Noguer, M., Van der Linden, P. J., Dai, X., Maskell, K., and C. A. Johnson. (2001). Climate Change 2001: The Scientific Basis. Cambridge University Press, England.

Kaltenborn, B.P., J.W., Nyahongo, J.R. Kidegesho, and H. Haaland. (2008). Serengeti National Park and its Neighbours – Do they Interact? *Journal for Nature Conservation,* Volume 16 (2): 96-108.

Kapinga, R. E., Rees, D., Westby, A., Ndunguru, G. T., Rwiza, E., and Tomlins, K. I. (2000). Increasing the Contribution of Sweet Potato to Sustainable Rural Livelihoods in Tanzania. Proceedings from the 12th Symposium: www.research4development.info.

Kideghesho, J. R. and Mtoni, P. E. (2008). Who Compensates for Wildlife Conservation in Serengeti? *International Journal of Biodiversity Science and Management*, 4(2):112-125.

Kideghesho, J. R., Roskaft, E., and Kaltenborn, B. P. (2007). Factors Influencing Conservation Attitudes of Local People in Western Serengeti, Tanzania. *Biodiversity and Conservation*, 16(7):2213-2230.

Kideghesho, J. R., Nyahonogo, J. W., Hassan, S.W., Tarimo, T. C., and Mbije, N. E. (2006). Factors and Ecological Impacts of Wildlife Habitat Destruction in the Serengeti Ecosystem in Northern Tanzania. *African Journal of Environmental Assessment and Management,* 11: 17-32.

Knapp, E.J. (2007). Who Poaches? Household Economies of Illegal Hunters in Western Serengeti, Tanzania. *Human Dimensions of Wildlife*, 12(3):195-196.

Krishna, A. (2004). Escaping Poverty and Becoming Poor: Who Gains, Who Loses, and Why? *World Development*, 32(1):121-36.

Kuper, A. (1982). Wives for Cattle: bridewealth and marriage in Southern Africa. Routledge & Kegan Paul, London.

Lewis, C. (2007). Personal Communication. Grumeti Fund, Tanzania.

Loibooki, M., Hofer, H., Campbell, K.L.I. & East, M.L. (2002). Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. *Environmental Conservation*, 29:391-398.

Lu Holt, F. (2005). The Catch-22 of Conservation: Indigenous Peoples, Biologists, and Culture Change. *Human Ecology*, 33(2):199-215.

Luoga, E. J., Witkowski, E. T. F., and K. Balkwill. (2002). Harvested and Standing Wood Stocks in Protected and Communal Miombo Woodlands of Eastern Tanzania. *Forest Ecology and Management*, 164(1-3):15-30.

Martin, M. (1985). Design of a Food Intake Study in Two Bambara Villages in the Segou Region of Mali with Preliminary Findings. *In* Population, Health and Nutrition in the Sahel. A. Hill (ed.), Routledge & Kegan Paul, London. pp. 289-317.

McNaughton, S. J., Ruess, R. W., and Seagle, S. W. (1988). Large Mammals and Process Dynamics in African Ecosystems. *Bioscience*, 38:794-800.

Millenium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: General Synthesis*, Island Press, Washington, DC.

Millenium Ecosystem Assessment. (2003). *Ecosystems and Human Well-being: A framework for assessment*. World Resources Institute, Washington, DC.

Mmbaga, M., Ndakidemi, P. A., and C. S. Muslin. (2008). Potential Herbicides for Weed Control in Common Beans (*Phaseolus vulgaris* L.) in Northern Tanzania. SADC. Regional Bean Workshop, CIAT.

National Bureau of Statistics, Tanzania (NBS) (2002). Household Budget Survey 2000/2001. Dar es Salaam.

Norton-Griffiths, M. & Southey, C. (1995). The opportunity costs of biodiversity conservation in Kenya. *Ecological Economics*, 12(2):125-139.

Norton-Griffith, M. (1975). Aerial Census of Serengeti National Park.

Nyahongo, J.W. (2007). Depredation of Livestock by Wild Carnivores and Illegal Utilization of Natural Resources by Humans in the Western Serengeti, Tanzania. Doctoral Dissertation, Norwegian University of Science and Technology, Faculty of Natural Sciences and Technology.

Nyahongo, J.W, Mturi, F.A., East, M.L. & Hofer, H. (2005). Patterns of illegal grazing and hunting in the Serengeti ecosystem. *Environmental Conservation*, 32:326-332.

Patterson, B. D., Kasiki, S. M., Selempo, E., and R. W. Kays. (2004). Livestock Predation by Lions (*Panthera Leo*) and other Carnivores on Ranches Neighboring Tsavo National Park, Kenya. *Biological Conservation*, 119(4):507-516.

Pearsall, W. H. (1957). Report of an Ecological Survey of the Serengeti National Park, Tanganyika. *Oryx*.

Population & Housing Census, Tanzania. (2002). Dar es Salaam.

Reardon, T., Taylor, J. E., Stamoulis, K., Lanjouw, P., & A. Balisacan. (2000). Effects of Non-Farm Employment on Rural Income Inequality in Developing Countries: An Investment Perspective. *Journal of Agricultural Economics*, 51(2):266-288.

Rosser, J. B. (2003). A Reconsideration of the Role of Discontinuity in Regional Economic Models. *Chaos, Solitons and Fractals*, 18:451-462.

Scheffer, M., Carpenter, S., Foley, J. A., Folke, C., and B. Walker. (2001). Catastrophic Shifts in Ecosystems. *Nature*, 413:591-596.

Scoones, I. (1995). Investigating difference: Applications of Wealth Ranking and Household Survey Approaches among Farming Households in Southern Zimbabwe, *Development and Change*, 26(1):67-88.

Shetler, J. B. (2007). Imagining Serengeti: A History of Landscape Memory in Tanzania from Earliest Times to the Present. Ohio State University Press.

Sieff, D. F. (1999). The Effects of Wealth on Livestock Dynamics Among the Datoga Pastoralists of Tanzania. *Agricultural Systems*, 59(1):1-25.

Sinclair, A.R.E., Mduma, S.A.R., Hopcraft, J.G.C., Fryxell, J.M., Hilborn, R., & Thirgood, S. (2007). Long-term Ecosystem Dynamics in the Serengeti: Lessons for Conservation. *Conservation Biology*, 21(3):580-590.

Sinclair, A. R. E. (1995). Population Limitations of Resident Herbivores. *In* Serengeti II: Dynamics, Management, and Conservation of an Ecosystem. A. R. E. Sinclair (Ed). Chicago University Press, Chicago.

Sinclair, A. R. E. (1979). The Serengeti Environment. *In* Serengeti: Dynamics of an Ecosystem. A. R. E. Sinclair and Norton-Griffiths (eds). Chicago University Press, Chicago.

Sitati, N. (2007). Challenges and partnerships in elephant conservation and conflict mitigation. *Oryx*, 41(2):137-138.

Smit, B., and Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16:282-292.

Strauch, A. M., Kapust, A. R., and C. C. Jost. (2009). Impact of Livestock Management on Water Quality and Streambank Structure in a Semi-arid, African Ecosystem. *Journal of Arid Environments*, 73(9):795-803.

Tanzania Regional Profile (2002). Mara Region Socio-economic Profile. The United Republic of Tanzania, The Planning Commission of Dar es Salaam.

Temu, A. E., & Due, J. M. (2000). Participatory Appraisal Approaches versus Sample Survey Data Collection: A Case of Smallholder Farmers Well-being in Njombe District, Tanzania. *Journal of African Economies*, 9(1):44-62.

Thirgood, S.J., Mduma, S.A.R., Keyyu, J.D. & Laurenson, M.K. (2007). Long-Term Ecosystem Dynamics in the Serengeti: Lessons for Conservation. *Conservation Biology*, 21(3):576-579.

Van Campenhout, B.F.H. (2006). Locally Adapted Poverty Indicators Derived from Participatory Wealth Rankings: A Case of Four Villages in Rural Tanzania. *Journal of African Economies*, 16(3):406-438.

Walker, B., Sayer, J., and N. Andrew. (2009). Resilience in Practice: Challenges and Opportunities for Natural Resource Management in the Developing World. Background paper to the CGIAR Science Forum Workshop.

Walker, B., and D. Salt. (2006). Resilience Thinking: Sustaining Ecosystems and People in a Changing World. Island Press, Washington, D.C.

Walker, B. S., Carpenter, S., Anderies, J., Abel, N., Cumming G. S., Janssen, M., Lebel, L., Norberg, J., Peterson, G. D., and R. Pritchard. (2002). Resilience management in social-ecological systems: A working hypothesis for a participatory approach. *Ecology and Society*, 6(1): 14.

West, P., and D. Brockington. (2006). An Anthropological Perspective on Some Unexpected Consequences of Protected Areas. *Conservation Biology*, 20(3):609-616.

Wijsen, F. J. S., and Tanner, E. S. (2002). "I am just a Sukuma": Globalization and Identity Construction in Northwest Tanzania. Rodopi, Amsterdam.

Woodroffe, R., Thirgood, S. & Rabinowitz, A. (Eds.), (2005). People and Wildlife: Conflict or Coexistence? Cambridge University Press. Cambridge, U.K.

Chapter Two

Bernard, H.R. (2006). Research Methods in Anthropology: Qualitative and Quantitative Approaches, Fourth Edition. Rowman Altamira, Lanham: Maryland.

Boone, R.B., Thirgood, S.J., Hopcraft, J.G.C. (2006). Serengeti wildebeest migratory patterns modeled from rainfall and new vegetation growth. *Ecology*, 87(8):1987-1994.

Brandl, R., Utschick, H., and K. Schmidtke. (1985). Raptors and Land-use Systems in Southern Africa. *African Journal of Ecology*, 23:11-20.

Cai, J., Jiang, Z., Zeng, Y., Li, C., & Bravery, B.D. (2008). Factors affecting crop damage by wild boar and methods of mitigation in a giant panda reserve. *European Journal of Wildlife Research*, 54(4):723-728.

Campbell, K.L.I., Nelson, V. & Loibooki, M. (2001). Sustainable use of wildland resources: Ecological, economic, and social interactions. An analysis of illegal hunting of wildlife in Serengeti National Park. Final Technical Report. DFID, London.

Charnley, S. (2005). From Nature to Ecotourism? The Case of the Ngorongoro Conservation Area, Tanzania. *Human Organization*, 64(1):75-88.

Cleaveland, S., Appel, M.G.J., Chalmers, W.S.K., Chillingworth, C., Kaare, M. & Dye, C. (2000). Serological and demographic evidence for domestic dogs as a source of canine distemper virus infection for Serengeti wildlife. Veterinary microbiology, 72(3):217-227.

Cleaveland, S. & Dye, C. (1995). Maintenance of a microparasite infecting several host species: rabies in the Serengeti. *Parasitology*, 111:33-47.

DeFries, R., Hansen, A., Turner, B.L., Reid, R. & Liu, J. (2007). Land use change around protected areas: management to balance human needs and ecological function. *Ecological Applications*, 17(4):1031-1038.

de Sherbinin, A. (2008). Is Poverty Highest Near Parks? An Assessment of Infant Mortality Rates Around Protected Areas in Developing Countries. *Oryx*, 42(1):26-35.

Emerton, L. & Mfunda, I. (1999). Making wildlife economically viable for communities living around the western Serengeti, Tanzania. Evaluating Eden Series Discussion Paper, No. 1, International Institute for Environment and Development, London.

Frank, L.G., Woodroffe, R.B., & Ogada, M. (2005). People and predators in Laikipia District, Kenya. In *The Conservation of Wildlife that Conflicts with Man*, R.B. Woodroffe, S. Thirgood & A. Rabinowitz (eds.). Cambridge University Press.

Graham, K., Beckerman, A.P. & Thirgood, S. (2005). Human-predator-prey conflicts: ecological correlates, prey losses and patterns of management. Biological Conservation, 122(2):159-171.

Harcourt, A.H., Parks, S.A., & Woodroffe, R. (2001). Human density as an influence on species/area relationships: double jeopardy for small African reserves? *Biodiversity and Conservation*, 10:1011-1026.

Hill, C.M. (2000). A conflict of interest between people and baboons: crop raiding in Uganda. *International Journal of Primatology*, 21, 299-315.

Himmelfarb, D. (2006). Moving People, Moving Boundaries: The Socio-economic Effects of Protectionist Conservation, Involuntary Resettlement and Tenure Insecurity on the Edge of Mt. Elgon National Park, Uganda. *Agroforestry in Landscape Mosaics Working Paper Series*. World Agroforestry Center, Tropical Resources Institute of Yale University, and the University of Georgia.

Hoare, R. (2000). African elephants and humans in conflict: the outlook for coexistence. *Oryx*, 34, 34-38.

Holmern, T., Muya, J. & Roskaft, E. (2007). Local law enforcement and illegal bushmeat hunting outside the Serengeti National Park, Tanzania. *Environmental Conservation*, 34:55-63.

Holmern, T., Nyahongo, J. & Roskaft, E. (2006). Livestock loss caused by predators outside the Serengeti National Park, Tanzania. *Biological Conservation*, 135(4):518-526.

Kasperson, R.E. (1992). The Social Amplification of Risk: Progress in Developing an Integrative Framework in Social Theories of Risk. Krimsky, S., & Golding, D. (eds). Westport, Connecticut.

Kaswamila, A., Russell, S. & McGibbon, M. (2007). Impacts of Wildlife on Household Food Security and Income in Northeastern Tanzania. *Human Dimensions of Wildlife*, 12(6):391-404.

Keesing, F. (2000). Cryptic Consumers and the Ecology of an African Savanna. *BioScience*, 50(3):205-215.

Kock, R.A., Wambua, J.M., Mwanzia, J., Wamwayi, H., Ndungu, E.K., and T. Barrett. (1999). Rinderpest epidemic in wild ruminants in Kenya 1993–97. *Veterinary Records*, (145): 275–283

Kolowski, J.M. and Holekamp, K.E. (2005). Spatial, temporal, and physical characteristics of livestock depredations by large carnivores along a Kenyan reserve border. *Biological Conservation*, 128(4):529-541.

Leirs, H., Verhagen, R., and W. Verheyen. (1993). Productivity of Different Generations in a Population of *Mastomys natalensis* in Tanzania. *Oikos*, 68(1):53-60.

Linkie, M., Dinata, Y., Nofrianto, A. & Leader-Williams, N. (2007). Patterns and perceptions of wildlife crop raiding in and around Kerinci Seblat National Park, Sumatra. *Animal Conservation*, 10, 127-135.

Loibooki, M., Hofer, H., Campbell, K.L.I. & East, M.L. (2002). Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. *Environmental Conservation*, 29:391-398.

Madulu, N. F. (1996). Population Dynamics and Sustainable Conservation of Protected Areas in Tanzania: The Case of Swagaswaga Game Reserve in Kondoa District. Unpublished PhD Thesis, University of Dar es Salaam.

Martinoli, A., Preatoni, D., Galanti, V., Codipietro, P., Kilewo, M., Fernandes, C. A. R., Wauters, L. A., and G. Tosi. (2006). Species Richness and Habitat Use of Small Carnivores in the Arusha National Park (Tanzania). *Biodiversity and Conservation*, 15(5):1729-1744.

Meertens, H. C. C., Ndege, L. J., and H. J. Enserink (1995). Dynamics in Farming Systems: Changes in Time and Space in Sukumaland, Tanzania, Royal Tropical Institute, Amsterdam.

Millenium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: General Synthesis*, Island Press, Washington, DC.

Mills, M.G.L. & Hofer, H. (1998). Hyaenas: status survey and conservation action plan. IUCN.

Minga, U. M., Katule, A., Maeda, T., and J. Musasa. (1989). Potential and Problems of the Traditional Chicken Industry in Tanzania. *In* Proceedings of the 7th Tanzania Veterinary Association Scientific Conference. pp. 207-215.

Mkanda, F.X. (1994). Conflicts between hippopotamus and man in Malawi. *African Journal of Ecology*, 32(1):75-79.

Msoffe, P. L. M., Mtambo, M. M. A., Minga, U. M., Gwakisa, P. S., Mdegela, R. H., and J. E. Olsen. (2002). Productivity and Natural Disease Resistance Potential of Free-ranging Local Chicken Ecotypes in Tanzania. *Livestock Research for Rural Development,* 14(3).

Musharaf, N. A. (1990). Rural Poultry Production in Sudan. *In* CTA Seminar: Proceedings of Smallholder Rural Poultry Production, Thessaloniki, Greece. pp. 227-232.

Nahonyo, C.L. (2000). Elephant damage to crops in the Greater Ruaha Ecosystem, Tanzania. Paper presented to the Regional Workshop on "Sustainable Management of Biodiversity in the Third Millenium and Beyond", September. Arusha, Tanzania.

Narayan, D., and L. Pritchett. (1999). Cents and Sociability: Household Income and Social Capital in Rural Tanzania. *Economic Development and Cultural Change*, 47:871-897.

National Bureau of Statistics, Tanzania (NBS). (2002). Dar es Salaam.

Naughton-Treves, L. (1996). Uneasy neighbors: wildlife and farmers around Kibale National Park, Uganda. PhD. thesis. University of Florida, Gainesville.

Naughton-Treves, L. (1997). Farming the forest edge: vulnerable places and people around Kibale National Park, Uganda. *The Geographical Review*, 87:27-47.

Naughton-Treves, L. (1998). Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. *Conservation Biology*, 12, 156-168.

Naughton-Treves, L. (1999). Whose animals? A history of property rights to wildlife in Toro, western Uganda. *Land Degradation & Development*, 10(4):311-328.

Newmark, W.D., Manyanza, D.M., Gamassa, D.M., & Sariko, H.I. (1994). The Conflict between Wildlife and Local People Living Adjacent to Protected Areas in Tanzania: Human Density as a Predictor. *Conservation Biology*, 8(1):249-255.

Norton-Griffiths, M. & Southey, C. (1995). The opportunity costs of biodiversity conservation in Kenya. *Ecological Economics*, 12(2):125-139.

Ntiamoa-Baidu, Y. (1997). Wildlife and Food Security in Africa. FAO Conservation Guide 33, United Nations Food and Agricultural Organization, Rome.

Nyahongo, J.W. (2007). Depredation of Livestock by Wild Carnivores and Illegal Utilization of Natural Resources by Humans in the Western Serengeti, Tanzania.

Doctoral Dissertation, Norwegian University of Science and Technology, Faculty of Natural Sciences and Technology.

O'Connell-Rodwell, C.E., Rodwell, T., Rice, M., & Hart, L.A. (2000). Living with the modern conservation paradigm: can agricultural communities co-exist with elephants? A five-year case study in East Caprivi, Namibia. *Conservation Biology*, 93:381-391.

Ogada, M.O., Woodroffe, R., Oguge, N.O., & Frank, L.G. (2003). Limiting Depredation by African Carnivores: the Role of Livestock Husbandry. *Conservation Biology*, 17(6):1521-1530.

Packer, C., Ikanda, D., Kissui, B., & Kushnir, H. (2005). Lion Attacks on Humans in Tanzania: understanding the timing and distribution of attacks on rural communities will help to prevent them. *Nature*, 436:927-928.

Pelkey, N. W., Stoner, C. J., and T. M. Caro. (2000). Vegetation in Tanzania: Assessing Long Term Trends and Effects of Protection using Satellite Imagery. *Biological Conservation*, 94(3):297-309.

Polisar, J., Maxit, I., Scognamillo, D., Farrell, L., Sunquist, M.E., & Eisenberg, J.F. (2003). Jaguars, pumas, their prey base, and cattle ranching: ecological interpretations of a management problem. *Biological Conservation*, 109(2):297-310.

Rao, K.S., Maikhuri, R.K., Nautiyal, S. & Saxena, K.G. (2002). Crop damage and livestock depredation by wildlife: a case study from Nanda Devi Biosphere Reserve, India. *Journal of Environmental Management*, 66(3):317-327.

Reardon, T., Berdegue, J. & Escobar, G. (2001). Rural Nonfarm Employment and Incomes in Latin America: Overview and Policy Implications. *World Development*, 29(3):395-409.

Reardon, T., Berdegue, J., Barrett, C.B. & Stamoulis, K. (2006). Household Income Diversification into Rural Nonfarm Activities. In *Transforming the Rural Nonfarm Economy*, S. Haggblade, P. Hazell, & T. Reardon, (eds). Johns Hopkins University Press: Baltimore.

Sherbinin, A. (2008). Is Poverty More Acute near Parks? An Assessment of Infant Mortality Rates around Protected Areas in Developing Countries. *Oryx*, 42:26-35.

Sinclair, A.R.E., Mduma, S.A.R., Hopcraft, J.G.C., Fryxell, J.M., Hilborn, R., & Thirgood, S. (2007). Long-term Ecosystem Dynamics in the Serengeti: Lessons for Conservation. *Conservation Biology*, 21(3):580-590.

Sinclair, A. R. E., Mduma, S. A. R., and P. Arcese. (2002). Protected Areas as Biodiversity Benchmarks for Human Impact: Agriculture and the Serengeti Avifauna. *Proceedings of the Royal Society of the Biological Sciences*, 269(1508):2401-2405.

Sinclair, A.R.E. (1995). Serengeti Past and Present. *In* Serengeti II: Dynamics, Management, and Conservation of an Ecosystem. A. Sinclair and P. Arcese (eds). University of Chicago Press.

Sonaiya, E. B., and V. E. Olori. (1990). Village Chicken Production in Southwestern Nigeria. *In* Sonaiya E. B. (ed). Rural Poultry in Africa. Theliatbuse, Nigeria. pp. 243-247.

Sorley, C. S., and D. E. Andersen. (1994). Raptor Abundance in South-Central Kenya in Relation to Land-Use Patterns. *African Journal of Ecology*, 32:30-38.

Tanzania Ministry of Natural Resources & Tourism and Tanzania Ngorongoro Conservation Area Authority (MNRT and NCAA). (2001). Walking Safaris Management Plan for the Ngorongoro Conservation Area. Dar es Salaam: Tanzania Printers Limited.

Terborgh, J. & van Schaik, C. (2002). Why the World Needs Parks. In Making Parks Work. J. Terborgh, C. van Schaik, & M. Rao (eds). Island Press, Washington DC.

Thirgood, S., Mosser, N., Tham, S., Hopcraft, G., Mwangomo, E., Mlengeya, T., Kilewo, M., Fryxell, J., Sinclair, A.R.E., & Borner, M. (2004). Can parks protect migratory ungulates? The case of the Serengeti wildebeest. *Animal Conservation*, 7: 113-120.

Thornton, P. K., Boone, R. B., Galvin, K. A., Burnsilver, S. B., Waithaka, M. M., Kuyiah, J., Karanja, S., Gonzales-Estrada, E., and M. Herrero (2007). Coping Strategies in Livestock-Dependent Households in East and Southern Africa: A Synthesis of Four Case Studies. *Human Ecology*, 35(4):461-476.

Upton, C., Ladle, R., Hulme, D., Jiang, T., Brockington, D. & Adams, W.M. (2008). Are poverty and protected area establishment linked at a national scale? *Oryx*, 42, 19-25.

Vina, A., Bearer, S., Chen, X., He, G., Linderman, M., An, L., Zhang, H., Ouyang, Z. & Liu, J. (2007). Temporal changes in giant panda habitat connectivity across boundaries of Wolong Nature Reserve, China. *Ecological Applications*, 17(4):1019-1030.

Webber, A.D., Hill, C.M., & Reynolds, V. (2007). Assessing the failure of a community-based human-wildlife conflict project in Budongo Forest Reserve, Uganda. *Oryx*, 41:177-184.

Woodroffe, R. & Ginsberg, J.R. (1998). Edge effects and the extinction of populations inside protected areas. *Science*, 280:2126-2128.

Woodroffe, R. & Frank, L.G. (2005). Lethal control of African lions (*Panthera leo*): local and regional population impacts. *Animal Conservation*, 8:91-99.

Woodroffe, R., Thirgood, S. & Rabinowitz, A. (Eds.), (2005). People and Wildlife: Conflict or Coexistence? Cambridge University Press. Cambridge, U.K.

Chapter Three

Arcese, P., Hando, J. & Campbell, K. (1995). Historical and present-day anti-poaching in Serengeti, *In* Serengeti II, A.R.E. Sinclair and P. Arcese (eds.) University of Chicago Press, Chicago, pp. 506-533.

Barrett, C.B. & Arcese, P. (1998). Wildlife harvest in integrated conservation and development projects: linking harvest to household demand, agricultural production, and environmental shocks in the Serengeti. *Land Economics*, 74:449-465.

Bennett, E.L., Blencowe, E., Brandon, K., Browns, D., Burn, R.W., Cowlishaw, G., Davies, G., Dublin, H., Fass, J.E., Milner-Gulland, E.J., Robinson, J.G., Rowcliffe, M., Underwood, F.M. & Wilkie, D.S. (2006). Hunting for Consensus: Reconciling Bushmeat Harvest, Conservation, and Development Policy in West and Central Africa. *Conservation Biology*, 21(3):884-887.

Bernard, H.R. (2006). Research Methods in Anthropology: Qualitative and Quantitative Approaches, Fourth Edition. Rowman Altamira, Lanham: Maryland.

Bulte, E.H. & Horan, R.D. (2003). Habitat Conservation, Wildlife Extraction and Agricultural Expansion. *Journal of Environmental Economics and Management*, 45, 109-127.

Campbell, K. L. I., Nelson, V., Loibooki, M. (2001). Sustainable Use of Wildland Resources, Ecological, Economic, and Social Interactions: An Analysis of Illegal Hunting in Serengeti National Park, Tanzania. Department for International Development (DFID) Animal Health Programme, and Livestock Production Programmes. Final Technical Report. Project R7050. Natural Resources Institute, Chatham, Kent, UK.

Campbell, K.L.I. & Hofer, H. (1995). People and wildlife: spatial dynamics and zones of interaction. *In* Serengeti II. Dynamics, Management, and Conservation of an Ecosystem, University of Chicago Press, Chicago, pp. 535-574.

Cleaveland, S., Appel, M.G.J., Chalmers, W.S.K., Chillingworth, C., Kaare, M. & Dye, C. (2000). Serological and demographic evidence for domestic dogs as a source of canine distemper virus infection for Serengeti wildlife. Veterinary microbiology, 72(3):217-227.

Coppolillo, P.B. (2000). The Landscape Ecology of Pastoral Herding: Spatial Analysis of Land Use and Livestock Production in East Africa. *Human Ecology*, 28(4):527-560.

Fleisher, M.L. (2000). Kuria Cattle Raiders: Violence and Vigilantism on the Tanzania-Kenya Frontier. Michigan University Press, Ann Arbor, MI.

Galvin, K. A., Boone, R. B., BurnSilver, S. B., and P. K. Thornton. (2009). Humans and Wildlife as Ecosystem Components in Integrated Assessments. *In* Wildlife and Society: The Science of Human Dimensions, (M. J. Manfredo, J. V. Vaske, P. J. Brown, D. J. Decker, and E. A. Duke (eds). pp. 129-143.

Hilborn, R., Arcese, P., Borner, M., Hando, J., Hopcraft, G., Loibooki, M., Mduma, S. & Sinclair, A.R.E. (2006). Effective Enforcement in a Conservation Area. *Science*, 314(5803):1266.

Hofer, H., Campbell, K.L.I., East, M.L. & Huish, S.A. (1996). The impact of game meat hunting on target and non-target species in the Serengeti. *In* The exploitation of mammal populations, V.J. Taylor and N. Dunstone (eds.). Chapman and Hall, London, UK, pp.117-146.

Hofer, H., Campbell, K.L.I., East, M.L. & Huish, S.A. (2000). Modeling the spatial distribution of the economic costs and benefits of illegal game meat hunting in the Serengeti. Natural Resource Modeling, 13(1):1-2.

Holmern, T., Muya, J. & Roskaft, E. (2007). Local law enforcement and illegal bushmeat hunting outside the Serengeti National Park, Tanzania. *Environmental Conservation*, 34:55-63.

Holmern, T., Johannesen, A.B., Mbaruka, J., Mkama, S., Muya, J. & Roskaft, E. (2004). Human-Wildlife Conflicts and Hunting in the Western Serengeti, Tanzania. Norwegion Institute for Nature Research, Norway.

Holmern, T., Roskaft, E., Mbaruka, J., Mkama, S.Y. & Muya, J. (2002). Uneconomical game cropping in a community-based conservation project outside the Serengeti National Park, Tanzania. *Oryx*, 36:364-372.

Infield, M. & Namara, A. (2001). Community attitudes and behavior towards conservation: an assessment of a community conservation programme around Lake Mburo National Park, Uganda. *Oryx*, 35(1):48-60.

Jachmann, H. & Billiouw, M. (1997). Elephant poaching and law enforcement in the central Luangwa Valley, Zambia. *Journal of Applied Ecology*, 34(1):233-344.

Kaltenborn, B.P., J.W., Nyahongo, J.R. Kidegesho, and H. Haaland. (2008). Serengeti National Park and its Neighbours – Do they Interact? *Journal for Nature Conservation,* Volume 16 (2): 96-108.

Kaltenborn, B. P., Bjerke, T., Nyahongo, J. W., and D. R. Williams. (2006). Animal Preferences and Acceptability of Wildlife Management Actions around Serengeti National Park, Tanzania. *Biodiversity and Conservation*, 15(14):4633-4649.

Kaltenborn, B.P., Nyahongo, J.W. & Tingstad, K.M. (2005). The nature of hunting around the Western Corridor of Serengeti National Park, Tanzania. *European Journal of Wildlife Research*, 51:213-222.

Knapp, E.J. (2007). Who Poaches? Household Economies of Illegal Hunters in Western Serengeti, Tanzania. *Human Dimensions of Wildlife*, 12(3):195-196.

Krishna, A. (2004). Escaping Poverty and Becoming Poor: Who Gains, Who Loses, and Why? *World Development*, 32(1):121-36.

Leader-Williams, N. & Milner-Gulland, E.J. (1993). Policies for the Enforcement of Wildlife Laws: The Balance between Detection and Penalties in Luangwa Valley, Zambia. *Conservation Biology*, 7(3):611-617.

Leader-Williams, N. & Albon, S.D. (1988). Allocation of resources for conservation. *Nature*, 336:533-535.

Leader-Williams, N. (1992). The World Trade in Rhino Horn: A Review. TRAFFIC International, Cambridge, England.

Lembo, T. (2006). An investigation of disease reservoirs in complex ecosystems: rabies and canine distemper in the Serengeti, Ph.D. Dissertation, University of Edinburgh.

Lewis, C. (2007). Personal Communication. Grumeti Fund, Tanzania.

Loibooki, M., Hofer, H., Campbell, K.L.I. & East, M.L. (2002). Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. *Environmental Conservation*, 29:391-398.

Makoye, E. (2007). Personal Communication. Field Assistant, Tanzania.

Milner-Gulland, E.J. & Leader-Williams, N. (1992). A model of incentives for the illegal exploitation of black rhinos and elephants: Poaching pays in Luangwa Valley, Zambia. *Journal of Applied Ecology*, 29(2):388-401.

Ndibalema, V.G. & Songorwa, A.N. (2008). Illegal meat Hunting in Serengeti: Dynamics in Consumption and Preferences. *African Journal of Ecology*, 46(3):311-319.

Noss, A.J. (1998). Cable snares and bushmeat markets in a central African forest. *Environmental Conservation*, 25(3):228-233.

Noss, A.J. (2000). Cable snares and nets in the Central African Republic. *In* Hunting for sustainability in tropical forests, J.G. Robinson and E.L. Bennet (eds.). Columbia University Press, New York, New York, USA.

Nyahongo, J.W, Mturi, F.A., East, M.L. & Hofer, H. (2005). Patterns of illegal grazing and hunting in the Serengeti ecosystem. *Environmental Conservation*, 32:326-332.

Nyahongo, J.W., East, M.L., Mturi, F.A. & Hofer, H. (2006). Benefits and costs of illegal grazing and hunting in the Serengeti ecosystem. *Environmental Conservation*, 32:326-332.

Nyahongo, J.W. (2007). Depredation of Livestock by Wild Carnivores and Illegal Utilization of Natural Resources by Humans in the Western Serengeti, Tanzania. Doctoral Dissertation, Norwegian University of Science and Technology, Faculty of Natural Sciences and Technology.

Rist, J., Rowcliffe, M., Cowlishaw, M. & Milner-Gulland, E.J. (2008). Evaluating measures of hunting effort in a bushmeat system, Biological Conservation, 141:2086-2099.

Shetler, J.B. (2007). Imagining Serengeti: A History of Landscape Memory in Tanzania from Earliest Times to the Present. Ohio University Press, Ohio.

Sinclair, A.R.E. (1995). Serengeti Past and Present. *In* Serengeti II: Dynamics, Management, and Conservation of an Ecosystem. A. Sinclair and P. Arcese (eds). University of Chicago Press.

Sinclair, A.R.E., Mduma, S.A.R., Hopcraft, J.G.C., Fryxell, J.M., Hilborn, R., & Thirgood, S. (2007). Long-term Ecosystem Dynamics in the Serengeti: Lessons for Conservation. *Conservation Biology*, 21(3):580-590.

Thirgood, S., Woodroffe, R. & Rabinowitz, A. (2005). The impact of human-wildlife conflict on human lives and livelihoods. *In* People and Wildlife: Conflict or Coexistence, S. Thirgood, R. Woodroffe, and A. Rabinowitz (eds). Cambridge University Press.

Thirgood, S., Mosser, N., Tham, S., Hopcraft, G., Mwangomo, E., Mlengeya, T., Kilewo, M., Fryxell, J., Sinclair, A.R.E., & Borner, M. (2004). Can parks protect migratory ungulates? The case of the Serengeti wildebeest. *Animal Conservation*, 7: 113-120.

United Republic of Tanzania, (1974), *The Wildlife Conservation Act, 1974*. The Gazette of the United Republic of Tanzania, Vol. LV.

Willcox, A.S. & Nambu, D.M. (2007). Wildlife hunting practices and bushmeat dynamics of the Banyangi and Mbo people of southwestern Cameroon. *Biological Conservation*, 134(2):251-261.

Chapter Four

Balmford, A., Moore, J. L., Brooks, T., Burgess, N., Hansen, L. A., Williams, P., and C. Rahbek. (2001). Conservation Conflicts Across Africa. *Science*, 291(5513):2616-2619.

Banana, A. Y., and W. Gombya-Ssembajjwe. (1996). Institutional Arrangements and Incentives for Sustainable Forest Use in Uganda: An IFRI Study. *In*: Mengech et al. (eds.). Supporting Capacity Building in Forestry Research. IFS.

Barrett, C. B., Bezuneh, M., Clay, C., and T. Reardon. (2000). Heterogeneous Constraints, Incentives and Income Diversification Strategies in Rural Africa. Mimeo.

Bennett, E. L. (2009). Social Dimensions of Managing Hunting in Tropical Forests. *In*: Wildlife and Society: The Science of Human Dimensions, Manfredo, M. J., Vaske, J. J., Brown, P. J., Decker, D. J., and E. A. Duke (eds). Island Press, Washington, D.C.

Bennett, A. F., Radford, J. Q., and A. Haslem. (2006). Properties of Land Mosaics: Implications for Nature Conservation in Agricultural Environments, *Biological Conservation*, 133(2):250-264.

Bennett, E.L., Blencowe, E., Brandon, K., Browns, D., Burn, R.W., Cowlishaw, G., Davies, G., Dublin, H., Fass, J.E., Milner-Gulland, E.J., Robinson, J.G., Rowcliffe, M., Underwood, F.M. & Wilkie, D.S. (2006). Hunting for Consensus: Reconciling Bushmeat Harvest, Conservation, and Development Policy in West and Central Africa. *Conservation Biology*, 21(3):884-887.

Berkes, F., Colding, J. & Folke, C. (2003). Navigating social-ecological systems: building resilience for complexity and change. Cambridge University Press, Cambridge.

Bernard, H.R. (2006). Research Methods in Anthropology: Qualitative and Quantitative Approaches, Fourth Edition. Rowman Altamira, Lanham: Maryland.

Bhima, R. (1998). Elephant Status and Conflict with Humans on the Western Bank of Liwonde National Park, Malawi. *Pachyderm*, 25:74-80.

Brashares, J. S., Arcese, P., and M. K. Sam. (2001). Human Demography and Reserve Size Predict Wildlife Extinction in West Africa. *Proceedings from the Royal Society of London*, 268:2473-2478.

Bulte, E. H., and R. D. Horan. (2003). Habitat Conservation, Wildlife Extraction, and Agricultural Expansion. Journal *of Environmental Economics and Management*, 45(1):109-127.

Burgess, N. D., Butynski, T. M., Cordeiro, N. J., Doggart, N. H., Fjeldsa, J., Howell, K. M., Kilahama, F. B., Loader, S. P., Lovett, J. C., Mbilinyi, B., Menegon, M., Moyer,

D. C., Nashanda, E., Perkin, A., Rovero, F., Stanley, W. T., and S. N. Stuart. (2007). The Biological Importance of the Eastern Arc Mountains of Tanzania and Kenya. *Biological Conservation*, 134(2):209-231.

BurnSilver, S. (2007). Pathways of Continuity and Change: Diversification, Intensification and Mobility in Southern Kajiado District, Kenya. Ph.D. Dissertation, Colorado State University.

Campbell, K.L.I. & Hofer, H. (1995). People and wildlife: spatial dynamics and zones of interaction. *In* Serengeti II. Dynamics, Management, and Conservation of an Ecosystem, University of Chicago Press, Chicago, pp. 535-574.

Carpenter, S.R., Westley, F. & Turner, M.G. (2005). Surrogates for Resilience of Social-Ecological Systems. *Ecosystems*, 8(8):941-944.

Carpenter, S.R., Walker, B.H., Anderies, J.M. & Abel, N. (2001). From metaphor to measurement: resilience of what to what? *Ecosystems*, 4:765-781.

Charnley, S. (2005). From Nature Tourism to Ecotourism? The Case of the Ngorongoro Conservation Area, Tanzania. *Human Organization*, 64(1):75-88.

Clay, D. C., Guizlo, M., and S. Wallace. (1994). Population and Land Degradation. Working Paper No. 14, pp. 1-24.

Coast, E. (2002). Maasai Socioeconomic Conditions: A Cross-Border Comparison. *Human Ecology*, 30(1):79-105.

Colchester, M. (2004). Conservation Policy and Indigenous Peoples. *Environmental Science & Policy*, 7(3):145-153.

Decker, D. J., Siemer, W. F., Leong, K. M., Riley, S. J., Rudolph, B. A., and L. H. Carpenter. (2009). Conclusion: What is Wildlife Management? *In*: Wildlife and Society: The Science of Human Dimensions, Manfredo, M. J., Vaske, J. J., Brown, P. J., Decker, D. J., and E. A. Duke (eds). Island Press, Washington, D.C.

DeFries, R., Hansen, A., Reid, R., and J. Liu. (2007). Land Use Change around Protected Areas: Management to Balance Human Needs and Ecological Function. *Ecological Applications*, 17(4):1031-1038.

De Sherbinin, A., and M. Freudenberger. (1998). Migration to Protected Areas and Buffer Zones: Can We Stem the Tide? *Parks*, 8(1):38-53.

Du Toit, J. T., Walker, B. H., and B. M. Campbell. (2004). Conserving Tropical Nature: Current Challenges for Ecologists. *Trends in Ecology and Evolution*, 19(1):12-17.

Emerton, L. & Mfunda, I. (1999). Making wildlife economically viable for communities living around the western Serengeti, Tanzania. Evaluating Eden Series Discussion Paper, No. 1, International Institute for Environment and Development, London.

Enck, J. W., Decker, D. J., Riley, S. J., Organ, J. F., Carpenter, L. H., and W. F. Siemer. (2006). Integrating Ecological and Human Dimensions in Adaptive Management of Wildlife-Related Impacts. *Wildlife Society Bulletin*, 34(3):698-705.

Fleisher, M.L. (2000). Kuria Cattle Raiders: Violence and Vigilantism on the Tanzania-Kenya Frontier. Michigan University Press, Ann Arbor, MI.

Folke, C., Carpenter, S.R., Elmqvist, T., Gunderson, L., Holling, C.S. & Walker, B. (2002). Resilience and sustainable development: building adaptive capacity in a world of transformations. *Ambio*, 31:437-440.

FAO/UNESCO (1984). The Food and Agriculture Organization of the United Nations (FAO) in Africa.

Galvin, K. A., Boone, R. B., BurnSilver, S. B., and P. K. Thornton. (2009). Humans and Wildlife as Ecosystem Components in Integrated Assessments. *In* Wildlife and Society: The Science of Human Dimensions, (M. J. Manfredo, J. V. Vaske, P. J. Brown, D. J. Decker, and E. A. Duke (eds). pp. 129-143.

Ghimire, K. B., and M. P. Pimbert. (1997). Social Change and Conservation: An Overview of Issues and Concepts. United Nations Research Institute for Social Development (UNRISD), Earthscan.

Gunderson, L.H. & Holling, C.S. (2002). Panarchy: understanding transformations in human and natural systems. Island Press, Washington, DC.

Hames, R. (1987). Game Conservation or Efficient Hunting. *In* The Question of the Commons. The Culture and Ecology of Communal Resources. McCay, B. J., and Acheson, J. M. (eds). University of Arizona Press, Tuscon. pp. 92-107.

Harcourt, A. H., Parks, S. A., and R. Woodroffe. (2001). Human Density as an Influence on Species/Area Relationships: Double Jeopardy for Small African Reserves? *Biodiversity Conservation*, 10:1011-1026.

Hardin, G. (1968). The Tragedy of the Commons. *Science,* 162 (3859): 1243-1248.

Hart, T., and J. Hart. (1997). Zaire: New Models for an Emerging State. *Conservation Biology*, 11:308-314.

Hilborn, R., Arcese, P., Borner, M., Hando, J., Hopcraft, G., Loibooki, M., Mduma, S. & Sinclair, A.R.E. (2006). Effective Enforcement in a Conservation Area. *Science*, 314(5803):1266.

Holling, C.S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecological Systems*, 4:1-23.

Holmern, T., Muya, J. & Roskaft, E. (2007). Local law enforcement and illegal bushmeat hunting outside the Serengeti National Park, Tanzania. *Environmental Conservation*, 34:55-63.

Hoskins, M. (1990). The Contribution of Forestry to Food Security. Food and Agriculture Organization (FAO).

IUCN (2004). Report of the Sixth World Congress on National Parks and Protected Areas. Gland, Switzerland.

Kaltenborn, B.P., J.W., Nyahongo, J.R. Kidegesho, and H. Haaland. (2008). Serengeti National Park and its Neighbours – Do they Interact? *Journal for Nature Conservation,* Volume 16 (2): 96-108.

Kaltenborn, B.P., Nyahongo, J.W. & Tingstad, K.M. (2005). The nature of hunting around the Western Corridor of Serengeti National Park, Tanzania. *European Journal of Wildlife Research*, 51:213-222.

Karanth, K. K., L. M. Curran., and J. D. Reuning-Scherer. (2006). Village Size and Forest Disturbance in Bhadra Wildlife Sanctuary, Western Ghats, India. *Biological Conservation*, 128:147-157.

Kaswamila, A., Russell, S. & McGibbon, M. (2007). Impacts of Wildlife on Household Food Security and Income in Northeastern Tanzania. *Human Dimensions of Wildlife*, 12(6):391-404.

Knapp, E.J. (2007). Who Poaches? Household Economies of Illegal Hunters in Western Serengeti, Tanzania. *Human Dimensions of Wildlife*, 12(3):195-196.

Knickerbocker, T. I., and I. Waithaka. (2005). People and Elephants in the Shimba Hills, Kenya. *In* People and Wildlife: Conflict or Co-existence? Woodroffe, R., Thirgood, S., and Rabinowitz, A. (eds.). Cambridge University Press, England.

Leader-Williams, N., and J. M. Hutton. (2005). Does Extractive Use Provide Opportunities to Offset Conflicts between People and Wildlife? *In* People and Wildlife: Conflict or Co-existence? Woodroffe, R., Thirgood, S., and Rabinowitz, A. (eds.). Cambridge University Press, England.

Leader-Williams, N. & Milner-Gulland, E.J. (1993). Policies for the Enforcement of Wildlife Laws: The Balance between Detection and Penalties in Luangwa Valley, Zambia. *Conservation Biology*, 7(3):611-617.

Loibooki, M., Hofer, H., Campbell, K.L.I. & East, M.L. (2002). Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. *Environmental Conservation*, 29:391-398.

Lu Holt, F. (2005). The Catch-22 of Conservation: Indigenous Peoples, Biologists, and Culture Change. *Human Ecology*, 33(2):199-215.

Madulu, N. F. (2003). Linking Poverty Levels to Water Resource Use and Conflicts in Rural Tanzania. *Physics and Chemistry of the Earth*, 28(20-27):911-917.

Madulu, N. F. (1996). Population Dynamics and Sustainable Conservation of Protected Areas in Tanzania: The Case of Swagaswaga Game Reserve in Kondoa District. Unpublished PhD Thesis, University of Dar es Salaam.

Martin, M. (1985). Design of a Food Intake Study in Two Bambara Villages in the Segou Region of Mali with Preliminary Findings. *In* Population, Health and Nutrition in the Sahel. A. Hill (ed.), Routledge & Kegan Paul, London. pp. 289-317.

Milner-Gulland, E.J. & Leader-Williams, N. (1992). A model of incentives for the illegal exploitation of black rhinos and elephants: Poaching pays in Luangwa Valley, Zambia. *Journal of Applied Ecology*, 29(2):388-401.

Msoffe, P. L. M., Mtambo, M. M. A., Minga, U. M., Gwakisa, P. S., Mdegela, R. H., and J. E. Olsen. (2002). Productivity and Natural Disease Resistance Potential of Free-ranging Local Chicken Ecotypes in Tanzania. *Livestock Research for Rural Development,* 14(3).

Mwamfupe, D. (1998). Demographic Impacts on Protected Areas in Tanzania and Options for Action. *Parks*, 8(1):3-14.

Naughton-Treves, L., and A. Treves. (2005). Socio-ecological Factors Shaping Local Support for Wildlife: Crop-raiding by Elephants and other Wildlife in Africa. *In* People and Wildlife: Conflict or Co-existence? Woodroffe, R., Thirgood, S., and Rabinowitz, A. (eds.). Cambridge University Press, England.

Naughton-Treves, L. (1997). Farming the forest edge: vulnerable places and people around Kibale National Park, Uganda. *The Geographical Review*, 87:27-47.

Nelson, F., Nshala, R., and W. A. Rodgers. (2007). The Evolution and Reform of Tanzanian Wildlife Management. *Conservation and Society*, 5(2):232-261.

Ngailo, J. A., Kaswamila, A. L., and C. J. Senkoro. (2002). Rice Farming System of the Wasukuma and its Contribution to Poverty Alleviation. Paper presented at the Fifth REPOA Workshops. Dar es Salaam.

Ntiamoa-Baidu, Y. (1997). Wildlife and Food Security in Africa. FAO Conservation Guide 33, United Nations Food and Agricultural Organization, Rome.

Nyhus, P. J., Osofsky, S. A., Ferraro, P., and F. Madden. (2005). Bearing the Costs of Human-Wildlife Conflict: The Challenges of Compensation Schemes. Conservation Biology Series, Cambridge, England. pp. 1-19.

Parker, G. E., and F. V. Osborn. (2001). Dual-Season Crop Damage by Elephants in Eastern Zambezi Valley, Zimbabwe. *Pachyderm*, 30:49-56.

Population & Housing Census, Tanzania. (2002). Dar es Salaam.

Reardon, T. (1997). Using Evidence of Household Income Diversification to Inform Study of the Rural Nonfarm Labor Market in Africa. *World Development*, 25(5):735-747.

Riley, S. J., Decker, D. J., Carpenter, L. H., Organ, J. F., Siemer, W. F., Mattfield, G. F., and G. Parsons. (2002). The Essence of Wildlife Management. *Wildlife Society Bulletin*, 30(2):585-593.

Robinson, J. G. (2005). Biting the Hand that Feeds You: The Consumption of Nature and Natural Resources in the Tropics. *In*: State of the Wild, Island Press, Washington, D.C.

Schmidt-Soltau, K. and D. Brockington. (2004). The Social and Environmental Impacts of Wilderness and Development. *Oryx*, 38(2):140-142.

Scholte, P. (2003). Immigration: A Potential Time Bomb Under the Integration of Conservation and Development. *Ambio*, 32(1):58-64.

Schneider, F. G. (2002). The Size and Development of the Shadow Economies of 22 Transition and 21 OECD Countries. IZA Discussion Paper No. 514. Institute for the Study of Labor, Germany.

Sinclair, A. R. E., and P. Arcese. (1995). Population Consequences of Predation-Sensitive Foraging: The Serengeti Wildebeest. *Ecological Society of America*, 76(3):882-891.

Sinclair, A. R. E., Hik, D. S., Schmitz, O. J., Scudder, G. G. E., Turpin, D. H., and N. C. Larter. (1995). Biodiversity and the Need for Habitat Renewal. *Ecological Applications*, 5(3):579-587.

Sitati, N. W., Walpole, M. J., Smith, R. J., and N. Leader-Williams. (2003). Predicting Spatial Aspects of Human-Elephant Conflict. *Journal of Applied Ecology*, 40:667-677.

Shetler, J.B. (2007). Imagining Serengeti: A History of Landscape Memory in Tanzania from Earliest Times to the Present. Ohio University Press, Ohio.

Thirgood, S., Woodroffe, R. & Rabinowitz, A. (2005). The impact of human-wildlife conflict on human lives and livelihoods. *In People and Wildlife: Conflict or Coexistence*, S. Thirgood, R. Woodroffe, and A. Rabinowitz (eds). Cambridge University Press.

Treves, A., Naughton-Treves, L., Harper, E. K., Mladenoff, D. J., Rose, R. A., Sickley, T. A., and A. P. Wydeven. (2004). Predicting Human-Carnivore Conflict: A Spatial Model Derived from 25 Years of Data on Wolf Predation on Livestock. *Conservation Biology*, 18(1):114-125.

United Republic of Tanzania (URT). 2001). Poverty and Human Development Report 2001. Dar es Salaam.

United Republic of Tanzania (URT). (1999). Public Expenditure Review (financial year 1999/2000) for the Agricultural Sector. Dar es Salaam.

Walpole, M. J., and C. R. Thouless. (2005). Increasing the Value of Wildlife through Non-consumptive Use? Deconstructing the Myths of Ecotourism and Community-based Tourism in the Tropics. *In*: People and Wildlife: Conflict or Co-existence. R.

Woodroffe, S. Thirgood, and Rabinowitz, A. (eds.). Cambridge University Press, England.

Western, D., and J. Waithaka. (2005). Policies for Reducing Human-Wildlife Conflict: A Kenya Case Study. *In*: People and Wildlife: Conflict or Co-existence. R. Woodroffe, S. Thirgood, and Rabinowitz, A. (eds.). Cambridge University Press, England.

Wilkie, D. S., Morelli, G. A., Demmer, J., Starkey, M., Paul, T., and M. Steil. (2006). Parks and People: Assessing the Human Welfare Effects of Establishing Protected Areas for Biodiversity Conservation. *Conservation Biology*, 20(1):247-249.

Wittemyer, G., Elsen, P., Bean, W. T., Burton, C. O., and J. S. Brashares. (2008). Accelerated Human Population Growth at Protected Area Edges. *Science*, 321(5885):123-126.

Woodroffe, R., Thirgood, S. & Rabinowitz, A. (Eds.), (2005). People and Wildlife: Conflict or Coexistence? Cambridge University Press. Cambridge, U.K.