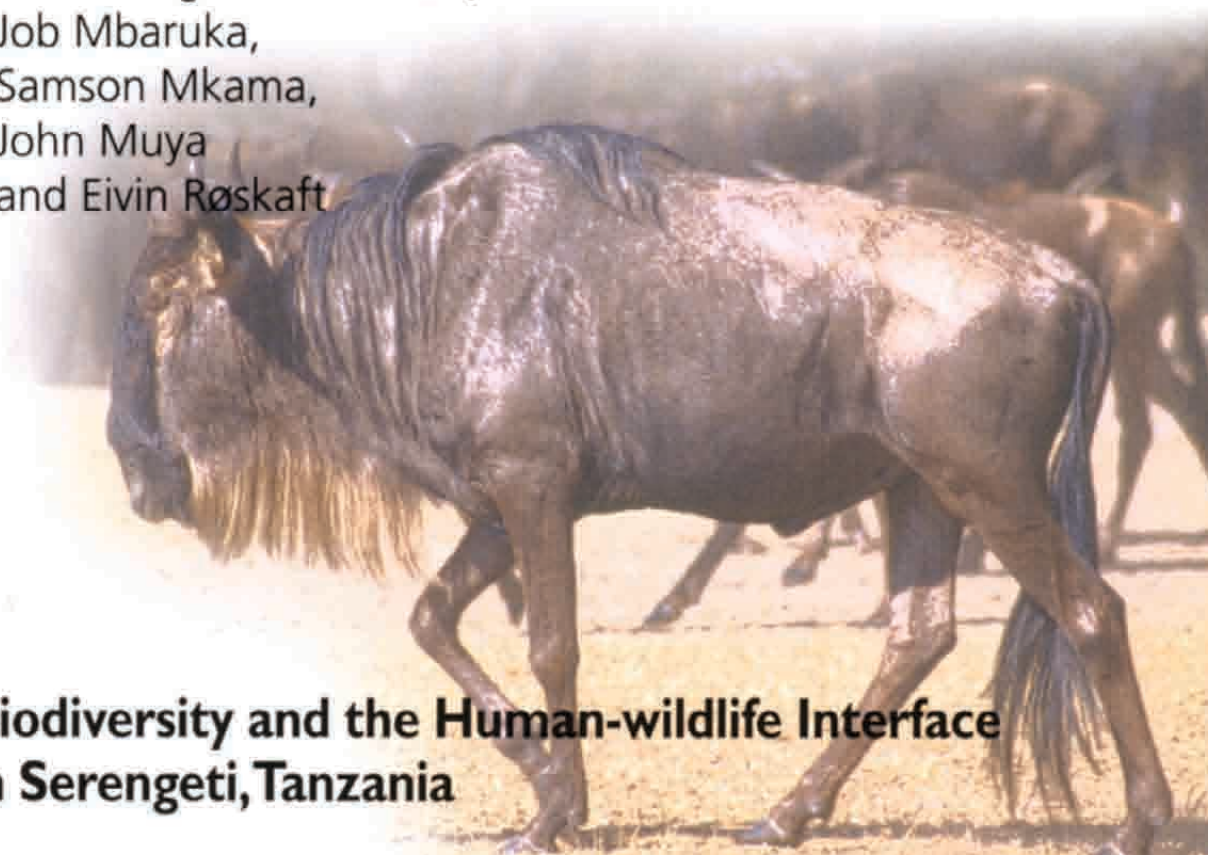


Human-Wildlife Conflicts and Hunting in the Western Serengeti, Tanzania

Tomas Holmern,
Anne Borge Johannesen,
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Samson Mkama,
John Muya
and Eivin Røskft

Biodiversity and the Human-wildlife Interface in Serengeti, Tanzania



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Tomas Holmern, Anne Borge Johannesen, Job Mbaruka, Samson Mkama, John Muya and Eivin Røskaft.
Human-Wildlife Conflicts and Hunting in the Western Serengeti, Tanzania. 1-26pp
Trondheim, May 2004

ISSN 1502-6779
ISBN 82-426-1468-7

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The report can be quoted with references to the source.

Editors:
Tomas Holmern, Anne Borge Johannesen, Job Mbaruka, Samson Mkama, John Muya and Eivin Røskaft.

Quality assurance

Print:
Norservice AS

Opplag: 200

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Accessibility: Open

Project no.:

Signature of responsible person:



Assignment for:
Norwegian Research Council
NORAD

Referat

Denne rapporten presenterer resultater fra to survey undersøkelser i landsbyer i randsonen til Serengeti nasjonalpark i Tanzania. Studien er en del av prosjektet: Biodiversity and the Human-Wildlife Interface in the Western Serengeti. Disse undersøkelsene fokuserer på interaksjonen mellom mennesker og dyr ved å se på forhold som jordbruk og husdyrhold, jordbruksskader forårsaket av ville dyr og jakt. Rapporten beskriver både lovlig jakt organisert via et lokalt ressursforvaltningsprosjekt og ulovlig jakt blant lokalbefolkningen fra landsbyer langs den vestlige korridoren i Serengeti nasjonalpark.

Nøkkelord: Afrika, Serengeti nasjonalpark, jakt, jordbruk, lokal naturressursforvaltning

Abstract

This report presents results from two surveys conducted in communities adjacent to Serengeti National Park in Tanzania. The study is part of the project: Biodiversity and the Human-Wildlife Interface in the Serengeti. The surveys focus on human-wildlife interactions such as agriculture and pastoral activities, wildlife-induced damage and hunting. The report describes both legal hunting organised by the community-based natural resource management project in the area and illegal hunting among local communities along the Western Corridor of Serengeti National Park.

Keywords: Africa, Serengeti National Park, hunting, agriculture, community-based natural resource management

Foreword

This report is part of the the project: Biodiversity and the Human-Wildlife Interface in the Western Serengeti, Tanzania, co-ordinated by G. M. Rusch at NINA. The aim of this report is to present a description of some of the human-wildlife interactions such as agriculture and pastoral activities, wildlife-induced damage and hunting. The report is based on two surveys conducted in several villages along the Western Corridor of Serengeti National Park. The first survey was conducted over a period of 9 months from December 1998 to August 1999, while the second survey was conducted from June – August 2001. While this is a descriptive report, most of the data has been analysed in more complex analyses some of which are already reported in scientific journals.

Biodiversity and the Human-Wildlife Interface in the Serengeti is a joint project between NINA, Tanzanian Wildlife Research Institute (TAWIRI), the University of Dar es Salaam (UDSM) and NTNU. For the work presented in this report TAWIRI has assisted in data collection, provided logistics support during the fieldwork and taken care of necessary communication with Tanzanian National Parks (TANAPA).

Funding for this work has been provided by the Research Council of Norway (NFR), TAN-94, a NORAD- funded programme at the Ministry of Natural Resources and Tourism (MNRT), and partly by NTNU and the European Commission's BIOECON programme. We are indebted to the people and Village Game Scouts (VGS) of Bunda and Serengeti Districts, which generously were able to spare their time to participate in the survey. We are also grateful to the district and village authorities and our field assistants. Serengeti Regional Conservation Project (SRCP) deserves special thanks for organising the necessary logistics, providing accommodation and assisting in the communication with the district authorities and village chairmen.

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Executive summary

The study

Wildlife conservation has emerged as a priority shared by conservation and development organisations. While national parks and protected areas with restricted human access have been the traditional approach to conservation, new approaches that integrate the needs of local people while conserving wildlife have increasingly been initiated over the past decades. Such projects face difficult challenges related to rural development and conservation, and therefore require comprehensive knowledge about economic as well as ecological aspects. This report presents human-wildlife interactions along the Western Corridor of Serengeti National Park, Tanzania with focus on the economic dimension.

Agriculture

People living in this area are mainly small-scale farmers who, to a varying degree complement with livestock keeping. Agricultural production consists mostly of subsistence crops such as maize, millet and cassava, and the cash crop cotton. Maize is produced both as a source of income and food for the household, while cassava and millet are produced mainly for domestic consumption. People cultivate small areas, on average 7.4 acres, using family labour and poor technology. The major inputs are labour and land and, consequently, output is sensitive to varying environmental conditions.

Cotton producers face an economic advantage over non-cotton producers. However, cotton cultivation is geographical limited to villages in Bunda District. Here, foreign agents enter the villages to buy cotton during the harvest period, which reflects that access to markets is relatively easy in Bunda. The situation is, however, somehow different in Serengeti District, where people complain about poor access to markets. This may be due to poor infrastructure in the area.

More than half of the households practice multi-commodity farming systems based on crop production and livestock keeping. Relying on two sources of income reduces the risk against crop failure. Livestock is seen both as a source of income and as a source of meat for consumption and some 73% earn income from the sale of animals or meat. In order to compensate for relatively low crop income, Serengeti households keep on average more cows and goats compared to households in Bunda.

Wildlife-induced damage

Community based natural resource management (CBNRM) projects tend to see wildlife as a positive economic asset to local communities and a promising incentive for wildlife conservation. However, it is important to consider the potential benefits in relation to the costs that wildlife imposes on the local people. These costs are related to damage such as crop destruction, livestock injuries and losses, human injury, property damage etc. While the transfers of wildlife benefits to the villages in Serengeti and Bunda Districts are small, the villages bear substantial costs related to agricultural damage. In order to stimulate the local people to change to wildlife-friendly activities it is therefore important to assess the extent of losses imposed by wildlife. For local communities to be willing to conserve wildlife, the advantages of participating in community-based projects must at least offset the wildlife costs.

Wildlife-induced damage to crops and domestic animals is a major problem in the area. Some 85% complain that wildlife cause much damage to crops, while the same number for domestic animals is some 60%. There seems to be no difference in damage between the districts. The monetary value of the losses is significant and considerably higher than the average transfers of wildlife benefits per household in villages participating in CBNRM projects.

Illegal hunting

Illegal hunting is widespread in the communities. Almost 30% voluntarily admitted that they hunt illegally and 87% state that they know poachers in their own village. Hunting is motivated mainly by economic and subsistence needs. The supply of legal meat is far from sufficient to meet the demand as illustrated by the finding that 83% of the households buy illegal meat.

One distinct feature appearing from the households voluntarily admitting to be involved in illegal hunting was the existence of two separate groups of hunters. First, we have hunters who usually go into the protected area to hunt and second, we have those who hunt within, or close to, the village area only. Both groups consist, however, of subsistence hunters targeting herbivores such as wildebeest (*Connochaetes taurinus*), gazelles (*Gazella* sp.) and impala (*Aepyceros melampus*) with the use of primitive hunting methods. On the other hand, the average annual offtake from hunting in the protected area is significantly higher than from hunting in the village area, which suggests that hunting in the protected area may danger wildlife populations more.

Whether people hunt in the protected area or not is closely related to geographical location in terms of district. A substantially higher share of the hunters from Bunda use to go into the protected area compared to hunters from Serengeti. The Bunda hunters also have a higher average annual offtake which, in turn, explains why the average annual income from hunting is higher in Bunda.

When separating between villages that participate in a CBNRM project and those who don't, we find that a lower share of households from villages without such projects participate in illegal hunting. However, the average annual offtake is lower in project villages, which implies that these villages insert a less intensive pressure on wildlife compared to non-project villages.

In addition to households voluntarily admitting to be involved in illegal hunting, this report presents data on arrested hunters. The results demonstrate many similarities between the two groups when it comes to age and tribe composition, hunting trips and annual offtake. The data on arrested hunters provides, however, additional information on the duration of hunting trips and hunting techniques. Hunters spend a maximum of two weeks out on hunting trips. A third of the hunters spent less than 4 days hunting and many spent only one day. These hunting excursions are often just night hunting trips with flashlights and hunting dogs, which most often take place in the areas close to the village. The actual number of days is, however, higher among hunters from Serengeti compared to those from Bunda District. Subsistence hunters concentrate their hunting effort in the dry season when the migration travels through the areas outside the Serengeti National Park. The migratory species represented the bulk of both the total carcasses recorded (75.3 %) and the total biomass (80.4 %). The hunting techniques are primitive, such as snares, pitfalls, and dogs and flashlights. The hunting methods

may be classified into two groups. First, we have active hunting where the hunters actively stalk and kill the animal, a method which represents 64.8% of the hunting mortality. Night hunting with flashlights was the overall most common method of active hunting. Second, we had passive hunting which refers to the use of snares, spring traps and pitfalls stands. The passive method represents 33% of the hunting mortality, and mainly catches the larger herbivores.

Legal hunting

A number of actors utilise the partially and non-protected areas along the Western Corridor. Trophy hunting is conducted in the Game Reserves, an activity which generates considerable revenues. Trophy hunting may therefore contribute significantly to economic development of some adjacent communities. The utilisation of resident hunting quotas was found to be highest in Serengeti District (92%). Bunda District had a low utilisation (39%), but human settlements inside some of the hunting areas may preclude effective utilisation. Moreover access to legal resident hunting was found to be very restricted in the study area. As a result, very few local people have bought a hunting license. In our sample none of the interviewed people had access to a vehicle, only two people had access to a firearm and no one had ever bought a hunting licence.

Community-based natural resource management

There are two community-based conservation projects in western Serengeti: the community conservation services organised by Tanzanian National Parks (TANAPA) and the Serengeti Regional Conservation Project (SRCP). This report focuses on the role of SRCP and presents data on the wildlife cropping program where SRCP distribute game meat to the project villages. Meat distributed from this programme generates income to the project villages in that people pay for received meat. SRCP has also assisted the establishment of village-level institutions responsible for managing the fund from the cropping revenues. These funds finance village projects such as schools and dispensaries.

SRCP is also responsible for the set-up and training of VGS in the project villages. In addition, SRCP works with awareness building in order to improve the relationship between the local people and the park. This includes public meetings at village level, seminars and training courses on wildlife utilization and management etc.

The cropping quota of SRCP, which is determined by the Wildlife Division, is set equal for each project village. The quota is small and utilisation has generally been low, which has been mainly due to long distances between villages, poor equipment and difficult cropping conditions. Despite the establishment of SRCP, people hunt illegally, but villages outside the project seem to insert a more intensive pressure on wildlife compared to the SRCP villages.

However, the expected revenue per villager from the cropping programme is low compared to the value of wildlife damage and income generated by illegal hunting. The individual income-advantage of participating in SRCP is therefore highly limited. Benefits and support to the local people can clearly be increased and more effort could be made in encouraging improvements and market access in the agricultural sector.

1. Background

In several parts of East Africa local communities rely heavily on the natural resources that nature provides: water, rangeland, firewood and bushmeat. The establishment of protected areas during and after the colonial period has, however, deprived local people from legal access to many traditional resources, which have led to antagonism among local communities towards wild-life and conservation authorities (Kiss 1990). Today, protected area managers are increasingly aware that law enforcement alone cannot conserve wildlife. Conservation requires a perspective that stretches well beyond park boundaries and needs to involve programs affecting the livelihood of local communities. This recognition has resulted in Community-based natural resource management (CBNRM), where the aim is to encourage conservation by reconciling the management of protected areas with the social and economic needs of the local people (Swanson and Barbier 1992, Hackel 1999). CBNRMs have, however, been under severe debate on their ability to fulfil the two-fold goal of wildlife conservation and improved local welfare. First, several projects have failed in addressing internal constraints (i.e. corruption and other institutional problems). Second, revenues are often transferred to local communities without being adequately linked to the conservation objective (Wells and Brandon 1992). Third, benefits of CBNRM may stimulate human migration to communities that receive conservation benefits, which may result in additional management problems.

Human-wildlife conflicts are one of the major threats to conservation in Africa (Dublin 1995, Tchamba 1996, Naughton-Treves 1997). While such conflicts have existed for decades – if not for centuries – they occur in a different setting today. Increasing land scarcity, hunting prohibitions and wildlife-induced damage to property are factors that may create local hostility towards wild-life and protected areas. Such aspects are therefore likely to be detrimental for local people's incentives to exploit wildlife and, hence, knowledge about human-wildlife conflicts in and around protected areas is crucial in wildlife management.

Wildlife hunting represents one of the major threats to biodiversity and the long-term survival of many ecosystems (Sinclair 1995). An appropriate knowledge of how economic and biological factors shape the patterns of wildlife hunting is therefore essential in order for economic development to encourage the local people to change to more park-friendly activities. While considerable knowledge exists about wildlife and ecological dynamics, we often lack information on the economy of human-wildlife interactions. Research on utilisation patterns and how people respond to different policies such as CBNRM will provide valuable information on how to regulate exploitation activities and reach development goals.

2. Objectives



Figure 1: Subsistence hunting is widespread in the study area. Feathers of a female ostrich and wire snares confiscated from arrested hunters are displayed by VGS in Kihumbu village.

This report is part of a larger interdisciplinary project which examines subjects on biodiversity and human-wildlife interactions in the Serengeti. The report presents some descriptive results of a particular part of the project which deals with the economics of human-wildlife interactions and hunting in the western Serengeti. The report is based on surveys carried out in villages along the western border of Serengeti National Park and among people arrested for illegal hunting (Figure 1). The descriptive results presented here deals with several of the topics covered in the surveys. The topics are covered in more detail both theoretically and empirically in a series of articles already published or under work. The objectives are:

- Identify characteristics and extent of land use and livestock keeping of households in western Serengeti
- Investigate wildlife-induced damage to crops and livestock
- Identify patterns and extent of legal and illegal hunting in the study area

3. Research design and methodology

3.1 Study area

The project is located along the western border, northeast of the western corridor, of the Serengeti National Park (Figure 2). The Serengeti National Park is on the border of Tanzania and Kenya and covers 14 763 km². The park is part of the Serengeti ecosystem which cover some 27 000 km². The Serengeti ecosystem is characterized by the yearly migration of large herbivore populations such as wildebeest (*Connochaetes taurinus*), Thomson's gazelle (*Gazella thomsoni*), zebra (*Equus burchelli*) and eland (*Tragelaphus oryx*). The overall migratory pattern is related to food supply, which in turn is connected to rainfall (Wolanski et al. 1999, Wolanski and Gereta 2001). The ecosystem can be divided into two main regions; the southern short grasslands with low annual rainfall and the wooded northern grassland with higher rainfall (Fryxell 1995). The migratory herds use the short grasslands in the south during the wet season and the tall grassland in the north during the dry season (Sinclair 1995, Fryxell 1995). The migratory herds know no boundaries, and make extensive use not only of the gazetted land, but also the open areas in the districts outside the borders of Serengeti National Park. The migration passes through the protected and partially protected areas in the western Serengeti during the early dry season (usually May-July). This is the time when they enter unprotected areas that are heavily populated by humans.

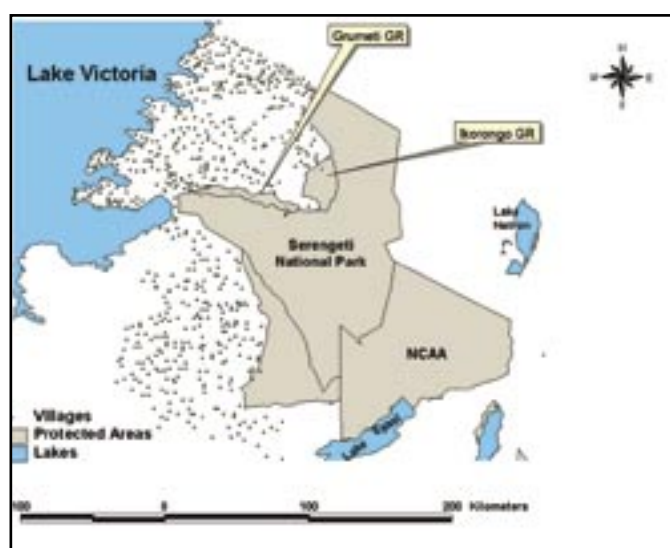


Figure 2: On the western side of the Serengeti ecosystem lives over 2 million people, which mostly rely on subsistence farming. As the human population increases wildlife interactions can be expected to become more severe (NCAA = Ngorongoro Conservation Area).

The wildlife conservation policies in Serengeti were traditionally based on strict protection through the establishment of protected areas and the use of anti-poaching law enforcement. This management system left the local people without any legal rights to exploit wildlife. However, during the 1980s the management authorities realized that long-term sustainability requires the support and co-operation of the local communities. A workshop organized by the Ministry of Natural Resources and Tourism in 1985 resulted in the Serengeti Regional Conservation

Strategy, which aimed at improving the park-people relationships and provide the local people with benefits from wildlife (Rugumayo 1999). Since the early 1990s, game cropping has been implemented in the project – a strategy which provides the project villages with game meat (see also section 4.6). Today this project is known as the Serengeti Regional Conservation Project (SRCP).

Except for the hunting organised by SRCP, it is basically illegal for the local people to hunt. The local people can buy hunting licences at the district authority office, but an allowance requires possession of firearm and access to a vehicle. Very few local inhabitants fulfil these requirements and most of the local people hunt illegally instead.

The rapid growth in human settlement in western Serengeti (annual population growth of 2.9%, Kilahama 2003) coincides with a marked increase in the number of illegal hunters arrested in the protected area (Arcese et al. 1995). The total annual offtake of harvested ungulates is estimated to 160,000 animals and supposed to benefit 1 million people (Hofer et al. 1996). Hunting on resident wildlife populations is considered unsustainable, while the effect of hunting on the migratory wildebeest does not currently threaten the population (Campbell and Hofer 1995, Mduma 1999). Still, Sinclair (1995) states “the illegal killing of the migrant ungulates by poachers is potentially the most serious threat to the Serengeti system”.

Illegal hunting is widespread among the communities located along the western border of Serengeti National Park, Grumeti Game Reserve and Ikorongo Game Reserve, but a seldom activity among communities on the eastern border. The geographical bias of hunting stems from cultural differences in the sense that the Maasai tribe occupying the eastern border consists of pastoralists with few traditions for hunting, while several tribes occupying the western border have long traditions for hunting. This is the main reason why this project is located along the western border, northeast of the western corridor, of the Serengeti National Park.

Hunting in western Serengeti is motivated by several factors. First, hunting provides protein and income. Second, wildlife may represent an important resource to fall back on in case of prolonged drought and a following low agricultural return. Third, the traditional conservation policy of strict protection may have caused the people-park conflicts to escalate and a continual hunting pressure. It is of crucial importance to understand people's incentives to hunt, the patterns of the hunting activities and the impact of SRCP. In order to estimate the extent of hunting and design policies which stimulate the local people to reduce hunting, it is urgent to acquire knowledge about hunting methods, targeted species, frequency of hunting and the relationship between the hunting activity and other labour demanding activities, such as crop farming and livestock husbandry.

3.2 Sample and data collection

Data was collected in two separate surveys; household interviews and a questionnaire filled out by Village Game Scouts (VGS). The resulting data set contains information on household economics, human-wildlife conflicts such as illegal hunting and wildlife-induced damage to agricultural crops and livestock, and anti-poaching law enforcement.

3.2.1 Household survey

In the household survey, people were interviewed by two native speakers who gained continuously assistance from Anne Borge Johannesen (Figure 3). The interviewers were provided with training on how to fill out the forms and how to approach the sensitive questions on income and illegal hunting. There are, of course, many potential pitfalls related to controversial issues like illegal hunting but our impression is that many people were confident and, moreover, grateful for the opportunity to tell us about the human-wildlife conflicts. To gain peoples confidence, every household were visited in advance of the interview and informed about the purpose of the survey. The interviews took place in the people's homes and, in order to get as good estimates as possible, we met with the head of the household.



Figure 3: Interview in Serengeti district (Photo: A. B. Johannesen).

The household questionnaire was conducted in six of the villages in Serengeti and Bunda districts distributed along the western corridor of the Serengeti National Park. The exact size or structure of the population in this area is not known, but we believe the sample captures sufficient size and diversity on selected variables to be close to a representative sample. In order to reflect any differences in illegal hunting between households from villages participating in SRCP and other households, half of the households in the sample live in a SRCP village. In addition, the sample is quite evenly distributed between the districts so as to capture any differences due to geographical location, varying soil composition etc. The sample contains 297 households.

3.2.2 VGS survey

The practice of VGS (Figure 4) was initiated by SRCP and each project village has an anti-poaching unit consisting 12 game scouts patrolling in the village area and, to some extent, in the adjacent game reserves. During a period of 9 months the VGS in five villages in Bunda and Serengeti districts filled out a questionnaire covering patrols, arrested hunters, methods of hunting and targeted species, without separating between porters and hunters. The questionnaire was written in Kiswahili. The VGS were provided with training in how to fill out the questionnaires and were assisted through regularly meetings with Tomas Holmern. All questionnaires and hunting equipment confiscated by the VGS were collected at these meetings. The VGS patrol areas varied from 80 - 310 km². In Bunda District the patrol areas overlapped with the adjacent protected areas (30 - 65 %). While in Serengeti District, both patrol areas lie outside the protected areas, entirely within the Ikoma Open Area.



Figure 4: The Village Game Scouts discuss the extent of their patrol area with the local District Game Officer (Photo: T. Holmern).

The degree of training varies between VGS, but the majority has a one month training course. The VGS exercise walking patrols and are equipped with traditional weapons such as bow and arrow. The Tanzanian wildlife policy of 1998 allows village game scouts to arrest perpetrators within their village land. Perpetrators are usually brought before the village government, which decide the sanction. Penalties range from verbal warnings and confiscation of equipment to fines and corporal punishment. The VGS have an intimate knowledge of the area and are very familiar to the hunters' mode of operation. Therefore, given the right incentives and support, they can be very effective in detecting illegal activities.

There are some biases in the data collection on arrested hunters. First the data collection was conducted from December until August and thus encompasses only parts of the dry season when most hunting occurs. Second arrested hunters might also be prone not to tell the truth when interviewed about illegal activities, because of fear of punishment. These factors might lead to an underestimation of the annual offtake per hunter, which means that our estimates probably are minimum figures. Furthermore we did not, when presenting data, control for the patrol effort, although the number of patrols per village was about the same across months.

4. Results

4.1 Household characteristics

The household survey contained household characteristics such as household size, age composition, level of education and tribes. Whenever possible, the head of the household was interviewed, which resulted in a gender composition of 79% men and 21% women. When it comes to age, one half of the people were in the 25-44 age group (Table 1). Relatively few persons were younger than 25 years of age or older than 65 years of age.

The households varied also in terms of the level of education of the respondents. Some 29% of the respondents had no education (Table 2). In general, the education level was low and usually limited to primary school education. However, the fraction of the respondents with some level of education varied between different age groups. 84% in the age group 18-44 years had at least primary school education, while the same number was less than 50% of the people above the age of 55 years (Table 3).

When it comes to the size of the households, the majority were small to medium sized. As seen in Table 4, more than three quarters of the households counted 1-4 or 5-9 people.

There were 23 different tribes represented in the household survey. Table 5 shows that Sukuma was the major tribe, followed by Ikoma and Kisii. However, the tribe composition differed between the districts. While most of the Bunda households belonged to the Sukuma tribe, this tribe was rarely observed in Serengeti. Here, the most frequently observed tribes were Ikoma and Kisii. The latter tribe was, however, not present among the Bunda households. The Ikizu and Ikoma tribes have long traditions for hunting, and these tribes represented some 65% of the Serengeti households and some 15% of the households from Bunda (see also section 4.4.2).

Table 1: Distribution of the different age classes in the household survey

Age classes (in years)	N	% of total
18-24	15	5.1
25-34	73	24.5
35-44	75	25.3
45-54	60	20.2
55-64	45	15.1
65-74	19	6.4
75 and older	10	3.4
Total	297	100

Table 2: The level of education of the respondents in the household survey

Education level	N	% of total
No education	25	28.8
Primary school	204	69.2
Secondary school	6	2.0
Total	295	100

Table 3: Education level as seen per age group

Education level	18-44 years		45-54 years		55 years and older	
	N	%	N	%	N	%
No education	26	16.0	20	33.9	39	52.7
Primary or secondary school	136	84.0	39	66.1	35	47.3
Total	162	100.0	59	100.0	74	100.0

Table 4: Number of members in different households

Number of members	N households	% of households
1-4	86	29.1
5-9	140	47.3
10-14	50	16.8
15-19	15	5.1
More than 20	5	1.7
Total	296	100

Table 5: Number of respondents from different tribes in the two districts

Tribe	Total sample		Serengeti		Bunda	
	N	%	N	%	N	%
Ikizu	23	7.7	2	1.5	21	12.7
Ikoma	58	19.5	55	42.0	3	1.8
Kisii	31	10.4	31	23.7	0	0
Sukuma	123	41.4	8	6.1	115	69.3
Others	62	21.0	35	26.7	27	16.2
Total	297	100	131	100	166	100

4.2 Agriculture, livestock keeping and non-agropastoral income generating activities

The people in the Mara region rely on agriculture as the major income generating activity, and close to all of the households in the household survey (99%) owned land for cultivation. However, most households owned relatively small pieces of land, with more than three-quarters owning between 0 and 9 acres (Table 6). The fraction of households holding more than 9 acres of land was higher in Serengeti than in Bunda.

Crops are produced both as a source of food for domestic consumption or to sell on markets. Table 7 shows that one-quarter of the sample earned no income from crop production. In total three quarters earned income from crops, but this fraction was significantly higher in Bunda (85.5%) compared to Serengeti (60.5%) (Kruskal Wallis Test: $\chi^2=23.995$, $df=1$, $P=0.000$). The observed difference in crop income may be explained by varying crop composition between the districts. Cotton was (Figure 5) the only crop produced solely to sell on markets. This crop was grown by 73% of the Bunda farmers and constituted more than one quarter of the total crop production in Bunda (Table 8). In contrast, 6% of the Serengeti farmers produced cotton and, here, cotton represented 2% of total crop production. As seen in Table 8, maize was the major crop in Serengeti and constituted more than one half of total crop production in this district. In contrast to cotton, maize was produced for domestic consumption as well as for the market.



Figure 5: Cotton was one of the most important cash crops in the study area (Photo: A. B. Johannesen).

Livestock and poultry keeping were the second major activity in the study area. As seen in Table 9, one half of the sample kept livestock, while more than three-quarters owned poultry. Poultry keeping was evenly distributed between the districts, while a significantly higher fraction of the households in Serengeti kept livestock compared to Bunda (Kruskal Wallis Test: $\chi^2=6.945$, $df=1$, $P=0.008$). When separating between different species, Table 10 shows that the average numbers were equal between the districts, except for sheep, which, on average, was more common in Bunda. The difference is, however, not statistically different from zero (Kruskal Wallis Test: $\chi^2=1.881$, $df=1$, $P=0.170$).

Some 61.5% of the households in the study area earned income from livestock and poultry keeping (Table 11). While there was no statistically difference in animal keeping between the dis-

tricts, the fraction of owners earning income from animal keeping was significantly higher in Serengeti (70.6%) of compared to Bunda (53.3%) (Kruskal Wallis Test: $\chi^2=7.296$, $df=1$, $P=0.007$). Table 11 also shows that the fraction in Serengeti was higher than in Bunda for all income groups. On average, the annual income from livestock and poultry keeping was significantly higher in Serengeti (43 390 tzh \pm 84 992) compared to Bunda (26 720 50 244) (Kruskal Wallis Test: $\chi^2=8.031$, $df=1$, $P=0.005$).

Finally, as seen in Table 12, 37% of the households in the sample earned income from other sources than agriculture and domestic animal keeping (Figure 6). These sources included charcoal and firewood, sale of fish, sale of water, making beverage, business and formal employment. Again, although not statistically significant, the rate differed between the districts: 40.4% earned income from such activities in Bunda and 32.8% in Serengeti (Kruskal Wallis Test: $\chi^2=2.164$, $df=1$, $P=0.141$).



Figure 6: A woman is preparing chapatti for a customer in her café (Photo: A. B. Johannesen).

Table 6: Amount of land cultivated for crops in the two districts

Amount of land (in acres)	Total sample		Serengeti		Bunda	
	N	%	N	%	N	%
0-3	59	19.9	27	20.6	32	19.3
3-6	112	37.7	44	33.6	68	41.0
6-9	57	19.2	24	18.3	33	19.9
9-12	31	10.4	17	13.0	14	8.4
More than 12	38	12.8	19	14.5	19	11.4
Total	297	100	131	100	166	100

Table 7: Income from crops (in 1000 tzh) in the two districts

Income (in 1000 tzh)	Total sample		Serengeti		Bunda	
	N	%	N	%	N	%
0	75	25.4	51	39.5	24	14.5
1-30	66	22.4	29	22.5	37	22.3
31-60	47	15.9	18	14.0	29	17.4
61-90	32	10.9	8	6.2	24	14.5
More than 90	75	25.4	23	17.8	52	31.3
Total	295	100	129	100	166	100

Table 8: Crop composition in the two districts

Crop	Total sample		Serengeti		Bunda	
	Acres	% ^a	Acres	%	Acres	%
Cassava	359	16.4	114	11.2	245	20.9
Cotton	350	15.9	24	2.3	326	27.7
Maize	714	32.6	572	56.0	142	12.1
Millet	375	17.3	205	20.0	170	14.5
Other crops ^b	397	17.8	105	10.5	292	24.8
Total	2195	100	1020	100	1175	100

^aPercentage of the total amount of cultivated land.

^bOther crops include potatoes, sorghum, beans, groundnut, rice, sesame seed, simsim and sunflower.

Table 9: Livestock and poultry owned or not in the two districts

	Total sample				Serengeti				Bunda			
	Yes		No		Yes		No		Yes		No	
	N	%	N	%	N	%	N	%	N	%	N	%
Livestock	146	52.7	131	47.3	80	61.1	51	38.9	66	45.4	80	54.8
Poultry	216	78.0	61	22.0	102	77.9	29	22.1	114	78.1	32	21.9

Table 10: Average number of livestock and poultry among owners in the two districts

	Total sample	Serengeti	Bunda
Cattle	10.7	9.9	12.0
Goats	9.6	9.4	9.8
Sheep	8.4	5.7	11.2
Poultry	13.5	14.2	13.0

Table 11: Income from livestock and poultry among owners (in 1000 tzh) in the two districts

Income (in 1000 tzh)	Total sample		Serengeti		Bunda	
	N	%	N	%	N	%
0	89	38.5	32	29.4	57	46.7
1-30	71	30.8	36	33.0	35	28.7
31-60	30	13	20	18.3	10	8.2
More than 60	41	17.7	21	19.3	20	16.4
Total	231	100	109	100	122	100

Table 12: Income from non-agropastoral activities (in 1000 tzh) in the two districts

Income (in 1000 tzh)	Total sample		Serengeti		Bunda	
	N	%	N	%	N	%
0	187	63.0	88	67.2	99	59.6
1-30	63	21.2	21	16.0	42	25.3
31-60	13	4.4	4	3.1	9	5.5
More than 60	34	11.4	18	13.7	16	9.6
Total	297	100	131	100	166	100

4.3 Wildlife-induced damage

The villages in the household survey were located adjacent to the border of the protected area. Wildlife, however, knows no boundaries and roams freely in and out of the protected area. When being outside, wildlife competes with crops and livestock for land and water. Wildlife also causes direct damage by destroying crops (Figure 7), killing or injuring livestock and poultry, and transmitting diseases to livestock. Hence, in this way, wildlife represents an economic cost for the local people.

When people were asked about the species causing damage, they claimed that crops were destroyed by elephants (*Loxodonta africana*), baboons (*Papio cynocephalus*) and bush pigs (*Potamochoerus porcus*), livestock was killed or injured mainly by hyenas (*Crocuta crocuta*), while poultry were killed by eagles and mongooses.

Wildlife-induced damage was reported in two ways. First, people were asked to indicate their impression of the extent of damage by using categories ranging from 'no', 'very little', 'much' to 'very much' damage. In addition, they estimated the crop damage as a percentage of total crop production in year 2000 and damage to livestock and poultry as the number of animals killed or injured during year 2000. There were some serious measurement problems related to all measures of damage. Regarding the reported crop damage, the respondents may have overestimated both the impression of damage and the percentage damage in hope for future compensations. In addition, most farmers found it difficult to estimate the crop damage as a percentage of total crop production. Instead, they reported the approximate number of acres damaged as a percentage of the number of acres cultivated, and not the actual share of crops damaged. Further, the estimated percentage damage did not reflect the monetary value of the loss as cash crops and food crops were given equal weights. Similar problems arised for the different measures of damage to livestock or poultry.

A clear majority of the people in this study (85.7%) reported that wildlife caused 'much' or 'very much' damage to crops (Table 13). The average crop damage was 19.1% of the total crop production, and it was quite evenly distributed between districts (Kruskal Wallis Test: $\chi^2=0.028$, $df=1$, $P=0.868$). See also Table 15. Based on the crop values presented by Emerton and Mfunda (1999), this corresponds to an average value loss of 84 000 tzh per household.

Compared to the reported crop damage, far more households claimed that they experienced 'no damage' to livestock and poultry (34.8%). Hence, it seems like wildlife-induced damage to crops was more widespread compared to damage to domestic animals. However, given that a household suffered from damage, the damage to domestic animals was characterised as 'much' or 'very much' just as often as for damage to crops (Table 14). There were no statistically significant difference in average reported number of livestock and poultry injured or killed by wildlife between districts (Table 15). The average number of 1.9 livestock killed or injured corresponds to a value loss of 48 002 tzh, when using the animal values presented by Loibooki et al. (2002).

There were no statistically significant difference in average reported percentage crop damage and number of livestock injured or killed by wildlife between households from SRCP- and non-SRCP villages (Table 15). However, the average number of injuries to poultry was significantly higher for households from

villages outside SRCP (Kruskal Wallis Test: $\chi^2=7.919$, $df=1$, $P=0.005$). Still, none of the activities of SRCP gave reasons to believe that that this difference was a result of the establishment of this project. SRCP assists, to some extent, in chasing problem animals such as elephants out of the project villages, but there was no records demonstrating attempts by SRCP to improve poultry protection. Instead, the observed difference may stem from the fact that the average number of poultry owned was significantly higher for owners outside SRCP (15.4 compared to 11.6 among owners from SRCP villages, Kruskal Wallis Test: $\chi^2=6.233$, $df=1$, $P=0.013$).



Figure 7: Elephants are mentioned as a problem species in many villages (Photo: E. Røskaft).

Table 13: Wildlife-induced damage to crops and livestock/ poultry

Damage	Crops		Livestock/poultry	
	N	%	N	%
No	24	8.2	73	34.8
Very little	18	6.1	12	5.7
Much	72	24.5	70	33.3
Very much	180	61.2	55	26.2
Total	294	100	210	100

Table 14: Wildlife-induced damage to crops and livestock/ poultry for households who experienced damage

Damage	Crops		Livestock/poultry	
	N	%	N	%
Very little	18	6.7	12	8.8
Much or very much	252	93.3	125	91.2
Total	270	100	137	100

Table 15: Percentage damage and number of injuries among owners in the two districts and SRCP or non-SRCP villages

		Total	Serengeti	Bunda	SRCP	Non-SRCP
%crop damage	Mean	19.1	19.4	18.9	19.9	18.3
	N	295	129	166	147	148
Livestock injuries	Mean	1.9	1.6	2.3	1.8	2.0
	N	145	79	66	63	82
Poultry injuries	Mean	5.1	5.4	4.8	3.9	6.3
	N	200	90	110	98	102

4.4 Illegal hunting

Illegal hunting of migratory herbivores in the Serengeti National Park and the adjacent areas is a major problem for the National Park managers. Possible future overexploitation of the migratory herbivores, particularly wildebeest, may threaten the entire Serengeti ecosystem. Because the majority of illegal hunting occurs along the western edge of the Serengeti National Park, it is important to assess the extent of the illegal hunting among people living in this area.

Our surveys involve both households who voluntarily told us that they participated in illegal hunting and hunters arrested by village game scouts. The pattern of the recorded hunting was, however, quite similar between the two surveys. The targeted species were the same and both surveys captured subsistence hunters only. Subsistence hunting is defined as hunting performed by people from the local communities who use traditional hunting methods and hunt for meat for own consumption or to sell on the local market (Leader-Williams and Milner-Gulland 1993). Organized hunting, on the other hand, is usually understood as hunting performed by people from outside the local community who use more sophisticated hunting methods and hunt more often for trophies (e.g. elephant).

4.4.1 The household survey and volunteered hunters

The households were asked whether they participated in illegal hunting, about hunting trips and travel distance to the hunting area. The data on hunted species covers wildebeest, zebra, gazelle, topi, and impala. Table 16 shows that in 80 households, (27 %) some of the members were involved in illegal hunting. This corresponds well with the findings of the household survey conducted by Loibooki et al. (2002). The participation rate in illegal hunting differed between sub-groups of the sample. For instance, the rate was higher among SRCP households (32%) than households outside SRCP (22%), but the difference is not statistically significant (Kruskal Wallis Test: $\chi^2=3.472$, $df=1$, $P=0.062$). In contrast, the participation rate was significantly higher in Serengeti (34%) compared to Bunda (22%) (Kruskal Wallis Test: $\chi^2=5.252$, $df=1$, $P=0.022$).

45% of the hunters were under 35 years of age (Table 17). The age distribution suggests, however, that hunting was a fairly common activity within most groups and not limited to young people. In addition, hunting seems to be widespread over different household sizes (Table 18). Both results suggest that hunting was common within the population in general and not limited to small sub-populations.

Among hunters in Serengeti, Ikoma was the most frequent tribe while the majority of hunters in Bunda are from Sukuma tribe (Table 19). Both tribes have long traditions for hunting. In total, these tribes constituted 59% of the hunters.

As seen in Table 20, we can divide the volunteered hunters into two groups. One group (55%) consisted of people who reported that they went on hunting trips, usually into the protected area, and a second group (45%) constitute those who did not go on hunting trips but hunted within or close to the village area. For the first group, the average annual number of trips was 5.2 per volunteered hunter.

The fraction of the volunteered hunters reporting a positive number of hunting trips to the protected area differed between sub-groups of the sample (Table 20). For instance, 43% of the hunters in the SRCP villages reported that they hunted in the

protected area, while the same rate for hunters outside SRCP was 73%. The fractions are significantly different (Kruskal Wallis Test: $\chi^2=7.043$, $df=1$, $P=0.008$). The rates differed even more between the districts: 86% of the hunters in Bunda went on hunting trips, while only 30% of the hunters in Serengeti report the same ($P=0.000$, Kruskal Wallis Test).

Hunting seems to be a salient activity in providing food and income. These factors outweigh other reasons for hunting if we look at the various motives for hunting. 30.7% of the volunteered hunters' reported that they hunt for meat as food for the household (Table 21). 65% of the volunteered hunters also report income as a motivation for hunting, while no more than 8.8% give cultural and traditional reasons for hunting. In the survey by Loibooki et al. (2002), only 0.8% claimed to hunt for the latter reasons. Finally, hunting is seldom reported as a way of exercising damage control, which seems reasonable because agricultural damage is imposed by other species than those targeted for hunting (see section 4.3 and Table 24).

The household survey includes data on income from illegal hunting (Table 22). In total, the average income from illegal hunting was 31 200 tzh, but it was significantly higher among those who hunted in the protected area compared to those who hunted in the village area (Kruskal Wallis Test: $\chi^2=50.588$, $df=1$, $P=0.000$). One plausible explanation of this deviation is that the average annual offtake was significantly higher among households who went on hunting trips in the protected area (13.9 animals) compared to those who hunted in the outer area (2.3 animals) (Kruskal Wallis Test: $\chi^2=42.179$, $df=1$, $P=0.000$).

Tables 22-23 also demonstrate that both average offtake and average income from hunting in the protected area were higher among hunters from villages outside SRCP compared to hunters from SRCP villages (Kruskal Wallis Test: $\chi^2=5.979$, $df=1$, $P=0.014$; $=2.315$, $df=1$, $P=0.128$, respectively). So, while there were no significant difference in rate of participation rate in illegal hunting between households from SRCP villages and households outside SRCP, it seems like those outside SRCP who choose to hunt inserted a relatively more intensive pressure on the wildlife. Tables 24-25 suggest that this is the case for each targeted species. We can also see that the total number and the average offtake were higher for hunters from Bunda than Serengeti.

As seen in Table 24, wildebeest was the major target species for the volunteered hunters, followed by zebra and gazelle. For the latter, we have no data separating between Thomson's gazelle and Grant's gazelle (*Gazella granti*).

Table 16: Participation in illegal hunting in relation to districts and whether they lived in a SRCP village or not

	Number	Participation	No participation
SRCP	148	47 (32%)	101 (68%)
Not SRCP	149	33 (22%)	116 (78%)
Bunda	166	36 (22%)	130 (78%)
Serengeti	131	44 (34%)	87 (66%)
Total	297	80 (27%)	217 (73%)

Table 17: Age composition of hunters in the household survey

Age in years	N	%
18-24	7	9
25-34	29	36
35-44	23	29
45-54	10	13
55-64	7	9
65-74	4	5
Total	80	100

Table 18: The size households involved in illegal hunting

Number of household members	N	%
1-4	28	35
5-9	40	50
10-14	8	10
15-19	4	5
More than 20	0	0
Total	80	100

Table 19: Tribe composition of hunters from the two districts

Tribe	Total		Bunda		Serengeti	
	N	%	N	%	N	%
Ikizu	7	9	5	14	2	5
Ikoma	17	21	0	0 ^a	17	39
Kisii	7	9	0	0 ^b	7	16
Sukuma	30	38	26	72	4	9
Others	19	24	5	14	14	31
Total	80	101	36	100	44	100

^a Zero because only 1.8% of the Bunda households belong to Ikoma.

^b Zero because none of the Bunda households belong to Kisii.

Table 20: Distribution of the households involved in hunting in the vicinity of or in the protected area in relation to district and village status

	Total	Hunting in the village area	Hunting trips to the protected area
SRCP	47	27 (57%)	20 (43%)
Not SRCP	33	9 (27%)	24 (73%)
Bunda	36	5 (14%)	31 (86%)
Serengeti	44	31 (70%)	13 (30%)
Total	80	36 (45%)	44 (55%)

Table 21: Motivations for hunting

Meat only for cons.	Meat only for sale	Both	Skin for own use	Skin for sale	Damage control	Cult./ trad.
30.7%	0%	65.0%	1.3%	0%	1.3%	8.8%

Table 22: Average income from hunting (in 1000 tzh) in relation to district and village status

	All hunters	Hunting in the village area	Hunting trips to the protected area
SRCP	18.8	6.7	34.5
Not SRCP	48.6	1.3	66.3
Bunda	49.4	7.6	56.1
Serengeti	16.0	4.9	41.5
Total	31.2	5.3	51.8

Table 23: Average annual number of animals per hunter in relation to hunting status, district and village status.

	All hunters	Hunting in the village area	Hunting trips to the protected area
SRCP	3.7	2.1	6.0
Not SRCP	15.7	2.8	20.7
Bunda	14.6	3.4	16.5
Serengeti	3.8	2.1	7.8
Total	8.6	2.3	13.9

Table 24: Illegal offtake as seen per species in relation to district and village status

	Gazelle	Impala	Topi	Wildebeest	Zebra
Serengeti (N=44)	25	9	14	104	13
Bunda (N=36)	61	49	21	238	147
SRCP (N=47)	27	16	13	101	19
Not SRCP (N=33)	59	42	22	241	141
Total (N=80)	86	58	35	342	160

Table 25: Average annual offtake by volunteered hunters as seen per species in relation to district and village status

	Gazelle	Impala	Topi	Wildebeest	Zebra
Serengeti (N=44)	0.6	0.2	0.3	2.4	0.3
Bunda (N=36)	1.7	1.4	0.6	6.6	4.2
SRCP (N=47)	0.6	0.3	0.3	2.2	0.4
Not SRCP (N=33)	1.8	1.3	0.7	7.3	4.4
Total (N=80)	1.1	0.7	0.4	4.3	2.0

4.4.2 The VGS survey and arrested hunters

As reported by Holmern et al. (2002) the VGS made 201 patrols in the study period and arrested a total of 96 hunters (Figure 8) for hunting illegally. Over 600 snares were collected, 32 pitfalls were recorded, substantial amounts of hunting equipment confiscated (bows, arrows, knives etc.), but no firearms were recorded. The average length of a hunting trip was 6.8 days and the average trips per year were 12.9. The illegal hunters killed 0.92 animals per trip (Holmern et al. 2002). The average number of hunting trips for arrested hunters exceeded the corresponding number for volunteered hunters who went on hunting trips (5.2 trips). The observed difference in the average number of trips may be explained by the nature of the respective samples. Only some 7% of the volunteered hunters with trips had been arrested during the period of report, and if we expect the probability of being detected during a year to increase with the number of hunting trips, the low detection rate may reflect a relatively low hunting intensity among the volunteered hunters. The motivation for hunting between the two samples was different, where the majority of the arrested hunters (60.5%) reported to hunt for own consumption, while this was considerably less for volunteered hunters (Table 21). Only 8.5 % hunted only to generate cash, while 31 % hunted for both reasons (Holmern et al. 2002).

Hunters seem to spend a maximum of about two weeks out hunting before returning to their village (Table 26). A third of the hunters spent less than 4 days hunting and many spent only one day. These hunting excursions are often just night hunting trips with flashlights and hunting dogs, that most often take place close to the village, either in the Open Areas or Game Reserve (Table 26). The number of hunting trips each hunter undertook in a year was not significantly different between hunters arrested in Bunda District (14.2 ± 2.6 hunting trips) to that of Serengeti District (11.7 ± 2.7 hunting trips) (t-test: $t_{39} = -0.669$, $p = 0.507$). However, there was a pronounced difference between hunters in their stated average length of hunting trips. Serengeti District hunters had significantly longer hunting trips (9.0 ± 1.1 days) than hunters caught in Bunda District (3.6 ± 0.7 days) (t-test: $t_{50} = -3.828$, $p < 0.001$). Illegal hunters originating from villages in Bunda District had generally shorter distances to the nearest protected area (i.e. Grumeti GR and Serengeti NP), which might explain the shorter length of trips. Moreover the protected areas, which the illegal hunters in Bunda District used, have higher wildlife densities than the Ikoma Open Area (Campbell and Borner 1995). Arrested hunters in Serengeti District were mainly hunting inside the Ikoma Open Area, and the low densities of wildlife here might make the hunters compensate by spending more time hunting. An additional factor might be the levels of law enforcement which is considerably lower in the Open Areas compared to the Game Reserves and national park. Arrested hunters went on more hunting trips during the dry season, which corresponds to the time when the migration passes through the area (Holmern et al. 2002). This is also reflected by the number of killed wildlife recorded by the VGS. In the months from June to August there was a sharp increase in the number of recorded kills, which was particularly noticeable in the migratory wildebeest (Figure 9). The hunters in Bunda District seem to concentrate mainly on small bodied species, such as Thomson's gazelle. On the other hand arrested hunters in Serengeti District took more large herbivores (zebra, wildebeest etc.). Another distinct feature is that nearly all the wildebeest killed were recorded in Serengeti District.

The majority (78 %) that were arrested during the study were apprehended in Serengeti District. All the arrested hunters were males and more than 50 % were younger than 30 years. The

age distribution of the hunters in Figure 10 suggests that it was a fairly common activity among the different age groups and that illegal hunting was not confined only to the younger age groups. However it might not be excluded that the distribution could also reflect that younger age groups were more prone to detection, due to their inexperience. The size of the households of the arrested hunters' corresponded very well with the distribution in the questionnaire survey (see Table 18 and 27). This suggests that illegal hunting was widespread (even among SRCP villages, Table 28) and that it was not confined to a small segment of the population.



Figure 8: Village Game Scouts in Nyichoka village with hunters arrested for illegal hunting (Photo: T. Holmern)

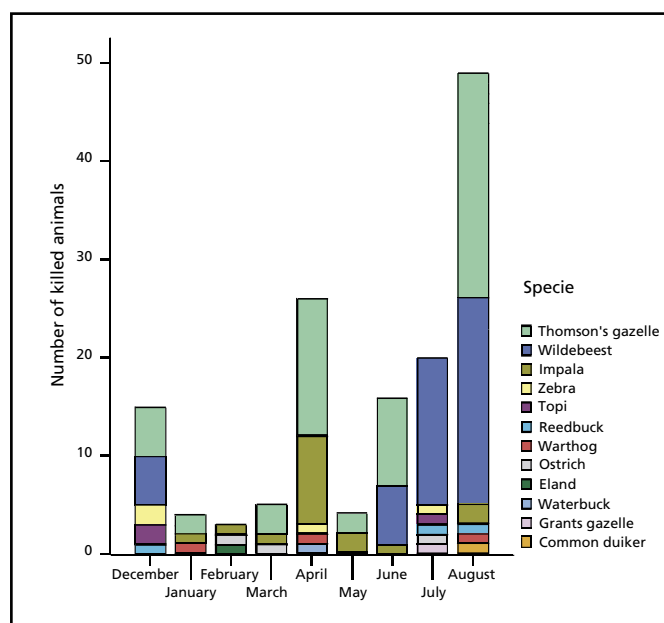


Figure 9: The number of wildlife reported killed by arrested hunters from December 1998 until August 1999. (No. of patrols: Dec= 19, Jan = 23, Feb = 20, Mar = 20, Apr = 20, May = 18, Jun = 17, Jul = 20, Aug = 30)

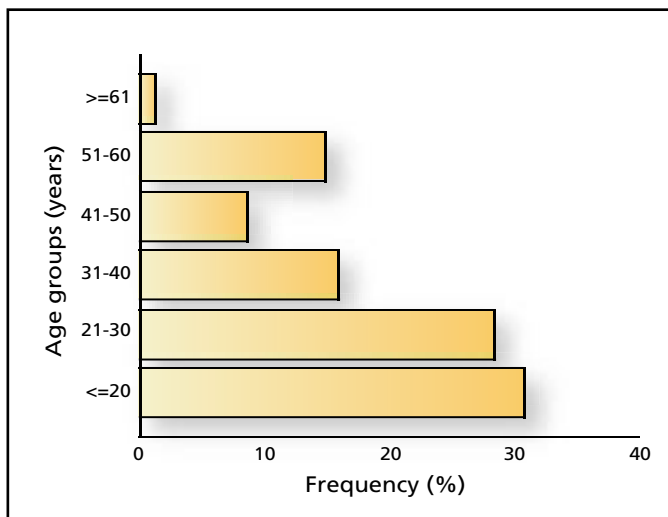


Figure 10: Age distribution of hunters apprehended by VGS (n = 81)

Table 26: The distribution of the average number of days spent hunting (N = 52)

Number of Days	N groups	% of groups
1 – 4	19	36.4
5 - 8	3	24.9
9 – 12	12	23.1
13 - 16	7	13.5
>17	1	1.9

Table 27: Number of members in arrested hunter’s household

Household size	N	%
1-4	21	29.2
5-9	37	51.4
10-14	11	15.3
15-19	2	1.4
More than 20	1	0.7
Total	72	100

Table 28: Illegal hunters arrested in the five project villages and the number of arrested illegal hunters originating from other villages than the home village of the VGS

Village	Total sample		Other villages		Same village	
	N	%	N	%	N	%
Robanda	24	25	7	7.3	17	17.7
Nyichoka	51	53.1	32	33.3	19	19.8
Kihumbu	11	11.4	11	11.4	-	-
Hunyari	6	6.3	6	6.3	-	-
Nyamatoke	4	4.2	4	4.2	-	-
Total	96	100	60	62.5	36	37.5



Figure 11: The spring trap is usually put up in the reverine forest in animal trek paths. A thin layer of leaves and sand hides the noose and trigger mechanism beneath (Photo: T. Holmern).

The arrested hunters represented 12 different tribes, where the tribal diversity was largest in Serengeti District (11 of 12). The majority of illegal hunters in Serengeti District came from the Ikoma tribe (41.7%) and Mgurime tribe (16.7%). The Ikoma tribe has long traditions for hunting and was well represented in the sample, although both of the study villages in Serengeti were Ikoma settlements, which might have lead to an overrepresentation. In Bunda District the Ikizu and the Sukuma tribes were the most numerous (81.8% and 2.7%). The ikizu represent the most common tribe in Bunda District (Table 29). However the sample of arrested hunters in Bunda District only contained 4 different tribes. Moreover the numbers indicate that there were less illegal hunters originating from within the study villages in Bunda District (Table 28). This is however unlikely, and may rather be due to the lack of moral backing from village government, poor linkage with perceived benefits of conservation to villages and unwillingness of the VGS of capturing friends and relatives. However in Serengeti District there was a higher percentage of arrested hunters originating from within the study villages. This might reflect that these villages have a better backing from the village authorities, receive more conservation benefits and that wildlife conservation was seen more as a possible means for village development.

During our meetings with VGS, SRCP, discussions with District Game Officers and anti-poaching personell we identified four general forms of illegal hunting commonly used in the western Serengeti: 1) Short active hunting excursions; either through day trips usually with hunting dogs in the adjacent protected areas or village areas. 2) Night hunting; carried out by small groups during moonless nights. This type was conducted with hunting dogs and powerful flashlights. The target species were usually the smaller plain game (body size \leq impala). These hunts were frequent and short, usually lasting no longer than one night. 3) Snare hunting and pitfalls; through setting snares or traps within walking distance from the village (< 5 km). These were usually checked on a daily basis and were probably also used as crop protection. Pitfalls were usually dug in known trek paths in natural bottlenecks, i.e. between two hills, river crossings and checked on a more infrequent basis depending on wildlife availability. Pitfalls were not recorded in Bunda District, but were more common in Serengeti District. 4) Expeditions lasting several days; usually involving setting up a camp. Hunting was both conducted with hunting dogs and with snares. The snares (or traps) (Figure 11) were set in the afternoon / dusk and checked again in the early morning. The meat was dried on site and then transported back to the village.

Table 29: Tribe composition of arrested hunters in Serengeti and Bunda Districts

Tribe	Total sample		Serengeti		Bunda	
	N	%	N	%	N	%
Ikoma	25	30.5	25	41.7	-	-
Ikizu	18	22	2	3.3	18	81.8
Sukuma	11	13.4	6	10	5	22.7
Mgurime	10	12.2	10	16.7	-	-
Issenye	4	4.9	4	6.7	-	-
Kurya	3	3.7	3	5	-	-
Zanaki	3	3.7	3	5	-	-
Jarud	2	2.4	2	3.3	-	-
Nandi	2	2.4	2	3.3	2	9.1
Kisii	1	1.2	1	1.7	-	-
Natta	1	1.2	1	1.7	-	-
Taturu	1	1.2	-	-	1	4.5
Total	82	100	60	100	22	100

A total of 142 animals belonging to 12 different species were recorded killed during the study (Table 30). The most numerous in terms of number of animals killed were Thomson's gazelle (40.8 %), followed by wildebeest (33.1 %) and impala (12 %; Figure 12). The migratory species represented the bulk of both the total carcasses recorded (75.3 %) and the total biomass (80.4 %). The hunting methods may be classified into two groups. First, we have active hunting where the hunters actively stalk and kill the animal, a method which represents 64.8% of the hunting mortality (Table 31). Night hunting with flashlights was the overall most common method of active hunting (Figure 12). Thomson's gazelle and impala were taken most frequently by active hunting (96.6 % and 70.6 %). Second, we have passive hunting which refers to the use of snares, spring traps and pitfalls stands. Snares are fastened between trees with an open noose vertically above the ground, so that an animal, above a certain size, trying to walk through the snare is captured. In spring traps a noose is made by wire or sisal rope and encircled over a hole with a rope to a bent over pole or tree. Pitfalls are usually dug in trek paths. The passive methods represent 33% of the hunting mortality. Passive hunting methods was most common for the large species (body size $>$ impala) (33, i.e., 61.1 %). Wildebeest was the major species in passive hunting (Table 31).

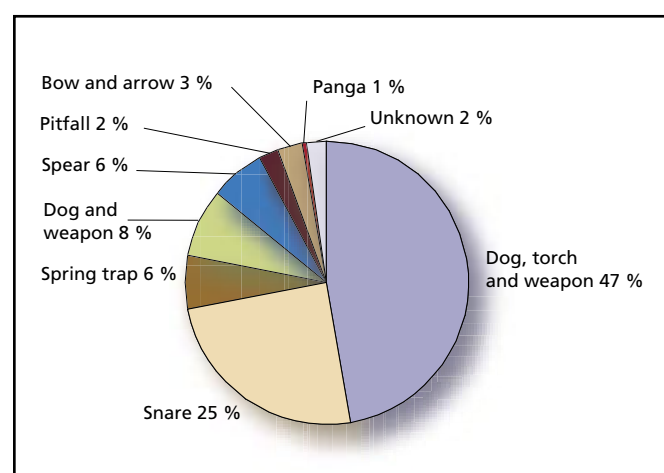


Figure 12: Hunting methods used by arrested hunters to kill wildlife

Table 30: Wildlife recorded killed by illegal hunters in Serengeti and Bunda Districts

Species	Status	Body weight (kg)	Serengeti	Serengeti Biomass	Bunda	Bunda Biomass	No. of animals
1. Thomson's gazelle	M	15	22	330	36	540	58
2. Wildebeest	M	123	43	5289	4	492	47
3. Impala	R	40	15	600	2	80	17
4. Zebra	M	200	3	600	1	200	4
5. Topi	R	100	1	100	2	200	3
6. Reedbuck	R	40	2	80	1	40	3
7. Ostrich	R	150	2	300	1	150	3
8. Warthog	R	45	3	135	-	-	3
9. Eland	M	340	1	340	-	-	1
10. Waterbuck	R	160	1	160	-	-	1
11. Common duiker	R	15	1	15	-	-	1
12. Grant's gazelle	R	40	-	-	1	40	1
Total			94	7949	48	1742	142

Table 31: Species and hunting methods of arrested hunters.

Species	Active hunting	Passive hunting	Unknown
1. Thomson's gazelle	56	2	-
2. Wildebeest	19	26	2
3. Impala	12	5	-
4. Zebra	1	3	-
5. Topi	1	2	-
6. Reedbuck	-	3	-
7. Ostrich	-	3	-
8. Warthog	2	1	-
9. Eland	-	1	-
10. Waterbuck	-	1	-
11. Common duiker	1	-	-
12. Grant's gazelle	-	-	1
Total	92	47	3

While wildebeest was the major target species for the volunteered hunters, records from the VGS on wildlife carcasses from arrested hunters suggest that Thomson's gazelle was the species most frequently killed, while wildebeest was the major species in terms of biomass (Table 30). There was however a clear difference between the two districts in the number of wildlife carcasses reported killed and biomass, where the majority of the kills and subsequently biomass (82%) were in Serengeti District. Furthermore the hunting activity and the number of animals killed in Serengeti was greater than in Bunda District, probably reflecting larger wildlife densities and better access to the migration. Compared to hunters arrested inside the Serengeti National Park by TANAPA rangers, the arrested hunters in our study catch significantly more animals, but fewer resident species (Campbell and Hofer 1995). We could not assess the effect of illegal hunting on wildlife, due to lack of density estimates. But judging from the extent of illegal hunting it is probably unsustainable for resident species. Illegal hunting might have less effect on the migratory species, since they only seasonally use the areas close to the villages. The targeted species for subsistence hunting are not the same that cause damage to crops and livestock. Subsistence hunting does therefore not contribute to control damage to crops. Although the occasional killing of carnivores that cause livestock damage may have gone unrecorded in our survey.

4.5 Legal hunting

Legal hunting in Tanzania is only allowed by using a firearm and holding a valid license, in the period from 1st of July until 31st December (URT 1974). Most legal resident and trophy hunting (Figure 13) in the area is conducted from vehicles. The trophy hunters may shoot from a quota of 29 species (Table 32). Licensed resident hunters may shoot a more limited range of species (16 different species), mainly ungulates. Both resident and trophy hunters are only allowed to shoot males. There are two trophy hunting blocks in the area, one in Grumeti and the other in Ikorongo Game Reserve, that are leased to tourist hunting companies by the Wildlife Division. In addition to the trophy hunting, SRCP, Pasiansi Wildlife Training Institute and Sanane Game Reserve hunt in both Ikoma Open Area and Grumeti Game Reserve. Lastly the District Game Office in Bunda and Serengeti District, and the Regional Game Officer in Musoma, can issue licenses for resident hunting for the Speke Gulf Game Controlled Area and Open Areas (Mugeta Open Area and the Ikoma Open Area). In the Mara region, both Musoma Rural District and Tarime District are without hunting areas, and in Bunda District human settlements along Lake Victoria make hunting difficult (i.e. in Speke Gulf Game Controlled Area). Therefore Serengeti District is the only area left in the region that offers viable hunting possibilities to resident and trophy hunters.



Figure 13: Trophy hunting can provide significant revenues, while shooting few animals (Photo: T. Holmern).

From the official data on quotas, we found that a total of 2018 mammals were harvested in Bunda and Serengeti Districts (Table 32). In Bunda District resident hunters utilised 39 % of the district's quota. On the other hand, Serengeti District had a substantial larger quota of 684 mammals and utilised 92 %. Resident hunters in Serengeti District killed mammals of 12 different species during the 1998 hunting season. Comparatively trophy hunting operations had a quota covering 29 species in 1998, mostly ungulates but it also included eight carnivore and one primate species. No information on the utilisation of the trophy hunting or the other actors involved in legal hunting in the area was available at the time of study. There was no available data on the sex and age groups killed. The low utilisation of quotas in Bunda District was probably due to human settlements inside hunting areas, low wildlife densities, large flight distances that make hunting from a vehicle difficult. In Serengeti District the utilisation percentage was overall high for the different species, probably reflecting an adequate access to wildlife.

However, the effect of legal hunting in the study area is difficult to assess, but considering the low densities of wildlife it may be unsustainable for most resident species, but probably not for the migratory species. The potential income from trophy hunting based on the allocated quotas was US\$ 188 325, but the actual income based on the minimum average utilisation criterion set by the Wildlife Division (40%) was US\$ 75 330. Of this amount 9.4 % (US\$ 7081) was returned to the districts (Planning and Assessment for Wildlife Management 1996). The resident hunting based on quota numbers constituted 1 587 500 tzh of income to the districts.

Hunting may generate considerable benefits to local communities and may prove to be an important asset in order to gain public support for wildlife conservation. But Emerton and Mfunda (1999) reported that it was questionable if the revenue generated from the hunting areas in Serengeti and Bunda Districts reached the communities. Moreover the current hunting legislation in Tanzania makes legal hunting for local people difficult because of: i.) the compulsory firearm hunting ii.) long distances to get to the District Game Office, and the fact that they need to declare each animal they would like to kill; the fee varies from 10,000 tzh for an eland to 400 tzh for a common

duiker. iii.) only 16 species of mammals can be killed iv.) limited quota numbers and they are not allowed to shoot more than one or two animals of each species per month. As a result, very few local people have bought a hunting license. In our sample none of the interviewed people had access to a vehicle, only two people had access to a firearm and no one had ever bought a hunting licence. The current legislation therefore, effectively excluded the local people, and makes them law offenders, when they exercised their traditional practice.

Table 32: Quotas, trophy fees (in US\$) and permit fees (in tzh for resident hunters) in 1998 for Bunda and Serengeti Districts. Quotas were given for both districts for resident hunting (utilisation in brackets), and quotas for Pasiansi Wildlife Training Institute (PWTI), Serengeti Regional Conservation Project (SRCP), Sanane Game Reserve (SGR) and VIP-Safaris.

Species	Bunda	Serengeti	PWTI ¹	SRCP	SGR	VIP-Safaris ²	Trophy fee(\$/tzh)	Total
Impala (<i>Aepyceros melampus</i>)	5 (5)	79 (70)	(3)	-	-	34	240/2000	121
Kongoni (<i>Alcelaphus buselaphus</i>)	-	10 (4)	-	-	-	14	370	24
Wildebeest (<i>Connochaetes taurinus</i>)	30 (29)	200 (201)	(3)	300	96	39	320/2000	668
Hyena (<i>Crocuta crocuta</i>)	-	-	-	-	-	17	190	17
Topi (<i>Damaliscus korrigum</i>)	10 (2)	170 (168)	(8)	100	-	27	350/3000	315
Zebra (<i>Equus burchelli</i>)	-	-	-	180	-	30	590	210
Serval (<i>Felis serval</i>)	-	-	-	-	-	6	180	6
African wildcat (<i>Felis sylvestrus</i>)	-	-	-	-	-	9	150	9
Grant's gazelle (<i>Gazella granti</i>)	10 (1)	55 (53)	(2)	-	-	30	220/1500	97
Thomson's gazelle (<i>Gazella thomsoni</i>)	25 (3)	75 (75)	(6)	-	-	42	190/1200	148
Genette (<i>Genetta genetta</i>)	-	-	-	-	-	7	180	7
African porcupine (<i>Hystrix sp.</i>)	-	-	-	-	-	11	10	11
Waterbuck (<i>Kobus ellipsiprymnus</i>)	-	-	-	-	-	17	440	17
Hare (<i>Lepus sp.</i>)	5 (-)	5 (-)	-	-	-	-	-	10
Kirk's dikdik (<i>Madoqua kirkii</i>)	5 (-)	5 (1)	-	-	-	16	170/400	26
African honey badger (<i>Melivora capensis</i>)	-	-	-	-	-	5	70	5
Klippspringer (<i>Oreotragus oreotragus</i>)	-	-	-	-	-	15	720	15
Oribi (<i>Ourebia ourebi</i>)	-	5 (-)	-	-	-	10	120	15
Lion (<i>Panthera leo</i>)	-	-	-	-	-	6	2000	6
Leopard (<i>Panthera pardus</i>)	-	-	-	-	-	8	2000	8
Baboon (<i>Papio cynocephalus</i>)	-	-	-	-	-	22	90	22
Warthog (<i>Phacochoerus aethiopicus</i>)	5 (-)	25 (24)	-	-	-	24	320/1200	54
Bushpig (<i>Potamochoerus porcus</i>)	5 (-)	5 (-)	-	-	-	13	190/1500	23
Steinbok (<i>Raphicerus campestris</i>)	-	-	-	-	-	13	-	13
Reedbuck (<i>Redunca sp.</i>)	- (1)	10 (6)	-	-	-	17	290/1200	27
Common duiker (<i>Sylvicapra grimmia</i>)	-	5 (-)	-	-	-	17	175/400	22
Buffalo (<i>Syncerus caffer</i>)	-	20 (18)	-	-	-	42	620/6000	64
Eland (<i>Tragelaphus oryx</i>)	-	10 (8)	(2)	-	-	12	840/10000	22
Bushbuck (<i>Tragulaphus scriptus</i>)	5 (-)	5 (1)	-	-	-	17	340/1200	27
African civet (<i>Viverra civetta</i>)	-	-	-	-	-	9	140	9
Total	105 (41)	684 (629)	(24)	580	96	529		2018

¹These animals were hunted during PWTI field safari in Ikorongo and Grumeti Game Reserve - 4 november to 3 december 1998.

²VIP safaris is the trophy hunting company that holds the lease for the hunting blocks in IGGR and Ikoma Open Area.

4.6 Interaction with outreach programs

Community Conservation Services (CCS) funded by TANAPA and SRCP works with development issues with the communities bordering the Serengeti National Park. CCS mainly build schools and does awareness raising (Bergin 2001). However, Kaltenborn et al. (2003) reported that communities in the area interact more with SRCP, although the majority of people had never been in direct contact with either of these organisations. SRCP was established in order to address human encroachment and illegal hunting in the Serengeti National Park, and it is currently working with 26 villages in four different districts: Ngorongoro District (Loliondo Division), Bunda District, Serengeti District and Tarime District (MNRT 1998, SRCP 1999).

It has since its early inception raised awareness of wildlife issues in the communities through regular visits, public meetings, seminars and training courses on wildlife utilisation and management. SRCP has also been responsible for the set-up and training of VGS in the project villages, together with organising institutions that manage revenues derived from the game cropping (Table 33). The revenues generated from the game cropping are used to finance village development projects (Holmern et al. 2002). When we asked the households to indicate how pleased they were with the benefits from SRCP, 95% said that the village as a whole benefit 'very much' and at the individual level (i.e. reduced tax burden), 87% benefit 'very much'.

Table 33: Overview over the species (wildebeest, zebra, topi), quota and utilisation of the game cropping during the period 1993-2001

Year	Wildebeest		Zebra		Topi	
	N	%	N	%	N	%
1993	480	19.6	192	32.8		
1994	700	15.4	90	27.8		
1995	592	38.3	64	45.3	39	56.4
1996	500	23.4	70	100	50	100.0
1997	250	-	140	-	100	-
1998	300	36	180	33.3	100	42.0
1999	210	71.4	140	47.8	70	47.1
2000	210	76.7	140	86.4	70	100.0
2001	210	100	140	94.3	70	100.0

Still, Holmern et al. (2002) reported that SRCP is not able to sustain wildlife conservation and promote rural development as long as its main strategy is based on game cropping. The SRCP game cropping is costly due to several different reasons, but the major reasons are long distances between villages, poor infrastructure in the area and the high costs of equipment. The game cropping has generally had low quota utilisation, even though the quotas have been small. In the latest village census (in 1993) the human population in the 14 project villages participating in the game cropping was 36 662. This means that the amount of meat provided by SRCP is very small compared to the demand. Further, as many as 83% of the households in our survey buy bushmeat from illegal hunting in addition to meat provided by SRCP, which reinforces the impression that contribution of SRCP is highly limited. The expected income from the cropping programme was 834 000 tzh per village in 2000, or some 2 300

tzh per household. This is low compared to the average value of crops and animals lost to wildlife and income from hunting (see sections 4.3 and 4.4.1). The benefit from SRCP is also low compared to potential return from agriculture, as seen by the fact that the average income from crops among cotton producers was 88 000 tzh. These numbers indicate that the individual income-advantage of participating in SRCP is very limited and unlikely to put an end to illegal hunting.

In addition to benefits from SRCP, one of the villages in our household survey receives money transfers from a tourism lodge located in the village area. Tourists visiting this lodge pay a fee of US\$10 per night which is transferred to the village without any deductions. The village partly invests this income in anti-poaching activities. In recent years, through collaboration between SRCP, CCS and tourist operators, several villages have set up a number of small-scale projects which intend to sell vegetables and fruits to tourist operators. These projects are just in their infancy, but may provide significant future benefits to some of the communities (Figure 14).



Figure 14: The Serengeti ecosystem is a unique place and may become a strong contributor to community development if properly managed (Photo: T. Holmern).

Together with several NGOs, SRCP has worked to establish Wildlife Management Areas (WMA). The new wildlife policy of Tanzania (URT 1998) devolves some user rights of wildlife to communities through the creation of WMA and is promoted as a possible means of distributing more direct benefits to communities. The intent is that the Wildlife Division determines the quotas, whereas the villages will gain the responsibility to manage quotas from the WMA. Other CBNRM schemes in Tanzania, such as the MBOMIPA approach (Matumizi Bora ya Malihai Idodi na Pawaga - Sustainable Use of Wild Resources in Idodi and Pawaga), which is located on the south-eastern edge of Ruaha National Park in Iringa District, have already tried this concept with good results. The villages involved in the project are allowed to sell their allocated quota to resident hunters. This is done by selling the quota by hunting block to the highest bidder and has increased the villages' incomes substantially (Walsh 1998). In Serengeti District, where SRCP is currently working for an establishment of a WMA, the sheer remoteness and poor accessibility of the hunting grounds, together with the fact that Mara Region does not have a very active hunting association, like the local branch of HAT (Hunters' Association of Tanzania)

in Iringa, probably precludes this possibility. Local trophy hunting companies may, however, serve as a substitute for the lack of hunting associations in this respect. But some of the villages have expressed considerable uneasiness towards development of WMA because they suspect that it may constrain their future development opportunities. The establishment of WMA is also an issue of conflict in other areas of Tanzania (Goldman 2003).

5 Concluding remarks

In Tanzania the country's wildlife diversity has a tremendous potential as a driving force and contributor to development processes. However, management in the western Serengeti faces a number of challenges in order to provide tangible wildlife benefits to local communities. First, the communities are heterogeneous, consisting of several tribes with different background and tradition. Second, the immigration rate to the area is high, mainly due to advantageous income opportunities in illegal hunting and trade of bushmeat (Friis et al. 2003). Third, most people are subsistence farmers and their crops are vulnerable to environmental fluctuations. Combined with restricted access to markets, this makes subsistence hunting an important asset in order to cope with draughts and crop failure.

The local people are constrained in their coping strategies, both through land scarcity and hunting prohibitions. Although the local people benefit from hunting of wildlife roaming outside the protected area, they are unlikely to tolerate loss of crops and domestic animals without complaint or action. Our household survey demonstrates that the value of wildlife-induced damage to crops and livestock is considerable higher than the wildlife-related benefits of SRCP. While subsistence hunting might offset some of this distortion, our survey shows that the animals targeted for hunting are not the species causing agricultural damage and, hence, illegal hunting does not reduce the costs related to damage. The quota of the trophy hunting company in the area contains, however, some of the problem animals and could therefore be more actively used when trying to curb damage to crops and livestock. Problem animal control is a contentious issue in the communities, especially for some of the larger carnivores like the hyena, which both can cause damage to livestock and can be an issue of fear and safety for humans (Kaltenborn et al. 2003). Moreover, in communities where the risk of property damage and loss of life by wildlife is perceived to be significant, local communities may be hostile to wildlife and oppose conservation programs.

The incentive for subsistence hunting in the western Serengeti is obviously strong. A substantial amount of wildlife is killed each year, especially during the dry season when the migratory species disperse into village land. The migratory Thomson's gazelle and wildebeest appear to be under heavy hunting pressure but the negative impact of hunting might be reduced by their migratory behaviour (Mduma et al. 1998, Thirgood et al. 2004). Mduma et al. (1998) reports that, although the wildebeest is a prime target for subsistence hunters, hunting is not a current threat to the migratory wildebeest. For resident species in areas bordering village land, the situation is, however, different. Due to high levels of unselective hunting and low densities of wildlife in the Ikoma OA and adjacent protected areas, the present harvest is most likely unsustainable (Campbell and Borner 1995).

Johannesen (2004) found that households from SRCP villages carry out fewer hunting trips compared to households outside SRCP, which suggests that the presence of SRCP may have reduced the illegal hunting pressure. However, this report shows that the potential benefit from SRCP is low, which, in turn, indicates that SRCP is not able to promote rural development in western Serengeti. Johannesen (2004) also reported that illegal hunting by a household decreases with the amount of land cultivated for maize and cotton (i.e. for cotton and maize) and increases with wildlife-induced damage to crops and domestic animals. Hence, strategies that stimulate increased maize and cotton

production and more extensive use of damage control have the potential to reduce hunting pressure. In addition, such strategies have the potential of generating significantly more income to the local people compared to the game cropping operations of today. Focusing on agricultural policies may therefore be a more viable mean of promoting wildlife conservation and rural development.

Considering the huge human population in the area, wildlife will probably be a means of future development for only a few strategically placed communities. For these communities, future cooperation with the tourist industry on, e.g., dispose of agricultural food and employment may improve the economic conditions in the area. The present level of tourism-related benefits to the local people can clearly be increased and more effort should be made in encouraging improvements and market access in agricultural sector. A broad knowledge about local economies and the relationship between different benefit schemes and illegal hunting is therefore vital in the future management the Serengeti.

References

- Arcese, P., Hando, J., Campbell, K. 1995. Historical and present-day anti-poaching in Serengeti, in Sinclair, A.R.E. and P. Arcese, eds., *Serengeti II*, University of Chicago Press, Chicago, 506-533.
- Bergin, P. 2001. Accommodating new narratives in a conservation bureaucracy: TANAPA and community conservation. In: D. Hulme and M. Murphree (eds) *African wildlife and livelihoods: The promise and performance of community conservation*, pp. 88 – 105.
- Campbell, K., and Borner, M. 1995. Population trends and distribution of Serengeti herbivores: implications for management. In: Sinclair, A.R.E., Arcese, P., (Eds.), *Serengeti II - Dynamics, Management, and Conservation of an Ecosystem*. The University of Chicago Press. Chicago, 117-145.
- Campbell, K. and Hofer, H. 1995. People and wildlife: Spatial dynamics and zones of interaction, in Sinclair, A.R.E. and P., eds., *Serengeti II - Dynamics, Management, and Conservation of an Ecosystem*. The University of Chicago Press. Chicago, 534-570.
- Dublin, H. 1995. Chairman's report: African elephant specialist group. *Pachyderm* 20. pp 8-9.
- Emerton, L. and 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.
- Friis, K., Johannesen, A.B., Kaltenborn, B.P., Muya, J., Røskaft, E. 2003. Biological and economical factors influencing human movement on the western border of Serengeti, Tanzania, Working paper, Institute of Biology, Norwegian University of Science and Technology, Norway.
- Fryxell, J.M. 1995. Aggregation and migration by grazing ungulates in relation to resources and predators, in Sinclair, A.R.E. and P. Arcese, eds., *Serengeti II*, University of Chicago Press, Chicago, 257-273.
- Goldman, M. 2003. Partitioned Nature, Privileged Knowledge: Community-based Conservation in Tanzania. *Development and Change*, 34 (5), 833 – 862.
- Hackel, J.D. 1999. Community Conservation and the Future of Africa's Wildlife. *Conservation Biology*, 13, 726-734.
- 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 Taylor, J. and N. Dunstone, eds., *The exploitation of mammal populations*, London, Chapman and Hall.
- Holmern, T., Røskaft, 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(4), 364-372.
- Johannesen, A.B. 2004. Wildlife conservation policies and incentives to hunt: An empirical analysis of illegal hunting in western Serengeti, Tanzania. Working paper. Norwegian University for Science and Technology, Trondheim.
- Kaltenborn, P., Nyahongo, J.W., Mayengo, M. 2003. People and Wildlife Interactions around Serengeti National Park, Tanzania. NINA Project Report 22: 31pp.
- Kilahama, F.B. 2003. Population pressure vis-avis Conservation of natural forests and woodlands in Tanzania. *Kakakuona (Tanzania Wildlife)* 29, 44-50.
- Kiss, A. 1990. Living with wildlife: Wildlife resource management with local participation in Africa, Technical Paper, 130, World Bank.
- Leader-Williams, N. and 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.
- Looibooki, M., Hofer, H., Campbell, K., 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(3), 391-398.
- Mduma, S.A.R. Hilborn, R., Sinclair, A.R.E. 1998. Limits to exploitation of Serengeti wildebeest and implications for its management. In: Newbery, D.M., Underwood, H.B., Prins, H.H.T., (Eds.), *Dynamics of Tropical Communities*. Blackwell Science, Oxford. pp. 243-265.
- Mduma, S.A.R., Sinclair, A.R.E., Hilborn, R. 1999. Food regulates the Serengeti wildebeest: a 40-year record. *Journal of Animal Ecology*, 68, 1101-1122.
- MNRT (Ministry of Natural Resources and Tourism). 1998. Project document, phase II. Serengeti Regional Conservation Project 1998 - 2002.
- Naughton-Treves, L. 1998. Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. *Conservation Biology* 12 (1), 156 - 158.
- Planning and Assessment for Wildlife Management, 1996. Returns from tourist hunting in Tanzania. In: Leader-Williams, L., Kayera, J.A., Overton, G.L., (Eds), *Tourist Hunting in Tanzania*. IUCN Gland, Switzerland and Cambridge, United Kingdom. pp. 71-80.
- Rugumayo, C.R. 1999. The participation in sustainable resource management. The case of Serengeti regional conservation strategy, Tanzania, Working Paper 112, Norwegian Institute for Urban and Regional Research, Oslo.
- Sinclair, A.R.E. 1995. Serengeti past and present, in Sinclair, A.R.E. and P. Arcese, eds, *Serengeti II*, University of Chicago Press, Chicago, 3-30.
- SRCP (Serengeti Regional Conservation Project). 1999. Annual Report July 1998 to June 1999. Ministry of Natural Resources and Tourism (Wildlife Department). Serengeti Regional Conservation Project.
- Swanson, T.M. and Barbier, E.B. 1992. Economics for the Wilds:

Wildlife, Wildlands, Diversity and Development, Earthscan, London.

Tchamba, M.N. 1996. History and the present status of the human/elephant conflict in the Waza-Logone region, Cameroon, West-africa. *Biological Conservation* 75, 35-41.

Thirgood, S.J., Mosser, A., Tham, S., Hopcraft, J.G.C, Mwangomo, E., Mlengeya, T., Kilewo, M., Fryxell, J.M., Sinclair, A.R.E., Borner, M. 2004. Can parks protect migratory ungulates? The case of the Serengeti wildebeest. *Animal Conservation* in the press.

URT (United Republic of Tanzania), 1974. The Wildlife Conservation Act, ACT 1974 No. 12 (Principal Legislation). Government Printer, Dar es Salaam-Tanzania.

URT (United Republic of Tanzania), 1998. The Wildlife Policy of Tanzania. Ministry of Natural Resources and Tourism, Dar es Salaam: Government Printer.

Wells, M. and Brandon, K. 1992. *People and Parks: Linking Protected Area Management with Local Communities*, World Bank, World Wildlife Fund and U.S. Agency for International Development, Washington DC.

Wolanski, E., Gereta, E., Borner, M., Mduma, S. 1999. Water migration and the Serengeti ecosystem. *American Scientist* 87, 526-533.

Wolanski, E., Gereta, E. 2001. Water quantity and quality as the factors driving the Serengeti ecosystem, Tanzania. *Hydrobiologia* 458, 169-180.

NINA Project report 26

ISSN 1502-6779

ISBN 82-426-1468-7

This report is made in co-operation with:
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