TRENDS AND DYNAMICS OF POACHING AT THE MOLE NATIONAL PARK

by

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CERTIFICATION

I hereby declare that this submission is my own work towards the MPHIL and that, to the best of my knowledge, it contains no material previously published by another person or material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Poaching is one of the major problems in wildlife conservation and management in the Mole National Park ecosystem. Unfortunately, it is not easy to identify poaching hotspots because poaching activities are dynamic and concealed in nature, thus there are no standardized methods to quantify them.This study was based on patrol data collectedbetween January 2003 to December 2008. The specific objectives of this study were: to identify the profile and motivational factors of poachers; to evaluate the categories of illegal activities committed by wildlife offenders; to determine trends in illegal activities in relation to patrol effort and abundance of large mammal and to demostrate how the Management Information System (MIST), a law enforcement monitoring tool depicts temporal and spatial trends in the distribution of illegal activites,patrol paths and animal sightings. To collect the data, both primary and secondary data sources were acquired. Primary data was gathered using questionnaires. Secondary data was gathered through literature review from both published and unpublished materials, internet, maps and records from the Wildlife Division of Forestry Commission and the wildlife conservation researchers in Ghana:s database. Data collected was coded and analyzed using the appropriate tool in the Statistical Package for Social Scientists (SPSS) to generate descriptive statistics. The illegal killing of wildlife for meat is believed to be one of the greatest direct causes of wildlife decline in West African;s parks.

This study used existing arrested poachers data which in which wascollectedfor the period of 2003 to 2008 as an indicator of human exploitation of the natural resources in thepark. The aim of this study was to investigate the trends and dynamics of poaching within and around Mole National Park. Many types of serious, as well as less serious, crimes have attracted the attention of protected areas managers in Africa. However, despite its detrimental effect upon wildlife populations, most managers have devoted scant attention to the study of

poaching and poachers. Identification of the specific motivations for poaching is necessary for wildlife. A law enforcement monitoring and a GIS based (MIST) system operational in the park was used to analyze the vulnerability of the park to illegal activities from the surrounding villages based on accessibility and level of motivation expressed in terms of the desire to exploit natural resources in the park. The motivation attributes of arrested poachers used were, poverty, hunting as a tradition/culture, food, medicinal, closeness to the park, easy access to ready market for bush meat trade, and others. MIST monitoring system was used to display spatial and temporal distribution of poaching events in the park. Patrol data from park field staff representing encounters with mammals and illegal activities were combined with patrol effort to get the trends in poaching and dynamics of poaching in the park. From 2006 to 2008 patrol staff performance steeply improved well above average (20.56 effective patrol day/staff/month), poaching reduced by 34.39 %/year on average and wildlife encounter increased by 3.85%/year. The dataset from arrested poachers and the five motivational factors (predictor variables) that are poverty, tradition (hunting), medicinal and others (-food, monetary profit, trophies and adventure) were tested for their significance in explaining some of the reasons for poaching within Mole National Park. A stepwise logistic regression method was used to select the explanatory variables. Among the five predictor variables, only poverty and food had significant relationships ($r=-0.2529, p<0.05$). Spatial distribution of poaching events were observed in the park except for the extreme north which had biased distribution as a result of minimal patrols in that area during the study period. The distribution of poaching events around the park could be linked with seasons as more events were recorded during the dry season. The poaching map also indicates that areas with high concentrations of animals were the high areas of poaching events. The distribution map of illegal activities and mammals in relation to patrol path in Mole National Park provided an insight on how vulnerable the park is to illegal activities. The MIST based analysis presented in this study

successfully depicted poaching areas in the park. Such maps are of benefit to management of Mole National Park. They facilitate decision making on intervention programs and how best to direct law enforcement patrols within and around the park.

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LIST OF ABBREVIATIONS/ACRONYMS

AfESG	African Elephants Specialists Group
CA	Conservation Area
CREMA	Community Resource Management Area
DGW	Department of Game and Wildlife
EU	European Union
EPMD	Effective Patrol Man-Days.
FC	Forestry Commission
FR	Forest Reserve
FRNR	Faculty of Renewable Natural Resource
GPS	Global Positioning System
GIS	Geographic Information System
IUCN	International Union for Conservation of Nature
KNUST	Kwame Nkrumah University of Science and Technology
LEU	Law Enforcement Unit
MLFM	Ministry of Lands, Forestry and Mines
MTC	Mim Timber Company
MNP	Mole National Park
MTU	Mobile Training Unit
NTFP	Non Timber Forest Product
OSS	Optimum Sample Size
MIST	Management Information System
WDSP	Wildlife Division Support Project
PAs	Protected Areas

RR	Resource Reserve
SPSS	Statistical Package for Social Scientist
WD	Wildlife Division
WWF	World Wide Fund for Nature

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CHAPTER ONE

1.0 INTRODUCTION

The study is about the trends and dynamics of poaching in Mole National Park (MNP) by individuals of the surrounding communities. In this chapter the research background and problem are introduced followed by the specification of the research objectives, research questions and hypothesis.

1.1. Background

Protected Areas ecosystems in the tropics are under increasing pressure for bush meat supply to local communities using traditional and quota harvesting (Barve *et al*. 2005; Tambling and du Toit 2005).

Local extinction of vulnerable wildlife species observed in African parks and reserves is a consequence of unsustainable hunting (Brashares *et al*. 2001).Enforcement of wildlife laws by park patrol staff is a response to unsustainable level of bush meat hunting around national parks (Jachmann and Billiouw 1997).

Funding limits enforcement of wildlife laws in protected areas and the efficiency of anti-poaching activities (Myers *et al*.2000).In Ghana funds allocations for protected area have been consistently low (Jachmann, 2008).One way to increase the efficiency of anti-poaching activities would be to identify areas with high poaching risks (salt-licks, waterholes, animal concentration areas) and flush the poachers out with well planned operation strategies.

However, Leader-Willams *et al.* (1990) stated in a study of designing protected area for conservation, that poaching activities in not easy to quantify for they are dynamic and

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concealed in nature. Hofer *et al*. (2000) on the other hand suggested that use of poaching data as an indicator by human activities, lead to identification of poaching hotspots.

The study used the Mole National Park law enforcement unit patrol data on poaching for the period 2003 to 2008 to determine trends and dynamics of poaching.

The main objectives of protected area system in Ghana are to conserve wildlife resources and biodiversity, thus contributing to the economy through tourism, recreation and securing the livelihoods in fringe communities (Jachmann, 2007).

The goal and primary mandate of Law Enforcement Unit (LEU) of PAs in Ghana is to protect wildlife and their habitat, enhance tourist security and assets of the parks/reserves. In PAs that there is a well planned and implemented law enforcement activities significantly reduced the level of poaching, improved visitor security and enhanced the general strengthening of protected area management (Wildlife Division,2009).

In Mole National Park the law enforcement unit (LEU) deals with the following aspects of PA security: wildlife protection, intelligence gathering, investigation and prosecution. Park security enhancing by the LEU which ensures that the boundary of the park is well
maintained.

The unit also conducts regular patrols, surveillance and monitoring operations against any illegal activities within the park as to safeguard its ecological integrity.Wildlife Division has details of policies and procedures provided on protected areas security.

Notable policies and procedures used by the LEU at Mole include; boundary maintenance, planning patrols, patrol safety, arresting of suspects, searching of suspect,

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seizure and confiscation, questioning the suspect, investigating crime, preferring charges, prosecution and intelligence gathering.

Planning protection patrols and prosecutions by the LEU are main areas of concern as far as data gathering of this study is concern. Law enforcement activities in most Protected Areas (PAs) in Africa entail conducting anti-poaching activities which includes patrolling with the aim of apprehending poachers.

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Motivation of patrol staff by provision of incentives enables them increase anti-poaching efforts which yields results. The quality of patrol using enforcement indicators makes it possible to compare standardized indicators for anti-poaching effectiveness between patrol teams and time period.

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The incentives of patrol staffs are core in the operation of effective anti-poaching patrols. According to Mesterton-Gibbons and Milner-Gulland (1998) cited by Ford (2005) patrol staff incurs an opportunity cost while patrolling and as such payment to the staff must exceed opportunity costs, to avert the tendency of corruption.

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In alike manner the costs to staff in conducting patrols can be greater than just the opportunity costs; for there is a risk to staff encountering armed poachers in some circumstances, they can become alienated from their community, for example in Zambia's Administrative Management Design for Game Management Areas (ADMADE) community wildlife project, in those areas if not with support of committed and effective unit leaders,residents accused staff for poaching, stealing, fighting, witchcraft and drunkenness as observed by Gibson and Marks (1995).

1.2. Research problem

Illegal hunting is one of the most serious problems faced by protected area managers in contemporary Ghana.

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Mole National Park the largest PA in the country faced persistent poaching and encroachment activities by the fringe communities. There are 29 communities fringing the park and who derive their livelihood directly or indirectly from resources of the park.

In Ghana as human populations in general around protected areas in particular is increasing, illegal activity will rise due to the increase demand for bush-meat for the external market and protein for the fringe communities.

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A better understandingthrougha study of trends and dynamics of poaching, the decision-making behavior of illegal hunters, as well as the temporal and spatial distribution of illegal activity will lead to improved strategies to deter poaching.

Some studies on monitoring illegal wildlife use and law enforcement were carried out in southern Africa. Only few studies had been done in West Africa, particularly in Ghana, where poaching activities differ from other parts of the continent where there is paucity of knowledge on the trends and dynamics of it..

Leader-Williams *et tal., (*1990) observed that offenders involved in the poaching of rhinos and elephants in Luangwa Valley were well-organized armed gangs and originated from areas outside.In contrast, offenders who hunt elephant and other larger mammals in Mole originated from fringe communities of the park .

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Law-enforcement monitoring was initiated in the late 1970s, in Kasungu National Park, Malawi (Bell, 1985). The same monitoring system was used in the central Luangwa Valley in Zambia, focusing on the penalty structure for wildlife offenders (Leader-Williams, 1996).

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In the early 1990s, the system was expanded and became more sophisticated, and was used to monitor all illegal activities and law enforcement in the central Luangwa Valley in Zambia (Jachmann, 1998; Bell *et al*,. 1992; Jachmann & Billiouw, 1997).

A similar system was introduced in protected areas in Ghana in 2004 . The focus was to upgrade existing law enforcement operations and to introduce adaptive management.

In Mole National Park, the history of law-enforcement monitoring shows many changes. In October 2004 the Management Information System (MIST) software program was introduced This system uses basic principles of quantifying patrol effort and encounters with illegal activity by means of the Global Positioning System (GPS). MIST was used as a visual tool for spatial analysis and spatial display of effort / illegal activities. Data gathered over years (2004-2008) had not been analysed to show trends and dynamics of poaching and effectivienes of the law enforcement system using MIST.Four years data is enough for a study of trends in all activities carried out by the law enforcement unit of the park during the period and urgent need for study to use the data.

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1.2 Justification for the study.

Many types of wildlife crimes have attracted the attention of sociologists and criminologists. However, despite the harm poaching has upon wildlife populations, social science researchers have devoted scant attention to the study of poaching and poachers(Elaison,2008). Investigation of the specific motivations for poaching is necessary for wildlife agencies to effectively address the problem by finding lasting solution to it. This study reviews literature on poaching and suggests strategies that will help refine our knowledge of the phenomenon.The study will also give specific directions for future research on what motivate individuals in fringe communities to poach and recommend possible solutions to addressed the issue of poaching.

Compared to other studies conducted in MNP,the ability of using poaching data to contribute to study of trend and dynamics of poaching appears to be poorly conducted and if even done,the majority of the published studies concentrated on law enforcement efforts whilst few studies dealt with conservation. MNP is renowed for its large mammals population has about 93 species of Ghana's known total of mammalspecies (Cletus 2003). Having been rated the best tourist attraction site ammongnt the protected areas in Ghana and aiding in the promotion of eco-tourism, poaching activities lead to reduction in mammal numbers and adversely affect tourist visitation and revenue.

Hence the study of poaching cannot easily be ingnored for if done it will add to knowledge on the status of mammal numbers in the park.This is important because dynamics of poaching over the years will give knowledge on pattern of increase or decrease of animal numbers.It is therefore essential that the trend and dynamis of poaching from the historical

poaching data dating 1992 to 2008 which the researcher contributed in gathering were analysed to show this.

Even though the main focus of this study was on trends and dynamics of poaching it was necessary to also look at what motivate poachers to indulge in poaching. Not much research in the area of factors that motivate poachers to poach in protected areas in Ghana has been carried out.

1.3. Research Objectives

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1.3.1. Overall Objective

The overall objective of this study was to illustrate the trends and dynamics of poaching by reviewing the existing Mole National Park law-enforcement monitoring systems (Wildlife Division Adaptive and MIST) to enable park management initiate new strategies to reduce illegal activity.

1.3.2. Specific Objectives

The specific objectives of this study were:

i. To identify the profile and motivational factors of poachers in Mole National Park.
ii. To evaluate the categories of illegal activities often committed by wildlife offenders in Mole National Park.
iii. To determine trends in prosecutions and convictions (penalties) per unit effort of law enforcement of wildlife offenders.
iv. To determine the trends in illegal activities in relation to patrol effort and abundance of large mammals in Mole National Park

v. To demonstrate how the Management Information System (MIST) depicts the temporal and spatial trend in distribution of illegal activities, patrol paths and animal sightings in Mole National Park.

1.4. Research Questions

The following research questions posed will be answered by this study:

i. What is the inspiring factor for poaching?
ii. What type of illegal activity do offenders engage in and where do they originate from?
iii. What is the trend in prosecutions over the years (2003-2008)?
iv. What are the relationships among illegal activities, patrol efforts and large mammals?
v. Is there a relationship between the spatial distribution of illegal activity (poachers arrested) and the origin of arrested poachers?

1.5. Hypothesis

The following hypothesis will be tested during the study.

Hypothesis 1

Ho: There is no relationship between poaching and the motivational factors of poaching.

Ha:There is a relationship between poaching and motivational factors of poaching.

Hypothesis 2

Ho: There is no difference in the frequency of poachers arrested within the categories of poaching offence.

Ha:There is a difference in the frequency of poachers arrested within the categories of poaching offence.

Hypothesis 3

Ho: Illegal activity does not affect patrol effort and mammal's abundance.

Ha: Illegal activity affect patrol effort and mammal's abundance.

1.6.Limitations

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Poaching in conservation areas in Ghana generally and in Mole National Park particularly, has always been a thorny issue to discuss with fringe communities members for it involves and affects their livelihoods. Therefore, people were reluctant in providing vital information necessary for the research.

Subjectivity of responses cannot be overlooked in a social research, particularly so when the subject of study, poaching, is known by most individuals within the fringe communities of Mole National Park that it is an illegal activity in the park and as such out of fear, arrested poachers'were not willing to give responses to questions that bothers on names of other people in the community also indulge in poaching and where they poach in the park.During the analysis it was obsevered that only few of the them gave response to this difficult question as one of them described it and as such little attention was given to it in order not to biased the study in this particular area.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1. Introduction

In the literature review, poaching, profile of arrested poachers, motivational factors of why they poach, trend in categories of illegal activities and penalties of wildlife poachers and the use of MIST to display temporal and spatial nature of illegal activities, patrol path and mammals encounters are reviewed.

2.2. Poaching

In the context of wildlife conservation and management, poaching is basically the illegal taking or possession of game, non-game, protected, threatened, or endangered species (Jachmann, 2004). According to him poaching are acts that violate the wildlife laws (hunting regulations) of Ghana. These are hunting wildlife with the aid of spotlight, during closed season, in forest reserve, or the killing of protected and endangered animals. For the purpose of categorizing the offences, acts that violates wildlife laws includes; the act of shooting, capturing, taking, injuring, lying in wait for, willfully disturbing, or molesting any wild animal or plant (wildlife),or any attempt to do so without permission. In a Protected Area it means illegally taking anything from inside it. Poaching is an old century rural practice, generally condoned by village society and is one of the major problems in wildlife conservation and management in most African Protected Areas (PAs).With human population increase around PAs, tropical ecosystems are under increasing pressure for bush meat supply to the surrounding local communities through traditional hunting and quota harvesting (Barve,2005)

Within the UK, game birds and fish are regularly poached and the USA is currently experiencing tremendous difficulties with illegal poaching in its 366 National Parks. More

than 100 species are particularly at risk, including the brown bear, bighorn sheep, elk, grey-banded king snake and various species of butterfly. Estimates suggest that at least 3000 American black bears are shot illegally every year; some to supply the black market traffic in animal parts for culinary or medicinal purposes. The size of poaching operations is astounding: 1994 estimates suggest that in the USA alone illegal killing of animals is worth more than $200 million per year (Van Biema, 1994).The global gloomy perspective of poaching has received attention in various forms: Public fora, regional meetings, and conferences. Law making and enforcement are some of the strategies to deal with the matter. Another strategy worth noting is the institution of awards to conservation heroes.

Jachmann (1998) categorized wildlife poaching into four as; subsistence gathering, subsistence hunting, commercial meat hunting, and commercial trophy hunting. These classes have varied impact on the wildlife resources. Subsistence gathering which involves gathering for household consumption purposes by majority of members of rural communities and does not have a major impact on the wildlife resources (Oppong, 2007; Jachmann 1998; Thorsell 1986).

Poaching which is a threat to many protected areas has been classified under three broad types as; subsistence, structured or commercial and 'Chopper' poaching.Subsistence poaching; where members of fringe communities of reserves where rhino's and wildl animals lived, used to poach animals, including rhino's, for their meat in order to feed their families and members of their community. For the rhino horn it is usefor traditional medicine (https://justinelenferna.wordpress.com/.Apr 22, 2013).

Structured or Commercial Poaching according to him is cause of most rhino's deaths.'. He described this type poachers to be involved in high risk criminal activities.The

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group size of of these poachers is 4 to 6 and are usually well organized and equipped with AK47's.These poachers are criminals which are involved in high risk criminal activities, like ATM bombings. These groups of poachers, consisting of 4 to 6 members a group are extremely organized, knowing the plan down to each second and are equipped with heavy equipment, like Ak47's.

The Chopper Poaching which is usually done by professionals by use of helicopters or small planes to fly over reserves and track the rhino's, where they then dart the rhino with an illegal subtances, which knocks the rhino out, allowing the poachers to approach and hack off the rhino's horn without a fight

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Subsistence hunting described as killing of wildlife for domestic uses such as meat and blood is the most widespread on the continent and often involves many members of the community. It is considered an essential part of the subsistence rural economy (Manyenye, 2008, Loishooki, 2006; Bell, 1986a;). Hunting in Africa was traditionally almost exclusively done for subsistence for several years and there are places today where the people only make game solely for subsistence (Bell, 1986b). There were traditional hunting rules, privileges and restrictions, which in part also served to conserve wildlife resources. These hunting rules largely became ineffective through colonization and western technology and through local population migration (Marks, 1984). Cleaver (1992) observed that the impact of traditional hunting on biodiversity is not yet quantified but is presumably very serious. In Zambia, most subsistence hunting is done with dogs, locally manufactured muzzle-loading guns, and snares mostly obtained from electrical conductors (Marks, 1989, Bell, 1986a).

Literature on hunting revealed that off reserve in rural areas harbours low densities of small game and little or no law enforcement and dogs are used to pursue animals such as

duiker, grysbok, bush pig, and warthog. On the contrary protected areas in rural settings harbours higher densities and greater varieties of game and wire snares are used to trap the animals (Fitzgibbon 1995).

Snaring has been noted to be the most destructive and indiscriminate way of killing wild animals. It is extremely difficult to control, since wires are usually available in large quantities, and it attract little attention from lawmakers (Oppong, 2007) . Wato *et al,* (2006) held the view that the traditional methods of wildlife hunting, like setting traps and snares are no longer sustainable as the reasons for hunting are largely moving from subsistence to commercial.

Three basic means of hunting widely occur in Protected Areas in Ghana and which are shooting, trapping and dogs, which are used in hunting small game as well as big game (Holbeck, 1998). Four other minor methods exist, that is catapult, use of fire, cutlass slaying and hand picking, which are mainly used in hunting smaller game and are often species specific (Aalangdon, 2005).

Commercial poaching which is a category of commercial large scale hunting involves hunting and capturing of live animals and sometimes involve extraction of derivatives and meat for trade (Manyenye, 2008). It is not as widespread as subsistence hunting, but sometimes constitutes a major industry, as in the Serengeti region of northern Tanzania (Campbell, 1989).Cleaver (1992) assessed the impact of traditional hunting on biodiversity and indicated that significant degradation of wildlife to supply urban centre's with bush meat affected large areas. He also emphasized that, the commercial bush meat trade is the most significant and immediate threat to the future of wildlife populations in Africa today, and could well lead to the loss of several species of animals (Oppong, 2007 ,Cleaver , 1992; de Klemm, 1991).

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In Ghana however, commercial hunting of large herbivores has never constituted a major industry, but small-scale commercial hunting of mainly bushbuck, duiker, antelopes and others (Oppong, 2007, Kasim, 2002; Hoffman, 1999; Ntiamoa-Baidu, 1998) has always taken place. Commercial trophy hunting encompasses such commercial hunting of elephants and rhino for high value, non-perishable commodities as ivory and rhino horn. This may be considered the most serious class of illegal hunting, firstly because it has caused the near extinction of black rhino and a drastic reduction in elephant numbers throughout the continent (Jachmann ,1998; Leader-Williams, 1996) . Three kinds of illegal wildlife use occur in Mole National Park that is subsistence hunting, commercial bush-meat hunting, and low levels of commercial trophy hunting for ivory. Commercial meat hunting mainly concerns large herbivores such as buffalo, roan antelope, waterbuck and hartebeest.

2.3. Degree of Poaching

Poaching is an unlawful practice in which an animal is hunted illegally mainly for food, subsistence and commercial reasons.Those who practice illegal hunting are known as poachers. Poaching is considered to be an illegal practice due to a number of reasons like the poacher is not a licensed hunter, the animal either belongs to category of endangered species or dwells in a restricted land (PA), the poacher does not have a legal right to hunt the animal, the means adopted by the poacher do not conform to the prescribed norms laid down by the concerned authorities and the animal is tagged beforehand for research purposes(www.bestindiansites.com 12/11/2010; Mesi, 2002; Bennet, 2001; Messer, 2000; Boshe, 1989; Chinzinga, 1986 and Bell, 1983).

The level of illegal activity is a principal indicator of the effectiveness of law-enforcement monitoring system in any protected area and as such it is imperative that the distribution and intensity of it is understood in order to respond to it (Hillman and Mesi,

2002; Jachmann, 1998; Leader-Williams, 1990; Boshe, 1989). A study carried out in 1997 showed that over-exploitation of the wildlife resources and destruction of habitats lead to the threat of wildlife in Africa (Browen-Jones and Penday, 1999). The global picture is that the number of bush meat consumers has increased by eight-fold since 1900 and currently represents an equally important conservation concern as growing global population is growing with corresponding increase in resource consumption (World Conservation Society (WCS), 1999). Poaching which is widespread activity has become a serious concern in India in the past few decades. Due to illegal wildlife trade, various species of birds and animals are on the verge of total extinction(www.bestindiansites.com ,12/11/2010).

Holbeck (1998) reporting the gloomy situation of Bia and Ankasa Conservation Areas, stated that a number of species especially monkeys, are now believed to be extinct in Bia and severely threatened in Ankasa. He also estimated that the total annual bush meat production ranges from, 3,200-3,800 tonnes for Ankasa Conservation Area valued at about $ 5 million and 5,200 tonnes in Bia also valued at $ 8 million respectively (Holbeck ,1998). Grainger (1994) quoting Mason (1993) observed that there is much unreliable evidence of poaching particularly of buffalo taking place throughout the Mole National Park (Grainger, 1994; Mason, 1993).

There is a very high dependency for bush meat by rural communities in Ghana. The wildlife regulations and laws are not respected by many people. Three decades ago, about 70% of Ghanaians ate bush meat but the quantity of bush meat has dwindled resulting in a bush meat crisis in the country (Aalangdon, 2005;Asibey, 1974) . The degree of wildlife poaching is worldwide in both on and off protected areas. In Ghana, many researchers have studied the phenomenon of bush meat trade that resulted from poaching especially in conservation areas and have come out with findings and recommendations which include the

introduction of alternative livelihood skills (Mason 1993 , Asibey ,1990; Amoah, 1977) and game farming. However, the alternative livelihood skills as mitigation to poaching recommended did not take into consideration the motivational factors of poaching, which is partly what this study is to address].

2.4. Profile and Motivational factors of poachers in Mole National Park

Poaching is one of the serious management problems that the Wildlife Division faces in Ghana. Although poaching around the study area is serious, there has not been much systematic data gathering attempts to appreciate the issue including understanding the poacher's decision –making process (motivational factors) and the dynamics of poaching around the area. The study therefore aims to undertake a social survey both informal and formal of arrested poachers and utilize the data gathered to understand poacher's *modus operandi* in the study area. This will help park management to effectively and tactically improve the existing law enforcement strategy to combat poaching.

Poachers have different motivations for what they do. Some kill illegally for food, others for strictly monetary profit. Some poach in order to secure what they consider to be valuable trophies. And a few individuals poach just for the adventure of seeing how many animals they can kill in a given time frame in competition with others (www.bestindiansites.com,12/11/2010). Loishooki and Tesha (2006) contended that people poach for several reasons, among others are people's believe that wildlife meat is better than livestock meat and has medicinal value while others does it as part of their culture as they have been hunting since time immemorial (Loishooki and Tesha 2006).

Marks (1979) in a study on hunting ecology of Bisa of the Luangwa Valley collected information on life history of hunters. The survey results which also included process of

training, kills and ceremonies after a kill revealed a profile of a subsistence hunter. He recognized four types of hunters in the Valley Bisa community as;*Chipumpi* or *bachibinda* as individuals do not use charms, *Bachibinda bamiti* as professional hunters who possess charms, *Nfundi wankomboyamipashi* as ancestral gourd hunters and *Bachibinda bawanga* or hunter sorcerers (Marks,1989 ;Marks,1984).

In a similar study of hunters in communities around Mole National Park a distinction was made between men who hunted occasionally and professional (possess magic or uses magic) hunters (Mason,1993).The two studies mentioned above focused on hunters in the communities. The limitations of interviewing hunters is that usually they consider themselves a mistreated group by wildlife authorities and as such getting information from them demand mutual understanding and respect which at times is difficult (Oppong, 2007).

2.4.1. Motivational Factors Influencing poaching-A Conceptual Framework

Few analytical frameworks have been used to study reasons for poaching.Poudyal (2005) used the conceptual model which is built on the factors that are hypothesized to influence the decision of poachers to indulge in poaching of the one-horned Indian Rhinoceros in Royal Chitwan National Park, Nepal. The model was based on a structure which looks into; effectiveness of anti-poaching measures that determine the probability of being caught and convicted, penalties when caught poaching and available economic alternatives among other factors.

Poaching which in general is an illegal activity in many forms can be studied under a similar incentive (or disincentive) structure. For the purpose of this study part of the questionnaire will focused on motivational factors that influence poachers to get involved in poaching, determine the trend of poaching in relation to these factors and possible factors that will reduce the level of poaching . The framework designed (Figure 3.13) that best fit

the study looks into (a) effectiveness of law enforcement effort (b) penalties (fines and prison sentences) when a poacher is caught poaching and (c) the abundance of large mammals as possible means that can reduce poaching.

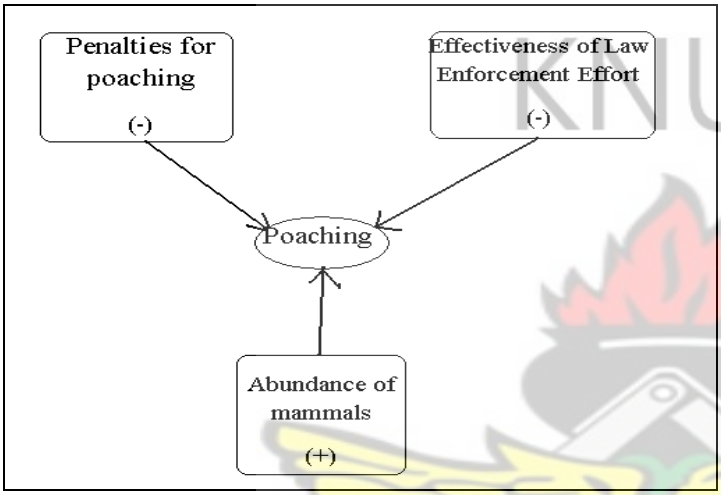

Figure 2.1. Motivational factors that influence poaching in Mole National Park(Adopted from Poudyl 2005).

The Figure 2.1 describes how motivational factors could influence poaching in Mole National Park by fringe communities. The frame work builds on the factors that are hypothesised to influence the decision to poach by local people and possible factors that can reduce poaching levels.

Functional Definitions of the Framework

Effectiveness of anti-poaching measures The effect of Anti-poaching activities with regards to patrol effort and its relation to reduction in illegal activities in a protected area.

Penalties	The punishment given to a poacher when captured and convicted in court. This includes fines, prison sentences or a combination of both. Trophies and equipment confiscated from the arrested poacher is often considered an additional penalty.
Abundance of mammals	The ease with which one can easily encounter mammals in a protected area. The abundance of mammals influences poaching in a park.
Protected areas	Predominantly natural areas established and managed in perpetuity through legal or customary regimes primarily for conservation of biological diversity and natural resources.

2.5. Categories of illegal activities often committed by wildlife offenders in Mole National Park.

The effective management of protected areas requires information about the many human impacts that threaten them (Hillman and Mesi, 2002).Understanding these impacts and how they vary over time and space enable managers to respond to them.

Illegal activity include any human signs that ranged from signs, such as sounds of gunshots, encounters with poachers, discovery of poachers camps, gin traps, snares etc. Jachmann, (1998) categorized illegal activity as *Serious offences* which directly relate to illegal killing of wildlife, *Minor offences*, which may or may not be related to poaching and Secondary offences which relate to a poacher arrested with firearms, trophies and snares (Jachmann, 1998) (Table 2.1).The table was constructed from information gathered during patrols used for monitoring purposes in LIRDP. Information on **Serious** and **Minor Offences** were collected in conservation areas where human being does not stay. Information on

Serious Offence alone is collected in conservation areas where people are resident. Secondary **Serious Offences** information were mainly items confiscated from arrested poachers such as firearms, trophies and snares **Encounters** in the field, includes information such as arrest and gunshots, whilst **Indicators** were information on indirect observation such as poachers camps and snares found in the field during patrols.

Table 2. 1 Classes of Serious,and Minor Offences used by Luangwa Integrated Resource Development Project (LIRDP) for monitoring of illegal activity in Central Luangwa Valley (adopted from Jachmann 1998)

SERIOUS OFFENCE ENCOUNTERS	SECONDARY SERIOUS OFFENCE	MINOR OFFENCE
Arrest of Poachers	Firearms Confiscated	
Poachers Observed	Ivory Confiscated	
Gunshots Heard	Skins Confiscated	
	Snares Confiscated	
INDICATORS		
Poachers' Camps Found		Fishing
Elephants Found Killed		Tree Cutting
Other Animals Found Killed		Burning
Snares Found		Motor Tracks
		Foot Prints

In Mole National Park, illegal activities recorded by patrol staff are distinguished as *Serious Offences*, those that directly relate to the illegal killing of wildlife and, *Minor Offences*, those that may or may not be related to poaching (Jachmann, 2007; Jachmann, 2006; Jachmann, 1998; Grainger, 1994; Mason, 1993;).

2.6. Trends in prosecutions and convictions (penalties) of wildlife offenders in Mole National Park.

Law enforcement is the most visible function of the Protected Area management. This single activity engages most of the staff. Between 80 and 90 percent of the department's

personnel work is anti-poaching activities and enforcement (Marks, 1984). Law-Enforcement Monitoring (LEM) by definition is a standardized method to register and report what is seen and done during protected-area patrols in a protected area (Hillman and Mesi, 2002). Patrolling involve routine inspection inside the park, checking the boundaries, sometimes patrolling outside the park, and visiting local villages bordering the park.

The law enforcement unit in any protected area deals with the following different aspects of security issues: Wildlife Protection, Intelligence Gathering, Investigation, Prosecution and Convictions (Wildlife Division, 2009). This involves the regulation of human activity in relation to wildlife and other resources in the best interest of society. In the early 1980s, a study on wildlife related offences was carried out in Luangwa Valley, Zambia (Leader-Williams, 1990). The main objectives of the above study were to determine whether minimum sentences laid down in law were being upheld, and if commercial elephant and rhino poaching was being differentiated from other types of illegal activity (Leader-Williams, 1996). An analysis of prosecutions in the central Luangwa Valley revealed that the level of deterrence of law-enforcement is a function of both the probability of arrest by scouts and the penalty expected for the offence (Boshe, 1989; Campbell, 1989). From analysis of sentences given to wildlife offenders Leader-Williams *et al.* (1990) determined the extent to which Zambia upheld its own wildlife laws. The results of the analysis showed that anti-poaching efforts were not helped by magistrates (courts) who misinterpreted the intentions of their country's own wildlife laws (Leader-Williams, 1990; Bell, 1986b). To augment knowledge in the above mentioned earlier studies, the current study is to monitor whether the penalties given to wildlife offenders are geared to the seriousness of the offence or the conservation value of the species and also determine whether penalties meted to poachers are deterrent enough to reduce poacher's incentive to poach.

All Protected Areas in Ghana are facing the problem of illegal hunting and trade in bush meat and wildlife products. Therefore, as an important aspect of wildlife management, it is important to ensure effective law enforcement so that the wildlife numbers increase. As such anybody suspected of committing a wildlife crime is subjected to arrest and prosecution. The Wild Animals Preservation Act of 1961 (Act 43), Section 8, empowers Wildlife Officers to arrest without warrant, any person suspected to be concerned with any offence punishable under the provisions of the Act. Wildlife Officers are therefore by law enabled to effect arrest of people suspected of any wildlife offences (Wildlife Division, 2009).

In Mole National Park arrested poachers suspected to have contravened the wildlife laws and regulations are investigated and prosecuted in a law court of competent jurisdiction with the field staff acting as witnesses. Mole National Park falls within Wa, Tamale, Bole and Damongo court of jurisdictions. This means that offenders arrested in the park have to appear in court in the district where they were arrested. Most often it is not the case because of difficulty in relating the locus of arrest to the district of jurisdiction. For this study most of the offenders were tried in Tamale and Damongo courts.

When it is established that an offence is committed by the suspect(s) then the relevant sections of the Wildlife Laws and regulations are used to prefer the appropriate charges against the suspect(Wildlife Division 2009). Wildlife offences are charged under the headings:

1. Unlawful entry into the park contrary to section 2 (a) of Wildlife Reserve Regulation LI 710 of 1971 as amended by LI 1283 of 1983.

2. Bringing into a reserve and using equipment (firearms, cutlass, snares, gin traps etc) capable of being used to destroy animals and plants contrary to section 3 (b) of Wildlife Reserves Regulations LI 710 of 1971 as amended by 1283 of 1983.
3. Destroying animals (species) inside a Wildlife Protected area contrary to section 3 (b) of Wildlife Reserve Regulation LI 710 of 1971 as amended by LI 1283 of 1983.
4. Hunting, capturing and destroying animals during the 'Close Season' contrary to section 3 of the Wildlife Conservation Regulations, I 685 of 1971 as amended by LI 1284 of 1983.
5. Hunting without a Game Licence, contrary to section 6 (1) b of Wildlife Conservation Regulations LI 685 of 1971 as amended by 1283 of 1983.
6. Hunting in a group contrary to section 5 of Wildlife Conservation (Amendment) Regulations LI 710 of 1971 as amended by LI 1452 of 1988.(Wildlife Division 2002)

2.6.1. Penalties when a poacher is arrested

Penalties imposed on arrested poachers is one of the factors that affect the level of poaching in a protected area. Penalties could either be fines, prison sentences or combination of both; confiscation of equipment (firearms) and trophies are often considered additional to the penalties faced by the poachers (Poudyal, 2005; Milner-Gulland 1992). The notion that an increase in penalties theoretically will reduce a poacher incentive to poach upheld by early scholars in the study of poaching seem to be mixed in this regard. The mixture in opinions to a large extend is attributed to the nature of penalty. Penalty does not constitute monetary fines but also prison sentences, administering a penalty that comprises a fine or a prison sentence or a mixture of both has a very different effect on a poacher's behavior (Leader-Williams 1993 ; Clarke 1993; Cleaver 1992; Milner-Gulland 1992; Chinzinga 1986; Morse 1980).

Clarke *et al* (1993) looked into a penalty structure that constitutes only fines, in their study of illegal logging in developing countries they pointed out that while higher fines might have a deterrent effect when poachers make a decision about whether to poach or not, the level of poaching itself depend on the marginal net benefits from poaching and hence on the marginal fines. Leader –Williams and Milner-Gulland (1993) on the other hand stated that due to poverty, fines are likely to deter local poachers from poaching elephants and rhinos and opined that too high a penalty could exacerbate poaching instead of reducing it. Penalties that constitute a prison sentence provide a different incentive (or disincentive) structure to poachers(Leader-Williams, 1993). Poudyal (2002) is of the view that the real penalty structures governing wildlife conservation in most countries are mixture of fines and prison sentences and that when characteristics of these two come into play determines the behavior of poachers.

In Mole National Park judgments of poaching cases are available at Tamale and Damongo Courts. Prosecution and convictions were distinguished as fines, prison sentence, others and pending. Court fines range from thirty Ghana cedis to six hundred Ghana cedis whilst prison sentence range from 3 months to 108 months.

2.7. Trends in illegal activities in relation to patrol effort and abundance of large mammals in Mole National Park.

Poaching in protected areas leads to decline in animal numbers, in order to avert this situation staff in Protected Area routinely patrol the area to enforce the wildlife laws and also to deter offenders. The fundamental activity for patrols in any law enforcement monitoring system is the standardized collection of indicators of illegalactivity and law enforcement, such as the discovery of poachers' camps or encounters with thepoachers themselves. However, such information is relatively useless without some measure of thepatrol effort

required to collect these data. Patrol effort must therefore be the cornerstone of any law-enforcement monitoring system (Hillman and Mesi, 2002).

It is a general perception that poachers change their behavior and decision to evade the probability of being detected and arrested. The probability of detection to a large extend depends on the level and effectiveness of the patrol effort put in by the anti-poaching unit.A number of studies have looked into the effect of the level of enforcement of the poaching of wildlife, most notably in African context (Jachmann, 1997; Milner-Gulland, 1993; Milner-Gulland, 1992; Leader-Williams,*et al* 1990). Leader-Williams *et al.* (1990) in the study of poaching of black rhino and elephant in the Luangwa Valley (Zambia) found that an increase patrol effort reduced illegal activities within the protected area, which in turn reduced the decline in rhino and elephant populations. A more recent study of monitoring law enforcement illegal activities, patrol effort, staff performance and wildlife trends in nine protected areas in Ghana which includes Mole National Park looked at the law enforcement effort with regards to encounters with illegal activities and mammal encounters, resource allocation to enforcement budget etc. The study concluded that the success in reducing encounters with illegal activities is due to increased level of enforcement (i.e. manpower and budget) and also due to effectiveness in enforcement (Jachmann, 2008; Jachmann, 2006; Jachmann 2004).That is increase in patrol effort reduces encounters with illegal activity with a corresponding increase in wildlife numbers.

In order to monitor trend in illegal activities and abundance of large mammals during a particular period or in particular area with that of another period or area , patrol effort is used to differentiate between encounters. Catch per Effort (C/E) is used as an index in law-enforcement monitoring system (Jachmann, 1998; Bell, 1985; Bell, 1983). Catch refers to

encounters with illegal activity and mammals, and the effort is the amount of time spent patrolling by a particular number of officers, or alternatively, the distance covered by a particular number of field staff (Jachmann, 2006).The technique of C/E measuring law-enforcement effort was first developed by Bell (1983). It underwent considerable review by Jachmann (1998) and used in the study of law enforcement monitoring system in most Protected Areas in Africa.

2.8. Temporal and Spatial distribution of illegal activity in relation to patrol path and animal sightings in Mole National Park.

Spatial patterns of illegal activities and corresponding data from the field have been used to identify those areas in the PA where anti-poaching patrols are urgently needed. On the other hand threats to PAs can be very dynamic over time and as such data from the field patrols allows PA managers to track temporal changes in illegal activities over time and respond to these changes (Hillman and Mesi, 2002).

2.8.1. Management information system (MIST)

MIST is a spatial Management Information System designed to service protected area and park management needs. It is undergoing development by Ecological Software Solutions since 1977 initially for Uganda Wildlife Authority (UWA) as part of a GTZ (German Technical Cooperation) project (http://www.ecostats.com/software/mist). It is developed as a user-friendly client/server application program.

MIST is a computer program which has been specially designed for wildlife patrols and is easy to use. It is a relatively simple GIS system for displaying and analyzing data that has been gathered by Wildlife Guards on patrol.

MIST is information systems convert data from internal and external sources into information and communicate that information, in an appropriate form, to managers at all levels in all functions to enable them make timely and effective decisions for planning, directing and controlling the activities for which they are responsible (Lucey, 1997).The software provides one of the new methods employed to improve protected area management and it has proven to be reliable. MIST is a spatially enabled information system aimed at assisting decision-making in protected area management at all levels (Nuwamanya, 2009).That is to say amongst other studies using Arc View, Arc GIS etc. MIST is designed to generate maps and reports of patrol coverage, wildlife observations, and distribution of illegal activities etc. It combines data entry and analysis of information collected in parks and protected areas, the majority of which consists of geo-referenced point observations.

Initially MIST was developed for UWA with funding from the GTZ (German Technical Cooperation). MIST is currently used in Uganda, Ghana, Rwanda, the Democratic Republic of Congo and several countries in South East Asia.It has since been roll-out in four PAs which includes; Kyabobo NP, Kakum NP, Bia and Ankasa Conservation Areas.

2.8.2 Types of reports generated by Management information system (MIST)

MIST-GIS is a component of the MIST software which has the mapping interface with data entry and analysis. The interface has the capabilities to convert data into information such as reports and maps.It can easily create standard and periodic (monthly, quarterly, yearly, From...To etc.) reports right after data entry. Data and information are often used interchangeably but in the context of information management they have distinct meanings: data are the facts which have been recorded and information is the processed data (Lucey, 1997). Data is gathered during patrols (illegal activities, ecological data) by GPS and

recorded on data sheet. On the other hand information is the analyzed data processed by the soft ware in terms of maps, tables and reports. The reports use data entered to do effort and location analyses of human and animal signs. Report wizard or query wizard analysis tools are employed to create reports. The law enforcement unit at Mole National Park since the introduction of MIST generated some reports and maps as show (Figure 2.a. & b from law enforcement unit).

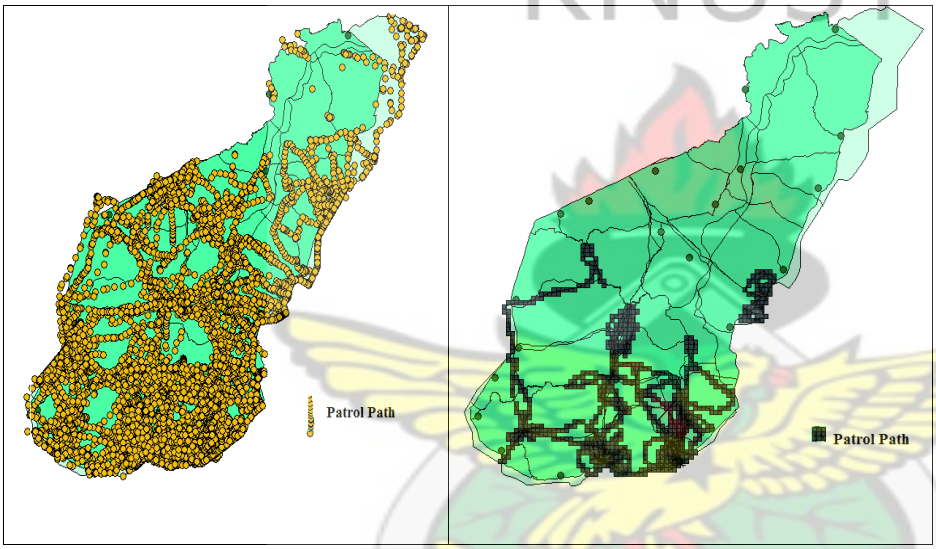

Figure 2.2b. MIST Patrol Path.Figure 2.2a. MIST Patrol Areas.

2.9. Law Enforcement Operations.

The law enforcement unit has 61 men (effective patrol men) to patrol about 5,000 km^2 (or almost 100 km^2 per man per day).In order to deploy these men to efficiently cover the park there is regular patrolling system in place (Appendix 7).There are 4 Range Camps – the HQ/Samole range in the south-east, Jang in the south-west, Ducie in the west and Bawena in the east. Each range has sectors they are to patrol (Fig. 3.11.).It is clear from the below map that the task facing the staff at Bawena (and to a lesser extent Ducie) is more difficult than

the others. From Bawena to the northern end of the park is about 66 kms, and the land is very hilly, while the distance from Jang to the furthest point of their range is 27kms. The situation for Bawena is made worse by the condition of the track along the eastern boundary of the park and the great difficulty of crossing some rivers in the rains. The worst problems are between Polzen and Kparia.

The above problem had been solved by the construction of a sub range camp at Kparia (in the north) in the Bawena range in early 2008. Ten (10) Satellite camps are constructed and distributed as follows; 3 in Bawena, 2 in Jang, 4 in HQ/Samole and 2 in Ducie. They are used for extended patrols and are designed to make the staff comfortable after a hard day's work. The Range System and the satellite camps are used to ensure effective ground coverage. The sectors are used to check that all areas of the park are covered regularly.

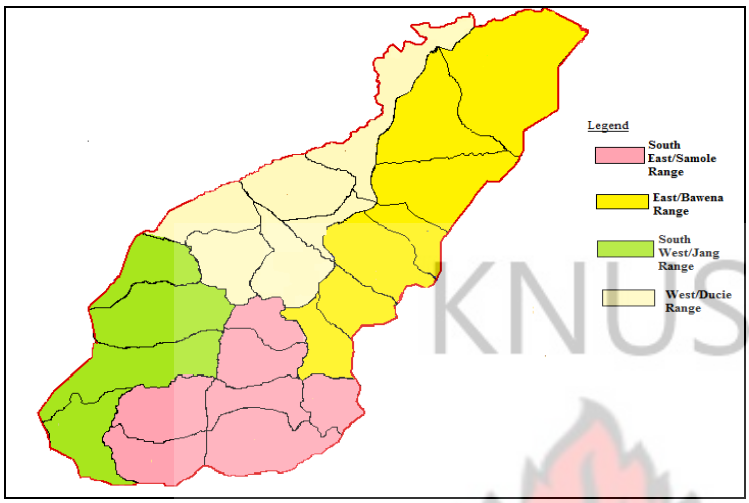

Figure 2.3.Mole National Park-Range System and Patrolling Sectors(LEU of MNP 2004).

During patrols staff record all illegal activities encountered, animal sightings and carcasses found. However, to enable comparison between periods, these observations are based on patrol effort (Appendix 1).

2.9.1. Illegal Activity

Analysis of law enforcement data with MIST has proven to be reliable tool, for it allows better deployment of patrols, the collation of intelligence, and an assessment of the effectiveness of the patrols used in curbing poaching. Data gathering involve field staffs that are trained to record observations made while on patrol. They record all information on actual encounters with poachers such as poachers observed or arrested and indicators of illegal activities such as poachers' camps found, poached carcasses, active snares/gin traps and gunshots heard. Spatial precision of the recordings was enhanced with the use of the global positioning system (GPS). A standardized patrol form for each conventional patrol, had in it the general information on the patrol, information on animal sightings and carcasses,

encounters with illegal activity or indicators of it, and information relating to the patrol route/path followed.(Mushenzi, 2004; Nuwamanya, 2009)

Patrol staff in Mole National Park record classes of illegal activity and relate this to patrol effort which makes it possible to assess areas/ranges are most affected in terms quantities of the number of encounters with illegal activities. The above information enable park management to direct law-enforcement effort towards priority areas and also enhance the evaluation of trends in illegal activity and animal sightings in relation to different effort. The patrol teams usually apply tactics and pay attention to thoughts about how they can be smarter than the poachers. From intelligence reports gathered over the years it has been found that *"Much of the poaching in Mole NP takes place at night using carbide lamps and battery torch-lights"* so patrols are also active at night when staff listen for sound of shots so that they will know where to go the next day. Patrol staffs are trained militarily and are armed during patrols. They are the key to achieving WD's core business of wildlife protection and are therefore well equipped, well housed and well managed(Balangtaa and Mackie, 2005). As part of the standard procedures every day activity start with a muster parade at each range camp and park headquarters (Fig.12, Appendix 3).

Figure 2.4. Wildlife Guards on parade at MNP HQ (Law Enforcement Unit MNP 2005).

To enhance effective communication patrol, staffs are well equipped with VHF radios. There are 22 radios distributed as follows; 4 in each Range and 6 at HQ plus 4 in vehicles. There is one sub-station at each range HQs(Balangtaa and Mackie, 2005).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1. Description of the Study Area

3.1.1. The Study Area

Mole National Park is Ghana's largest National Park and covers about 4,577 km². It is the only one with visitor accommodation facilities. The park is situated in the Northern Region and includes parts of West Gonja, Sawla-Tuna-Kalaba, Wa East and West Mampurusi Districts. It lies between 9º 11'and 10º 10' N, and between 1º22' and 2º13' W, between Wa and Tamale. It is surrounded by 27 villages. Mole National Park harbours 93 species of mammals, over 304 species of birds, 9 species of Amphibians and 33 reptile species (Wildlife Division, 2005; Aberdeen University Expedition reports, 1974-1978)

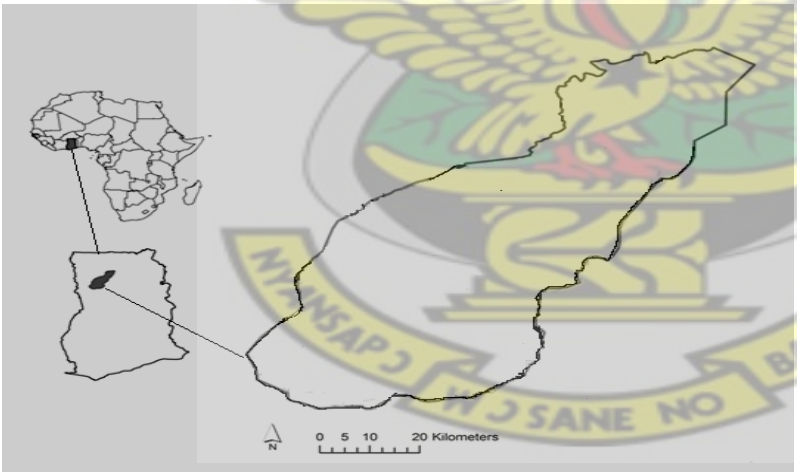

Figure 3.1.Map of Mole National Park(Wildlife Division, 2005)].

3.1.2. Choice of the study area

The study area was chosen based on the following criteria:

i. Mole National Park (MNP) one of the protected areas in Ghana with the highest density of large mammals which are persistently poached.

ii. The farming system of the communities around MNP is rain fed. During the dry season which is also a period of open season for hunting, farm work is completed and most of the farmers engage in hunting in the park. Dry season is a period between October –April and marked as the peak (March) season of poaching.

iii. The period of the study coincided with the introduction of a GIS based law enforcement monitoring system (MIST) and the WD Adaptive Management monitoring in MNP. Prior to the two monitoring systems law enforcement activities before 2004 were ad hoc and not cost effective and as such study of trend and dynamic of poaching in the context of law enforcement is of paramount importance.

The above characteristics of MNP, is evident that knowledge regarding trends and dynamics of poaching will be extremely important for devising anti-poaching measures that are more effective in deterring poachers. The study will also contribute significantly in enhancing the conservation of flagship species (elephant) and other wildlife species in the park.

3.1.3. Vegetation

The Mole National Park is situated in the fairly undisturbed Guinea Savannah (figure 3.2).

Figure 3.2. The savannah woodland in Mole National Park (Picture taken by C.Balangtaa, 2005).

The vegetation of Mole National Park can be grouped into eight broad vegetation types, as described below and shown in figure 3.3. Their distribution is mainly determined by soil depth and drainage (Schmitt K and Adu-Nsiah 1993).

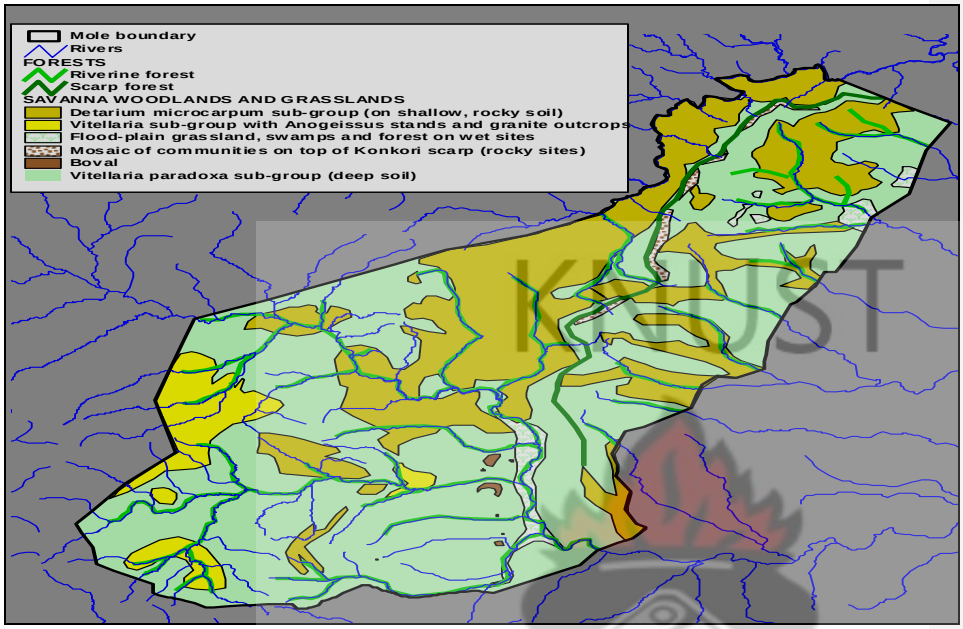

Figure 3.3. Vegetation map of Mole National Park (Wildlife Division,2005).

The most important vegetation types comprise a combination of **open savannah woodland** dominated by:

- *Burkea - Terminalia* savanna woodland with *Vitellaria paradoxa*(the shea-nut tree)
- *Burkea - Terminalia* savanna woodland with *Detarium microcarpum* confined to shallow and rocky soils
- *Anogeissus* with *Vitellaria paradoxa* found on the granite outcrops andwith grasses that can reach 3m during the rainy season.

Burning plays an integral part in the maintenance of this vegetation, **boval** dominated by *Loudetiopsis kerstingii - Polycarpaea tenuifolia* community with short grassland which are found on areas with shallow soils and iron pans, and **riverine forest** found along most of the rivers in the park. It often forms bands of generally dense and species-rich forests of up to

38m in height. The width of these bands varies from a few metres to more than 100m on either side of the river and is mainly determined by topography and geology. Other plant communities, such as swamps and flood-plain grasslands, cover only small areas. Most of the 742 plant species found in Mole are widespread throughout the savanna zone. However, the species of conservation value (4 endemic, 12 disjunct and 24 species which are rare or have a very limited distribution) is relatively high. Their abundance is generally low and they are often confined to small areas (Wildlife Division, 2005; Grainger, 1994; Schmitt and Adu-Nsiah,1993).

3.1.4. Major Wildlife Species

Mole National Park provides habitat for a large diversity of fauna. The large mammals that are commonly seen in Mole include elephant, kob, waterbuck, bushbuck, warthog, hartebeest, roan antelope, buffalo, duiker, oribi, baboon, patas monkey, and green (vervet) monkey. Carnivore's common in the park includes the spotted hyena, leopard, jackal, African civet, caracal, Gambian mongoose, Marsh mongoose, White-tailed mongoose, and Large-Spotted genet. Figure 3.4, 3.5, 3.6, 3.7, 3.8 &3.9 shows common mammals in Mole National Park (Balangtaa,2005; Burton, 2010).

Figure 3.4. Roan Antelopes (a) & Kobs (b) grazing in Mole National Park.

Figure 3.5.Territorial male Kob (a)& Warthogs (b) in Mole National Park.

Figure 3.6. Roan Antelope (a)& Hartebeest (b) in Mole National Park.

Figure 3.7. Waterbucks (a)& Buffaloes (b) in Mole National Park.

Figure 3.8. Leopard (a) & Spotted Hyena (b) in Mole National Park.

Figure 3.9. Elephants grazing in Mole National Park.

The birds of Mole National Park have been studied quite thoroughly and the report by Dowsett (2005) provides a full checklist and details of their occurrence and preferred habitats. There are at least 344 different species of birds to be seen in Mole and although there are no endemics, it is a good destination for bird-watchers. Some birds are so spectacular e.g., carmine bee-eater and saddle - billed stork, which ordinary tourists like to,

see. Some tour-operators that specialize in birds are already organizing visits to Mole for groups of birders. Mole's extensive bird list confirms the extremely important status of the park for the preservation of savanna environments; indeed, Mole is the single most important site in the country for the conservation of Guinea-Sudanian biome species (all 37 species recorded in Ghana are in Mole(Wildlife Division, 2005; Dowsett-Lemaire, 2005).The Nile crocodile is common in the dams near the motel and in the rivers, and the slender snouted crocodile also occurs. Mole also harbours butterflies. The best season is probably late May and early June is best for butterfly observation. Fifty-six (56) species have been observed including the only recorded sighting in West Africa for *Anthene talboti* which is normally confined to East Africa(Wildlife Division, 2005; Leaché, 2005; Dowsett-Lemaire, 2005; Wilson, 1993)

3.1.5 Soil and Geology

The soils of Mole are mostly plinthic ferrisols in the south and rhodic nitisols in the north. Ferrisols often develop a hardened layer at a depth of 0.2-1.2 m. Iron pan or laterite outcrops are the result of the exposure of iron-rich horizons. All soil types have low fertility and are very susceptible to erosion and are generally unsuitable for agriculture (Grainger, 1994; Wildlife Division, 2005).The western part of the park consists mainly of Lower Birimian schists from the middle Pre-Cambrian era which are more than 2000 million years old. Granitic rocks around 1800 to 2100 million years old were intruded into the schists, and form a band along the western boundary. In the eastern half of the Park the sandstones, shales and mudstones of the Voltaian System were deposited by a shallow sea in the Palaeozoic era (Wildlife Division, 2005).

3.1.6. Climate

The average annual rainfall is about 1100 mm, decreasing to 1000 mm in the north of

the park. More than 90% of the rain falls in the rainy season from April to October, with peaks in July and September. The dry season lasts from November to March.

The mean annual temperature of 28°C varies from 26°C in December to 31°C in March. The average range from day to night is 13°C. It can be unpleasantly hot in March and April, with temperatures sometimes in the 40°s. The Harmattan - the dry wind from the Sahara – may blow during December to February bringing dusty, hazy weather. The relative humidity reaches 90% at night in the rains and falls to about 70% in the afternoons. In the dry season, the figures are 50% and 20% respectively(Jachmann, 2008; Wildlife Division, 2005;).

3.1.7. Topography

The topography is mostly fairly flat, with the narrow Konkori Escarpment running north-south (Fig.3.10). The elevation ranges from 120 to 490 metres above sea level (a.s.l.). Most of the rivers are seasonal and drain into the White Volta. It is thought that the conditions may be getting drier - for example the Asibey pool used to be perennial but has been drying up for the last few years(Bouché2002; *Balangtaa*2005; Division 2005; Jachmann 2008).

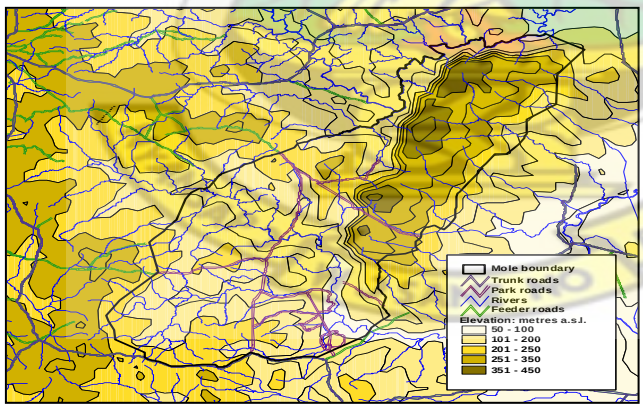

Figure 3.10. Topography of Mole National Park(Wildlife Division,2005).

3.1.8. Management

Mole National Park is in Category II in the IUCN system of protected area classification(Mackinnon,1982). Mole is the best park for wildlife viewing in Ghana but poaching must be controlled to allow animal numbers to increase. It was legally gazetted as National Park in 1971 under the Wildlife Reserve Regulations (LI 710) and its area was enlarged to 4,554 km^2 by extending the boundaries north to the Kulpawn River and eastward over the Konkori escarpment. In 1992 the Park was further enlarged to its present size of about 4,663 km^2 with the addition of the Gbantala triangle.

Between 1979 and 1985 the park experienced considerable problems owing to Ghana's severe economic decline. Infrastructure was neglected and poaching was virtually uncontrolled. In 1993 and 1994 a team funded by IUCN produced the first management plan for the park, following a series of studies and surveys into the socio-economic situation of the surrounding communities, the wildlife and the vegetation of the park (Wildlife Division, 2002 Grainger, 1994; Mason, 1993).

Mole benefited from infrastructural development and management support under the Dutch-funded Wildlife Division Support Project (WDSP). This five-year, 10 million Euro project began in 2001 and the major achievements from the project are outlined below:

- Park management infrastructure development – e.g. building of roads, bridges and range camps, installation of water and electricity services, improvement of airstrip,
- Improvement in resource protection – strengthening of anti-poaching activities including the range system of law enforcement and community initiatives,
- Development of basic tourism infrastructure – e.g. picnic/camp sites, tented camp, entrance gate, interpretation facilities, signage, game-viewing hides,

- Development of planning and park management systems – e.g. park management planning, financial, administrative and human resource management systems,
- Aerial surveys of the wildlife and the establishment of the MIST system for monitoring patrols and wildlife distribution
- Staff training and capacity building – training of all field and administrative staff,
- Institutional reform – restructuring of the entire Wildlife Division to transform it into a modern service- and commercially-oriented state wildlife conservation organization (Wildlife Division, 2002; Grainger, 1994; Mason, 1993).

With the tremendous development received from WDSP as mentioned above Mole National Park embarked on an effective way of managing the wildlife by implementing an effective law enforcement strategy so that animal numbers can increase. A pragmatic t burning regime has been put in place so that the herbivores have reasonable conditions of food availability in the dry season.

3.1.8.2. Collaborative Management

Mole National Park has 29 communities and about 22,000 people living around its boundaries. These people depend mainly on farming and hunting for their livelihoods. The Gbantala people were compensated when they were moved out of the park in 1992, but most were moved in 1962, before gazettement and their situation is more uncertain. Some people still have hard feelings about Mole National Park because, they say:

- Some animals (especially elephants) come out of the park and damage their crops
- They are not allowed to enter the park to harvest various natural products, such as Dawadawa fruit, Shea nuts, grass for brooms and thatching, firewood, grazing for livestock, land for farming, bush meat and fish;

- They get no benefits from the park
- They have lost farmland to the park;

In an effort to try to address such issues the Wildlife Division has devised and is actively implementing the Collaborative Management Policy.The Division now has a Collaborative Resource Management Policy, and Mole National Park has been one of the first parks to implement the PAMAU and CREMA concepts. A PAMAU (Protected Area Management Advisory Unit) covers one administrative district. The PAMAU is made up of Wildlife Division, District Assembly and Traditional Authority representatives. The PAMAUs should give advice to the Park, especially on management and community outreach issues. The CREMA (Community Resource Management Area) is a geographically defined area (normally just outside the park) with sufficient resources where communities have organized themselves to use resources sustainably (Grainger 1994; Ministry of Lands 1994; Division 2005).

Collaboration is beginning to make progress, but there is still lack of appreciation by some people. It must be accepted that change sometimes takes a long time to give benefits. As part of implementing the community use of resources in the park policy, community's members are allowed to collect /harvest various plant products that they might like to collect. The products that are harvested include: Shea nut (*Vitellaria paradoxa)* ,thatching grass (various spp), dawa-dawa (*Parkia biglobosa),* grass for brooms, various medicinal plants and firewood (dead and fallen only)((WDSP). 2004).

3.2. Methods

3.2.1. Data collection procedures

3.2.1.1. The Study Design

The study involvesanalysis of data from law enforcement database. The researcher at the time of this study was the officer in-charge of Law Enforcement in the park. Deployment, monitoring of staff, processing of arrested wildlife offenders for prosecution in court and collation of patrol reports were the major duties carried out by the researcher. Both quantitative (data on arrested poachers which assume numerical values e.g., ages of poachers arrested, number of poachers arrested in a month or year etc.) and qualitative (data on arrested poachers which assume non-numerical values, that is those that are classified into one of a group of categories e.g. motivations for poaching, hunting group size and poaching duration etc.,) methods of data collection were applied. This was because no single study method was sufficient for data collection and analysis for the topic of study.

3.2.1.2. Sources of Data

Data was gathered from both primary and secondary sources.

3.2.1.2.1. Primary Source

Primary data source constitutes data collected in its original form from the field by the researcher. This includes downloading of global positioning system (GPS) coordinates from patrols and entering the data into the MIST database. Data collection involved taking pictures of arrested poachers, one-on-one interviews with the arrested poachers and questionnaire administration.

3.2.1.2.2. Secondary source

The investigator visited various courts that handled wildlife related cases and recorded information on type of offence and the fine or prisons terms meted to poachers. The study also reviewed the past and contemporary authorities, who have researched into wildlife crime, law enforcement monitoring systems in protected areas.

3.2.1.3. Target Population

The study covered 204 arrested poachers in Mole National Park during the study period. A casual interview with few arrested poachers gave an insight to poacher's behaviour and this contributed in the design of the questionnaire.

Arrested poachers were interviewed using a style that allows for the interview to follow the interests of the poachers. This was done using open-ended and close-ended questionnaires. The liker –scale type of questions embodied in the questionnaires helped to obtain a picture of the profile of poachers and motivation for poaching. Categorical and numerical type of questions in the questionnaire covered the social, occupation, type of animal killed, type of wildlife regulation violated, time of arrest in relation to the lunar cycle, economic and demographic background of the poachers.

3.3. Data analysis procedures

This study used law enforcement secondary data to determine the trends in poaching in Mole. The assumptions were that the relationship between the law enforcement patrol effort and encounters with illegal and wildlife data were reliable and being true accounts of the patrol activities (Jachmann 2008). He contended that patrol data faces the problem of omission attributed to high vegetation density and rainfall in the wet season that may limit visibility and accessibility to certain areas of the park by patrolled teams. The inability for

patrols to cover the entire park within certain period of the year resulted in omission in no or low encounters with wildlife and illegal activities.

Statistical software-SPSS frequency, cross tabulation and other descriptive statistics procedures were used to analyze the responses from the arrested poacher's data to obtain trends: in number of poachers arrested, age class, occupation, time of day of poaching, relation of arrest of poachers to the lunar cycle, ownership of fire arm, areas in the park where poaching is commonly done, market out lets for bush meat, hunting group size poaching duration and arrested poachers origin.

3.3.1. Profile and motivation factors of poachers

The statistical software – SPSS was used to analyze the arrested poachers' data (2003-2008) to obtain profile of the poachers. To show a temporal pattern of poaching events (incidences) in the park from the poaching data, a graphical presentation which relate incidence and poachers arrested was constructed using Microsoft excel.

Trends of poachers arrested over the years (2003-2008) from the poaching data represented separate measurements and as such a scatter chart was constructed and a trend/regression type of polynomial of order three was used to explain the model. SPSS offers a wide variety of charts which are useful in exploring and summarizing data and as such was used to analyze the responses to the questionnaire administered to the arrested poacher's .

The analytical software tool of SPSS was used to describe the data by way of summarized frequency tables, charts and other descriptive statistics of the data as well. Basically the frequencies procedure provided the statistics and graphical displays of some of the variables in the arrested poacher's data. That is the procedure is useful for obtaining

summaries of individual variables measured at nominal, ordinal and scale levels. A frequency table shows the precise frequency of each category of a variable. Frequency tables were used to describe variables such as; occupation of the arrested poachers, proportion of poachers arrested within the patrol sectors of the park and origin of poachers arrested in the park.

A bar chart displays the count for each distinct value or category as a separate bar, allowing one to compare categories in any data visually. Simple bar charts were used to describe some of the variables such as; age of poacher, time of poaching, ownership of firearms, bush meat markets and hunting group size. The bars represented different categories of the variables.

Clustered chart was used to describe the relationship between arrested poachers age class and their occupation. The difference between this type of chart and a simple bar chart is that you can categorize levels of one variable within the categories of a second variable in the former, rather than within a functionof the secondvariable as in simple barcharts. In the example above the clustered bar chart was used to break down further the poachers age class scores according to both occupation and the number of poachers arrested.

A pie chart is a good visual tool for assessing the relative frequencies of each category in a data. A pie chart was used to graphically display the distributions of motivational factors of poaching as was gathered from the arrested poachers.

Multiple regression analyses were used to assess the factors that motivate poaching by poachers arrested during the study period. In this case the statistics package StatView 5.0.1 was used. The main goal was show the relationship between the response variable (poachers arrested) and the predictor variables (poverty, tradition, food, medicinal and others).

The relationship between each of the individual predictor variables (motivational factors of poaching) and the response variable were further enhanced using the multiple

regressions module in program STATISTICA 8 (Stat soft Inc., Tulsa, OK).Correlations between the above mentioned variables provided significant relationship between predictor and response variable.

Cross tabulation tables or contingency tables it is at times called display the relationship between two or more categorical (nominal or ordinal) variables. Crosstabs under descriptive statistics available on the SPSS analyze tool was used to construct tables between number of poachers arrested and lunar cycle, hunting group size and the season of the year poachers were arrested ,hunting group size and hunting success and finally poaching duration and seasons within the years poaching events occurred. The sizes of the tables were determined by the number of distinct values for each variable, with each cell in the table representing a unique combination of values. Numerous statistical tests are available on SPSS package to determine whether there is a relationship between the variables in a table. One of the purpose of a cross tabulation is to show the relationship (or lack thereof) between two variables. Tests are available to determine if the relationship between two cross tabulated variables is significant. One of the more common tests is chi-square which is appropriate for almost any kind of data. Pearson chi-square tests the hypothesis that the row and column variables are independent. The significance value (Asymptotic Significance) was the information that was used to establish the relationship between the variables. The importance of Chi –square test is that the lower the significance value, the less likely it is that the two variables are independent (unrelated). Chi-square test were out to establish possible relationship between hunting group size and hunting success

3.3.2. Categories of illegal activities often committed by wildlife offenders.

Poachers arrested were by foot patrols. Firearms, gin traps and trophies posses by the poachers were sized .Poachers were placed under three categories depending on whether they

committed serious, less serious and minor offences. The firearms confiscated were classified as rifle, single barrel shot gun, double barrel shotgun and locally made pistol. Data from the above were mainly actual count values in the case of confiscated items from poachers over the years(2003-2008).The hunting group size of poachers encountered and categories of offences committed by poachers formed a qualitative data.

Clustered chart was used to describe the relationship between the hunting group sizes over the six years of the study. A simple bar chart was used to graphical represent the types of offences committed by arrested poachers and the types of animals poached over the years.

A stacked bar chart was used to show the relationship of category of firearms confiscated within the years. Proportion of firearms confiscated and category of offences committed by poachers were also compared using the G-test. The G-test was used to test the level of significance of any independence shown between firearms confiscated and offences committed over the years of the study. A G-test of independence for two by three (2 X 3) with Williams', correction (Sokal and Rohlf, 1981) was used. A frequency table was constructed for quantity of firearms confiscated and arrested poachers.

3.3.3. Assessment of prosecutions and convictions (penalties) with regards to law enforcement effort.

Data on prosecutions and convictions (penalties) in Mole National Park were used in excel to produce trend analysis, proportions in terms of sentences and fines (graphs) over the study period. Trends of patrol staff performance, incidence of poaching (illegal activity) and encounters with animals were examined by Excel. Catch/effort(C/E) indices of illegal and wildlife encounters over the years (2003-2008) were used to show trends as mentioned above.

Sentences and court fines were log-transformed in Excel over the years (2002-2003) and a third degree polynomial was applied and that provided the best fit. That is a plot of $\log_e$

fines and $\log_e$ prison sentences against the years explained the variation of each model. An effective patrol day (epd) is used as a measure of patrol effort.EPD is the effective patrol day spent by a patrol staff per month. Catch per effort(C/E) is measured as the number of encounters with illegal activities and mammals. A line graph depicting staff performance, illegal activities (C/E) and encounters with animals(C/E) over the years of the study was produced by use of Excel.

3.3.4. Determination of trend in illegal activities in relation to patrol effort and abundance of large mammals.

Towards the end of 2006, patrol staff was moved from 25 camps distributed over the entire park to 4 range camps of which 3 are located on the peripheral of the park .With this change in camp infrastructure ,perimeter areas of the park were patrolled more intensively than the previous years, and encounter rates dropped.

The above situation necessitated for correction which will enable a better fit in relation to wildlife encounters. This was done by correcting wildlife encounters from 2004 to 2006 to accommodate the change in patrol coverage within the period. Using indicators of illegal activity and wildlife encounters as an index, consistency in data is paramount and applies to both temporal and spatial data as well . For the purpose of consistency, correction for wildlife and illegal activity indicators considered interval between data collection and the areas that were covered during data collection to be the same in terms of time and area.

Simple linear regression is used to model the value of a dependent scale variable based on its linear relationship to one or more predictors. The linear regression model assumes that there is a linear, or "straight line," relationship between the dependent variable and each predictor.

This relationship is described in the following formula.

yi=b0+b1xi1+bpxip+ei

where;

yi is the value of the ith case of the dependent scale variable

p is the number of predictors

bj is the value of the jth coefficient, j=0,...,p

xij is the value of the ith case of the jth predictor

ei is the error in the observed value for the *ith* case

1. The model summary table reports the strength of the relationship between the model and the dependent variable.
2. Simple linear regression analysis tool in software package StatView (version 2.1) was used to establish the relationship between illegal activities as the dependent/ response variable and mammal encounter the predictor variable. The second step was to regress each of the predicator variable (patrol effort and mammals encounters) in turn against the response variable (illegal activity).
3. The relationship between patrol effort (EPMD) and mammal sighted(C/E) and illegal activity(C/E) was established using a simple and multiple regression module of the software StarView. Mammal encounters over the years (2003-2008) was log-transformed and were used in the above regression module.

3.3.4. Demonstration of how the Management Information System (MIST) depicts temporal and spatial distribution of illegal activities, patrol paths and animal sightings.

Spatial data collected by law-enforcement patrols are geo-referenced using Global Positioning System (GPS).The GPS used in MNP are Magellan and eTrex Garmin which are user friendly, robust, hand-held units. The data consist of GPS waypoints of observations

(mammals & numbers and illegal activities & numbers) and number of the rangers on patrol. Based on the above set of geo-referenced raw data, the Management Information System (MIST) was used to produce the following out puts: indices of encounter rates, maps, wildlife populationperformance indicators and reports.GPS reading by ranger patrols are taken at least every 30 minutes. This enables calculation of distance-related indices. MIST software produced distance-related indices such as; elephants seen per kilometer patrolled, gin trap collected per kilometer patrolled. An index such as gin trap removed/confiscated per kilometer patrolled can show changes in relative poaching pressure over time without knowing the actual number of animals killed.

MIST (version 2.2) produced maps from downloaded GPS coordinates of patrol data which shows exact distribution of species and illegal activities (Lucey, 1977). MIST-GIS interface of the software (MIST) was used to create periodic (monthly, yearly, quarterly etc.) standard reports from data that was entered from October 2004-December 2008. The interface has the capability of using two methods for creating a report i.e.-with the report wizard or with the query wizard(Lucey, 1997; Nuwamanya, 2009).

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The query wizard which is one of the methods used to create reports from MIST was used to create spatial maps of patrol path for the period of Jan-October 2008.This period was selected from different years and it was observed that 2008 data was suitable if consistency in data collection and area covered by patrol staff is to be complied with. Also the month of October marked the end of the raining season and beginning of the dry season.

The report wizard of the MIST-GIS has an analysis and readymade/fixed report imbedded in it. The wizard was used to create reports on illegal activities, mammal, ranger reports and special observation within the same period as the others above (Appendices 9, 10, 11)

CHAPTER FOUR

4.0 RESULTS

4.1 Introduction

As has been described in chapter two, trends and dynamics of poachers' decision making is important in combating poaching in protected areas. Management of information from arrested poachers' is a critical mission in law enforcement monitoring. In order to improve the way information from arrested poachers is managed, it is imperative that the existing situations and conditions under which they operate, is understood. This chapter deals with the pattern and changes of poaching within the period under study with regards to law enforcement monitoring and how changes in poacher's behavior and decision making are affected.

The analysis covered the motivational factors of poachers, type of illegal activities poachers are involved in, trends in prosecutions and convictions, patrol performance and success of arrest of poachers and the spatial distribution of illegal activities, patrol path and areas and the abundance of large mammals in Mole National Park.

4.2 Trends in incidences and Arrest of poachers.

The trend of poachers arrested during the study period revealed that 2004 had the highest number of poachers arrested (n=44, 21.1%) and 2003 showed the lowest number of arrest (n=29, 11.8%). A scatter plot of poachers arrested against the years of the study was used to determine the pattern of poaching. There was a steep increase from 2003 to 2004, gradual and minor decrease to 2007, increasing again in 2008 (Fig.4.1).A third degree polynomial trendline gives a highly significant fit, with as much as 91.51% of the variance explained by the model.

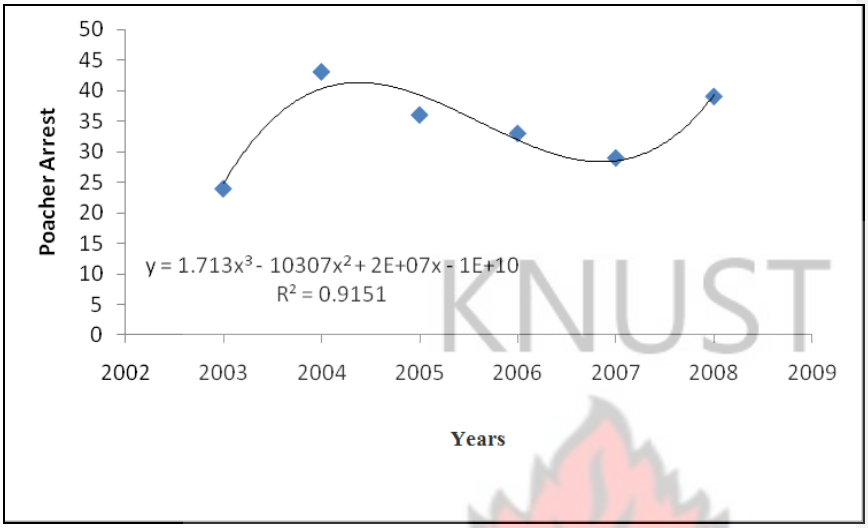

Figure 4.1. Poachers arrest in MNP between 2003 and 2008.

A total of 147 poaching events (incidences) were encountered by foot patrols between 2003 and 2008,which comprised 207 arrested poachers with 204 interviewed.Of the three poachers that were not interviewed,one died in the field during arrest and two were seriously injured and were hospitalized. The month of March recorded 37 poaching incidences with 48 poachers arrested. October which mark the beginning of the dry season recorded the lowest (4) poaching incidence with 6 arrested poachers. However, September had 4 poaching incidence and 21 poachers were arrested (Table 4.1).

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Table 4. 1 Monthly records of poaching incidences and poachers arrested from January 2003-December 2008.

	Year													
	2003		**2004**		**2005**		**2006**		**2007**		**2008**		**Total**	
Mth	**Incd**	**Ar**	**Incd**	**Ar**	**Incd**	**Ar**	**Incd**	**Ar**	**Incd**	**Ar**	**Incd**	**Ar**	**Incd**	**Ar**
Jan	2	3	0	0	4	5	2	2	0	0	1	2	**9**	**12**
Feb	1	1	3	8	2	5	3	2	3	4	4	5	**16**	**25**
Mar	3	4	4	5	3	7	6	7	5	6	11	13	**32**	**48**
Apr	1	1	2	2	1	1	1	1	0	0	7	6	**12**	**11**
May	1	2	4	5	5	4	1	1	1	2	3	2	**15**	**16**
Jun	1	1	2	3	1	1	2	2	4	3	4	4	**14**	**14**
Jul	1	1	3	7	3	2	0	0	1	1	1	4	**9**	**14**
Aug	2	2	1	3	3	5	2	4	4	5	2	4	**14**	**23**
Sep	2	12	1	6	0	0	1	3	0	0	0	0	**4**	**21**
Oct	1	1	0	0	1	1	1	2	1	1	1	1	**4**	**6**
Nov	0	0	3	4	1	1	0	0	4	4	0	0	**8**	**9**
Dec	2	1	1	1	4	3	3	3	0	0	0	0	**10**	**8**
Tota	**17**	**29**	**24**	**44**	**28**	**35**	**22**	**27**	**23**	**26**	**34**	**41**	**147**	**207**

***Mth_Month** **Incd_Incidence** **Ar_No of Poachers Arrested**

The trend of poachers arrested during the study period revealed that 2004 had the highest number of poachers arrested (n=44,21.6%) and 2003 showed the lowest number of arrest (n=29,14.2%).

4.2.1. Profile of Arrested poachers.

4.2.1.1. Age.

The age range of arrested poachers was 18 to 60 years, with an average age of 35 years. Most of poachers age was in 31-39 years class (n=65, 31.9%) and the least recorded age was in the class 56-60 years (n=3, 1.5%) (Fig.4.2).

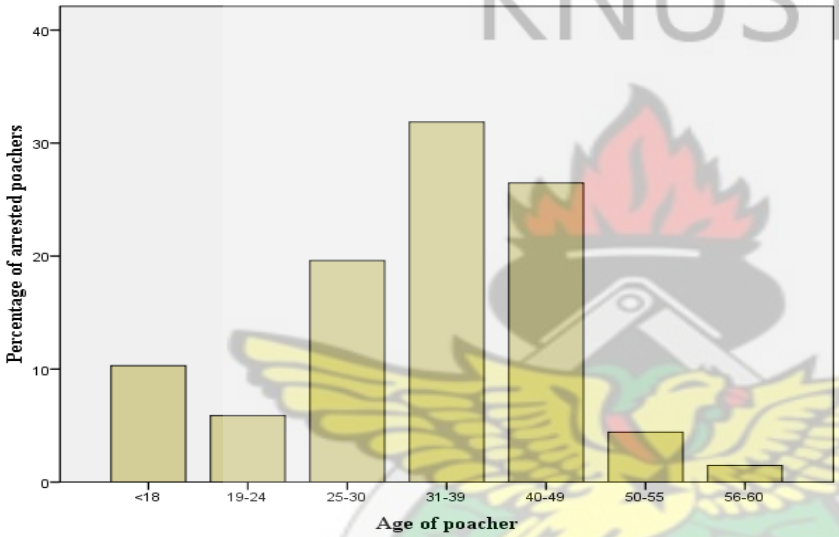

Figure 4.2. Age Class distribution of arrested poachers.

The age class 31-39 as the modal class had the highest number of arrested poachers. Age class 56-60 had the lowest. The general observation from the graph is that most of the arrested poachers were of ages between 25 to 48 years. Minors (<18 years) arrested were mostly carriers to the poachers

A clustered bar graph of poachers occupation revealed subsistence farming as the main occupation along side, petty traders, public servant, and unemployed. Subsistence farming as an occupation cut across all the age classes (Table 4.2).

Table 4. 2 Age class of poachers in relation to their occupation

Age of poacher	Arrested poachers occupation							
	Subsistence Farmer	Petty Trader	Public Servant	Fishing	Herbalist	Student	Unemployed	Total
<18	7	0	0	0	0	3	11	**21**
19-24	6	0	0	0	0	1	5	**12**
25-30	36	2	1	0	0	0	1	**40**
31-39	60	2	1	2	0	0	0	**65**
40-49	50	0	1	0	2	0	1	**54**
50-55	9	0	0	0	0	0	0	**9**
56-60	3	0	0	0	0	0	0	**3**
Total	**171(83.82%)**	**4 (1.96%)**	**3(1.47%)**	**2(0.98%)**	**2(0.98%)**	**4(1.96%)**	**18(8.82%)**	

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4.2.1.2 Occupations of poachers.

Most of the poachers were subsistence farmers (n=171,84%) and others were unemployed (n=18,9%), petty traders (n=4,2%), public servants (n=3,1%), students (n=4,2%), herbalists (n=2,1%) and fishermen (n=2,1%) (Table 4.2)

4.2.1.3 Time of Poaching.

The highest arrests were made in the afternoon (n=110, 53.9%), some in the morning (n= 59, 28.9%), a few at night (n=25.12.3%) and the least at dawn (n=10, 4.9%) (Fig.4.3)

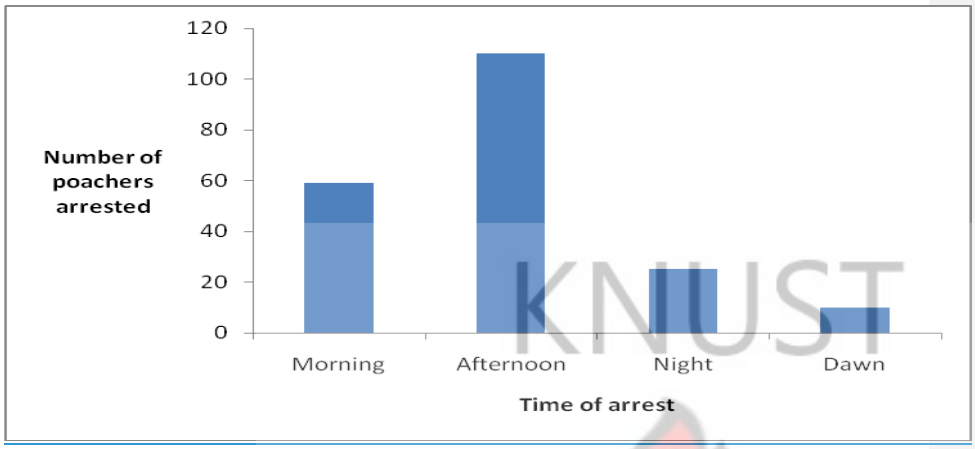


Figure 4.3. Time of the day poachers were arrested.

The time of arrests of poachers follows the lunar cycle. Arrest of poachers were varied and were as follows; highest arrest were made during the waning moon, Crescent cycle 43.6%(n=89), and preceded in a descending order as follows new moon 23% (n=47),full moon 21.1%(n=43) and waxing moon 12.3%(n=25) (Table 4.4).The time of arrest and lunar cycle are significantly related (Asymptotic significance 2-sided =0.023).The chi square statistic value is low which implied that the two variables are related (Appendix L).

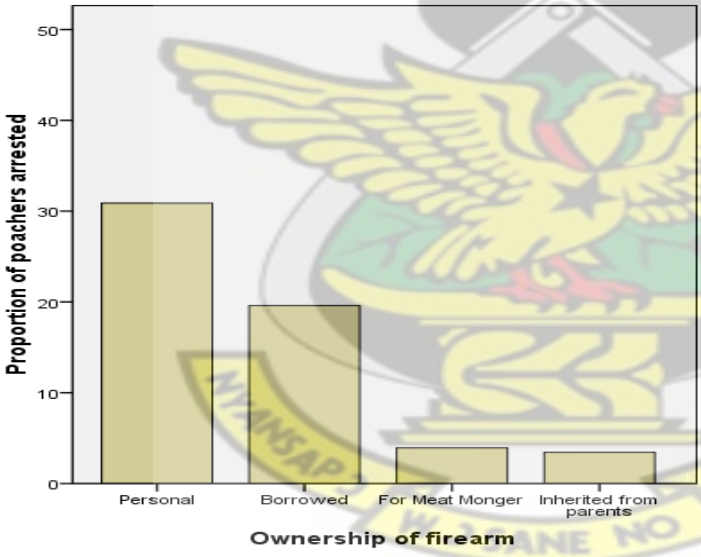
Table 4.3. Arrest of poachers in relation to the lunar cycle

Time of Arrest	**Lunar Cycle during Arrest**				**Total**
	Full Moon	New Moon	Waxing moon, Crescent	Waning moon, Crescent	
Morning	9	14	5	31	59
Afternoon	31	26	10	43	110
Night	2	6	6	11	25
Dawn	1	1	4	4	10

Total	**43**	**47**	**25**	**89**	**204**

4.2.1.4 Ownership and type of Firearms.

Ownership of firearms varied and was in four categories; personal, borrowed, owned by the meat monger and by inheritance from deceased parents (Fig.4.4). Most the poachers have their own weapons (n=63, 30.9%). Eighty (80) arrested poachers which represent 39.2% did not possess a firearm when they were arrested. A few of them owned the weapon by inheritance (n=7, 3.4%). Most of the guns confiscated were single-barrel shotguns (n=116, 56.9%) which were purchased from the southern parts of Ghana, including Kumasi, Ejura and Techiman.



4.2.1.5. Areas commonly hunted in MNP.

The poaching areas in MNP varied with the seasons. Most poachers (61.3%) were arrested in the dry season with 38.7% of them arrested in the wet season. In the dry season, areas along the Nyanga (SE 6) and Mole rivers (SE 5), Hawa pool (SE 4), Kulzeri (SE 3), Gonbegni (SE 2), Lingbum (SE 1) and Gozin (SW 2) are the most popular hunting areas. In the wet season, the poachers go to the higher well-drained areas such as Grantable scarp, Hega and Beling Hills. Around the park HQ poaching takes place all year around. These areas mentioned as poachers hot spots falls within the sectors as shown in the map (Fig.4.5).

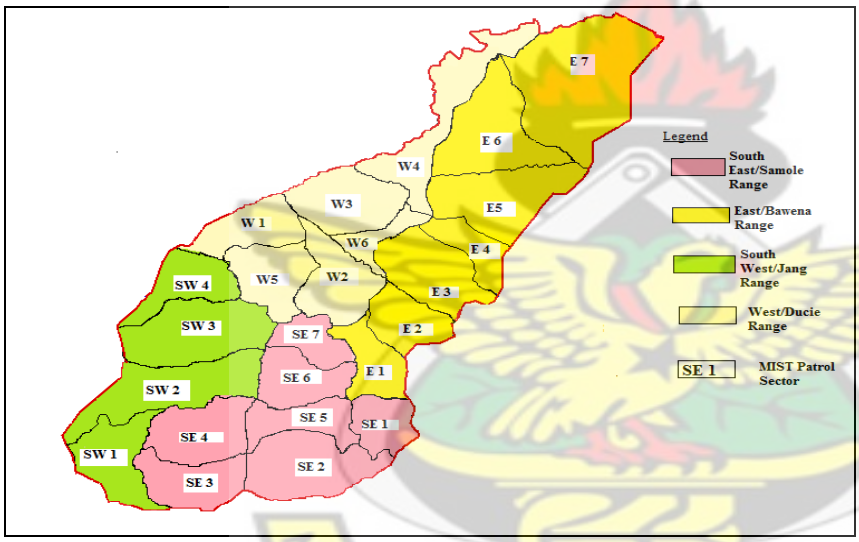


Figure 4.5. Delineated Sectors for patrolling by ranges in MNP(LEU MNP,2004).

Most of the poachers (15.7%) arrested were within South Eastern 2 sector (SE 2) which comprises poachers from Larabanga, Grupe, Murugu and Kananto villages. South Eastern 2 within the park encompasses park headquarters, Brugbani and Lovi camp beats where animals abound. Two poachers (1.0%) were arrested in West 1 sector (W 1) and comprises poachers from Ducie community (Table 4.4)

Table 4. 4 Proportion of poachers arrested within the patrol sectors

Patrol Sector	Frequency	Percentage (%)
SE 1	21	10.3
E 3	10	4.9
E 4	4	2.0
E 5	5	2.5
E 6	6	2.9
SW 1	15	7.4
SW 3	14	6.9
SW 4	15	7.4
W 1	2	1.0
W 2	10	4.9
SE 2	32	15.7
W 3	4	2.0
W 4	5	2.5
W 5	8	3.9
E 7	8	3.9
SE 3	4	2.0
SE 4	6	2.9
SE 5	14	6.9
SE 7	8	3.9
E 1	4	2.0
E 2	9	4.4
Total	**204**	**100.0**

4.2.1.6. Meat Disposal.

The arrested poachers revealed that they dispose of their kill at small bush meat market outlets where they are preserved by smoking before it is transported to the big bushmeat markets in Techiman and Kumasi. Small bushmeat outlets established at Sawla, Tuna, Wa, Damongo, Daboya, Larabanga and Kundugu which serve as conduit points where poached meat is sold to traders (middlemen) who inturn transport to bigger markets in southern Ghana. Damongo market an outlet had the highest market, 21.6% (n=44) where poached meat was disposed of. Only few poachers could afford transporting their bush meat

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directly to the big markets in Kumasi 0.5% (n=1,). However, some respondents did not respond because they had no kill and were not privy to answer questions on bush meat markets 10.5% (n=21,) (Fig 4.6).

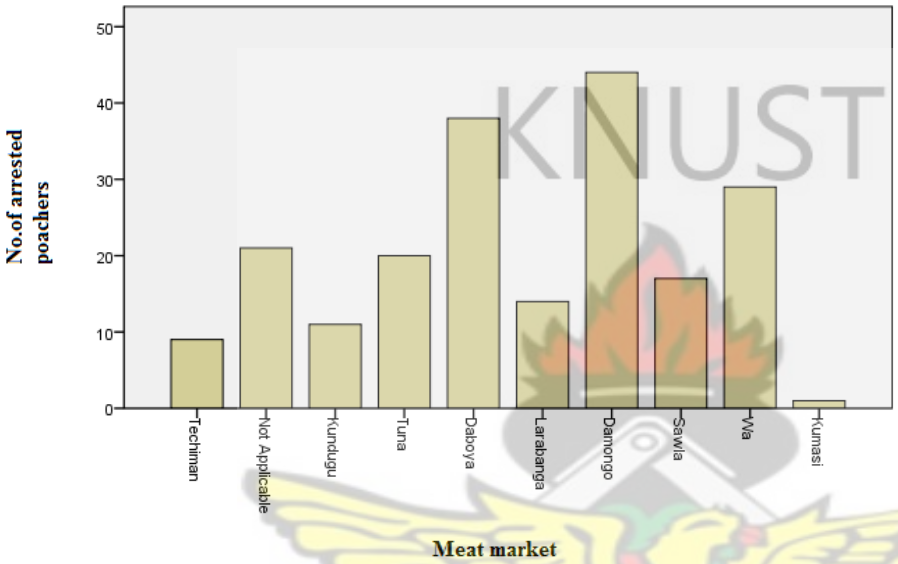

Figure 4.6. Bush meat markets used by poachers arrested in the Mole National Park.

4.2.1.7. Hunting Group Size

The hunting group size of a poaching gang has an influence on the hunting success in case of big game. Fifty eight percent of the poachers arrested were in group size of 1-2. Over the 5 year period hunting group size of 1-2 dominated with 5 or more category being the least (Fig.4.8). Group size of 5 or more had the least (10.3%, n=21) number of poachers arrested. The number of poachers arrested between the seasons were 10 and 11 for dry and wet respectively (Table 4.5, and Figure 4.6).

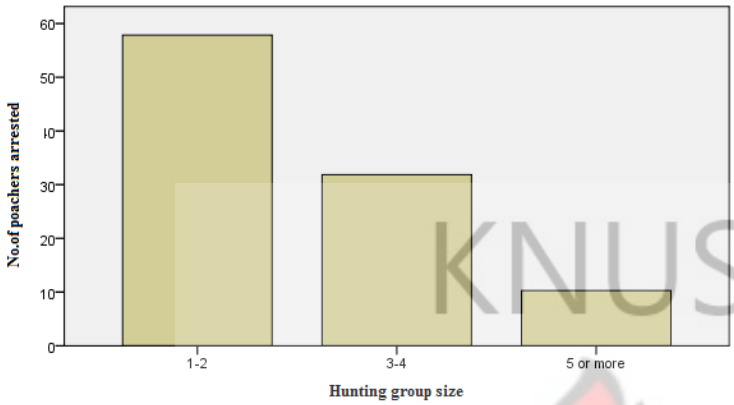

Figure 4.7. The group size of poachers arrested in MNP during the period of 2003 to 2008.

Table 4. 5 Hunting group size of arrested poachers between the seasons in MNP (2003-2008)

Season within the year	Hunting Group Size			Total
	1-2	3-4	5 or more	
Wet	46	22	11	79
Dry	72	43	10	125
Total	118	65	21	204

Hunting success in terms of number of game killed (No_k) by hunting group size decreased as the group size increased; No_k=118 for group size 1-2; No_k=65 for group size 3-4; No_k=21 for group size 5 or more (Table 4.5). The hunting group and hunting success are significantly related (Asymptotic significance 2-sided =0.336).The chi square statistic value is low which implied that the two variables are related (Appendix M).

Table 4. 6 Hunting group size in relation to number of animals killed

Hunting Group Size	Quantity of animals killed
1-2	117
3-4	65
5 or more	21
Total	**203**

4.2.1.8. Duration of poaching excursion.

On average poachers spend one to six or more days in the field in the dry season and one to five days in the wet season, although the true time may be much longer. Most of the poachers spent between two-three days in the field 46% (n=94) and six or more days in the field as the least recorded 1.5% (n=3) (Table 4.7.). Poaching excursion of between two to three days was recorded as the highest for both seasons and equal records for between four and five for both seasons. Poaching excursion of between six or more days was only recorded in the dry season (Table 4.7)

Table 4.7 Poaching duration and season within the year

Seasons within the Year	Poaching Duration (days)				Total
	1	4-5	6 or more	2-3	
Wet	31	13	0	35	79
Dry	50	13	3	59	125
Total	81	26	3	94	204

Most of the poachers that spent one day hunting came from villages around MNP that are less than 10km to the park boundary. Poaching duration of between two to five days came from villages far off the park catchment communities with distances between 10 to

more than 40 km. Three poachers were recorded having spent 6 or more days in the field and came from villages that are less than 30km to the park boundary.

4.2.1.9. Poachers' origin.

Most poachers arrested came from villages that are 10-40 km to the park boundary. Larabanga, which is located less than 7km from the park, had the highest poacher arrest 19.6% (n=40), with the lowest from Grubagu, Gellinkon, Bole, Kaden, Jentilpe and Tantale 0.5% (n=1) (Table 4.9).

Exclusive interviews with some of the poachers arrested led to the arrest of other notorious poachers in the communities. An interview with a notorious poacher from Grupe village 2 km away from the park boundary along the Larabanga-Sawla showed time he entered the park, the location he went to poach, reasons for poaching, revelation of other known poachers and bush meat mongers in his communities and others (Appendix H)

Table 4. 8 Origin and proportion of poachers arrested in MNP.

Origin of arrested poachers	Percentage (%)
Larabanga	19.6
Damongo	2.0
Bawena	7.4
Murugu	3.4
Grupe	3.9
Nyole,Grungbele,Hellibele,Sombisi,Gbantala,Goriba,Naasoyiri	1.0
Soma	3.4
Grubagu,Bole,Jentilpe,Gellinkon,Kaden,Tantale	0.5
Tuna	2.0
Kabampe	4.9
Ducie	3.9
Chasia	3.4
Tamale,Taari,Sagiya,Gbasimpa,Wiase,Dabori	1.5
Mognori	3.4
Kplumbo	2.9
Wa	2.0
Jinfronu	5.4
Jang	4.4
Kong	2.9
Holomuni	2.9
Kananto	3.4
Total	**100.0**

4.2.3. Correlates of motivational factors of poachers arrested

Motivational factors enumerated by arrested poachers were categorised as; poverty, tradition, food, medicinal and others. Poverty generally is difficult to quantify.The study considered poverty parameters such as the size of farm, types of crops grown, household size, availability to health and educational facilities and annual income.

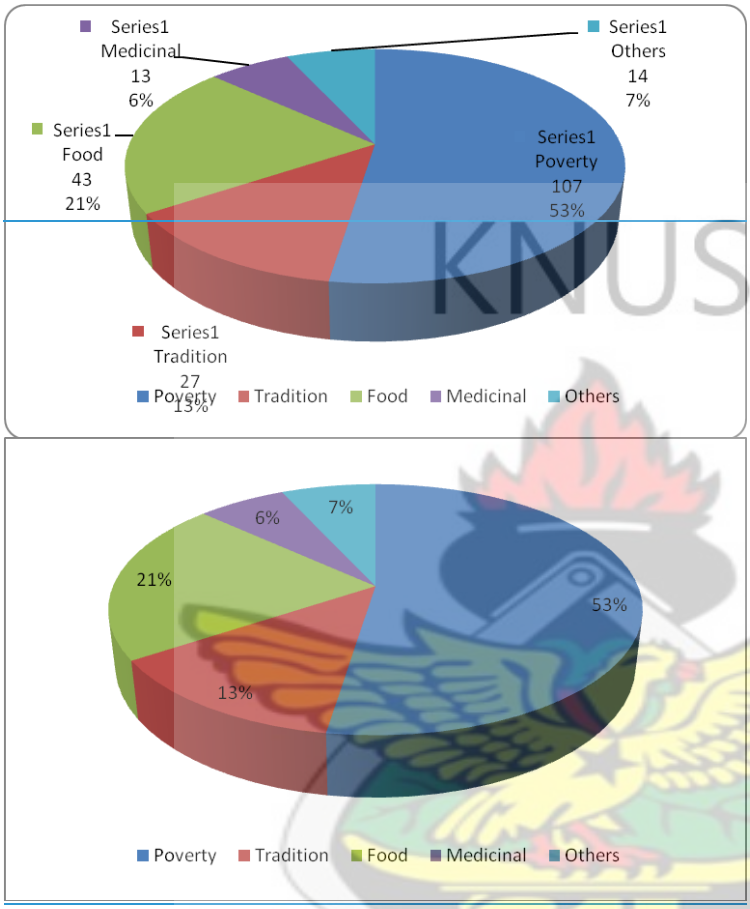

Figure 4.8. The distribution of motivational factors of poaching.

Poverty was the highest motivational factor recorded from respondents (53%; n=107) and the least was medicinal (6%; n=13).

Table 4. 3 Relationships between motivational factors of poaching and poachers arrested

Motivational factors of poaching	Poverty	Tradition	Food	Medicinal	Others	Poachers arrested
Poverty	1.000000	-0.144174	-0.252884*	-0.239639*	-0.035718	0.533628*

Motivational factors of poaching	Poverty	Tradition	Food	Medicinal	Others	Poachers arrested
Tradition	-0.144174	1.000000	-0.141635	-0.094509	-0.090687	0.384428*
Food	-0.252884*	-0.141635	1.000000	-0.147004	-0.057080	0.331945*
Medicinal	-0.239639*	-0.094509	-0.147004	1.000000	-0.072572	-0.116252
†Others	-0.035718	-0.090687	-0.057080	-0.072572	1.000000	0.182027*
Poachers arrested	0.533628*	0.384428*	0.331945	-0.116252	0.182027*	1.000000

***-Correlations are significant at p<0.05**

†Others –hobby, habit conferred on grandparents, for fame in hunting big game, show of charm etc.

Motivational factors had somewhat different effects upon the poacher's arrested. Multiple regression of poachers arrested on poverty, tradition, food and medicinal tended to be significant($r=0.5336$; $p<0.05$). There was a strong relationship between poverty and poachers arrested (53.3%) and with a weak relationship between other motivational factors and poachers arrested (18.20%) (Table 4.9).

4.3 Categories of illegal activities involved by arrested poachers in Mole National Park]

Two poachers were identified involved in elephant poaching. Three poachers provided information on notorious poachers in their communities and they were arrested. Appendix 8 is an interview with a arrested poacher during the study.

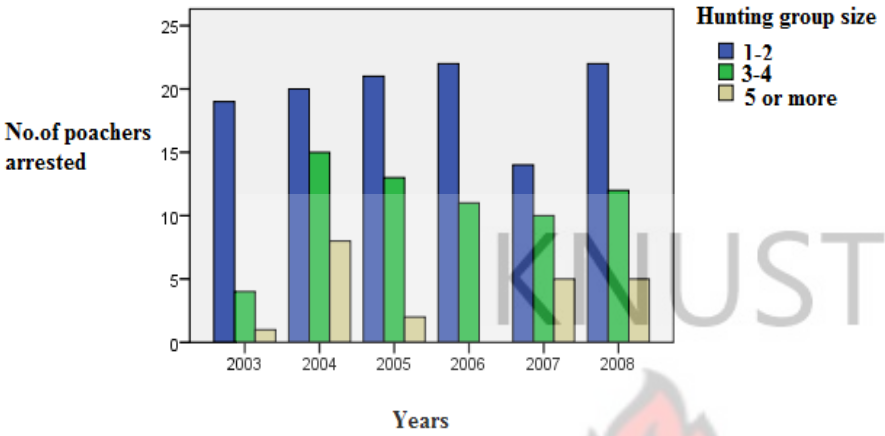

Figure 4.9. Hunting group sizes of poachers arrested for the peeriod 2003 to 2008.

Poachers arrested were classified under *serious, less serious* and *minor offences.* Most of the offenders charged committed serious offence, 84.8% (n=173) while few were charged with minor offences and 28 offenders with less serious offences which represents 13.7% (Fig.410)

Arrested poachers were further grouped in three offence classes which depended on the number of times (first and second) the individual is encountered poaching and arrested in the park and number of times that individual escaped from arrest in the park (notorious). Most of the poachers arrested were first offenders (85.3%; n=174) and few were notorious poachers (2.9%;n=6). Second offenders constituted 11.8% (n=24) of total poachers arrested. A G-test analysis of frequency of arrested poachers distributed within categories of illegal activities (offences vs. classes) showed that the distribution is not significant (G=7.22,d.f.=4,p<0.12).

Eighty (80) of the arrested poachers which represents 39.2 % were carriers and had no firearm. A total of 124 firearms were confiscated from 124 arrested poachers (60.8%) and

grouped into categories of guns (Plate 4.1, and Fig.4.10). Single barrel shot guns were confiscated (n=117, 94.4 %) as compared to double barrel shot guns (n=4, 3.2%). Few automatic rifles were confiscated from elephant poachers (n=2, 1.6%).

Two poachers on different episodes were arrested with single barrel shot gun and locally manufactured pistol. A total of two elephant tusks were confiscated from a notorious poacher during the study period.

Table 4.10 Firearms confiscated from poachers arrested in MNP.

Type of firearm	Quantity confiscated	Percentage (%)
Rifle	2	1.6
Single Barrel shotgun	117	94.4
Double Barrel shotgun	4	3.2
Locally made pistol	1	0.8
Total	**124**	**100**

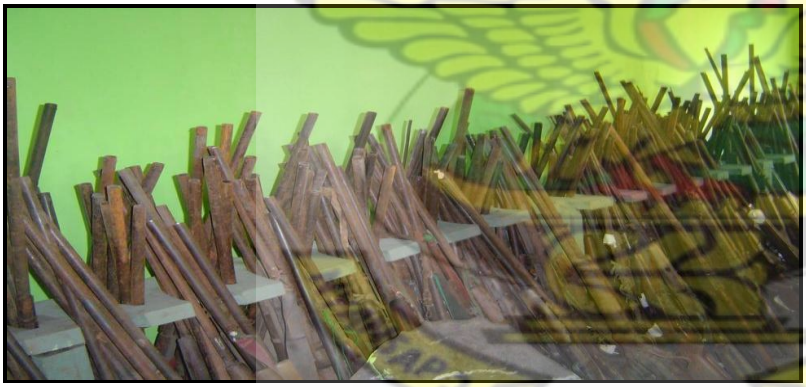

Plate 4.1. Photograph of firearms confiscated from poachers arrested in MNP.

More firearms were confiscated in 2008 (n=30) compared to the previous year's within the study period. Least firearms were confiscated in 2003(n=11).The number of firearms confiscated and the proportions of the various categories of firearms differed

between the years (Fig.4.11).Single barrel shot guns were the most confiscated in each of the years. Least recorded was double barrel shot guns and local pistols More firearms were confiscated from poachers categorized under serious offence (G=11.81, d.f. =2, p<0.003).Gin traps were observed to be commonly used by poachers in MNP to trap big game. A total of 57 gin traps which comprised double blade (n=41) and single blade (n=16) were confiscated during the study (Appendix 5).

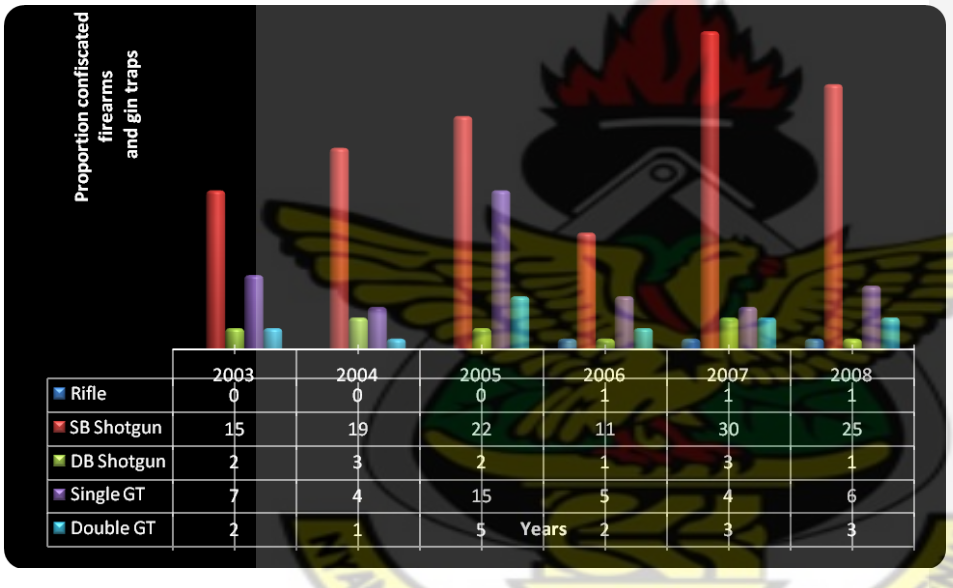

Figure 4.12. Category of firearms and gintraps confiscated.

Most of the poachers arrested are "opportunistic poachers". That is whatever comes their way they kill it regardless of age or sex. A few were recorded as specialists in killing small to medium sized species such as warthog, waterbuck, roan, hartebeest and bush -buck. Large sized species such as elephant and buffalo were also targeted.

A total of two hundred and three wild animals were killed by arrested poachers and sixty-nine animals killed by escaped poachers which comprised twenty-eight wildlife species (Fig.4.13).The animals range from small to large mammals. Three endangered species (lion, elephant, Nile crocodile) were killed. Fruit bats were the most poached (n=360) but for ease of presentation they were not included. Grass cutter (n=50) which most poachers cherished ranked second on the list of animals killed during the period of study.

Table 4.11 Type of animals poached in MNP (2003-2008)

Name of Species	No Killed by poachers
Waterbuck	8
Roan Antelope	5
Bushbuck	17
Green Monkey	6
Green-Fruit-Pigeon	1
Hartebeest	16
Warthog	12
Oribi	9
Kob	20
Buffalo	14
Red.F.Duiker	13
Grey Duiker	10
Patas Monkey	13
Baboon	13
Grass Cutter	50
Fish	530
Guinea Fowl	11
Nile Monitor Lizard	4
Lion	1
Mongoose	20
B/W Colobus Monkey	5
Crested Porcupine	4
Genet Cat	4
Bats	250
Elephant	2
Crocodile	3
African Python	3
Ground Squirrel	10
Total	**1,054**

4.4. Trends in prosecutions and convictions (penalties) in Mole National Park.

Poachers arrested contravened one or more of the wildlife laws and regulations and as such were investigated and prosecuted in the law courts (Tamale and Damongo) of competent jurisdiction. The relevant sections of wildlife laws and regulations were used by prosecutors to prefer the appropriate charges against poachers that were arrested during the study.

With the exception of three poachers (1.47%), the rest (98.53%) were charged for unauthorised entry into the park without permission (L.I.710) that is the principal law guiding all PAs in Ghana. Most of the poachers violated four offences under L.I.710 & L.I.685 and all the amendments (Fig.4.14 & 4.15). Three poachers were charged for violating one offence under L.I.685 for possessing a wholly protected species trophy (ivory).

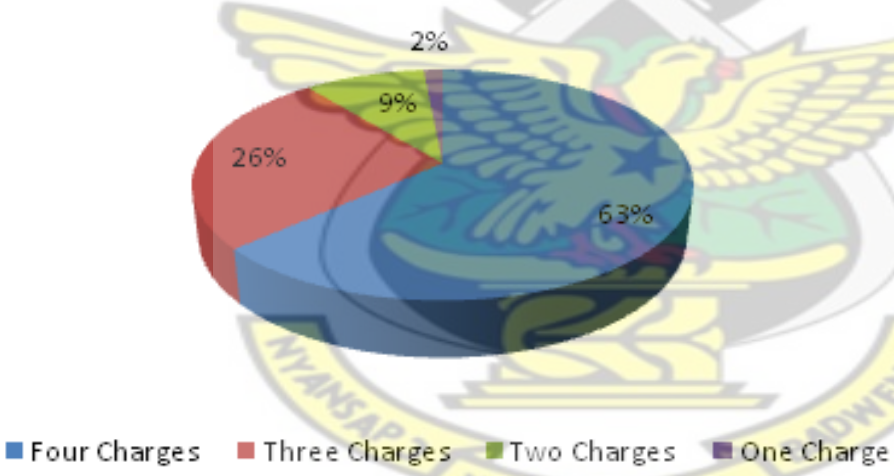

Figure 4.14. Types of violation of wildlife laws committed by poachers.

Judgments' of poaching cases were made available for the study at Tamale and Damongo courts. Out of the two hundred and four (204) poachers arrested between 2003 and

2008, one hundred and sixty-one (161) were successfully prosecuted in the courts. The types of prosecution and conviction delivered during the period were different in proportions (Fig.4.16).

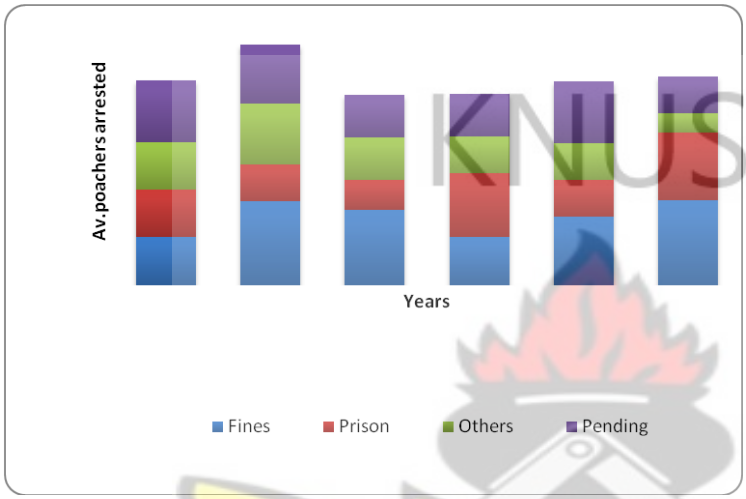

Figure 4.16. Proportional representation of different sentences given to poachers between 2003- 2008.

Thirty-one offenders (31) were given other sentences (acquittals, death, warned and released, signing of a bond etc) instead of a fine or prison terms at the courts and they are as follows: seven were acquitted for loss of exhibits/case docket, ten were made to sign bonds of good behaviour for period between 2 to 4 years, four were minors and were warned and released, one died on transit to the park headquarters ,three escaped from police custody and six of them turned informers and were not given any punishment with the promise that they will give intelligence information of other poachers within the communities to the law enforcement unit.

During the study period there were forty-three poaching cases pending at the courts due to misplaced case dockets, loss of trophies, death of accused or sureties, transfer of

personnel handling the case etc. The types of sentence delivered to the remaining 130 offenders ranged from fines to terms in prison. The maximum court fine was six hundred Ghana cedis and was imposed on 9 poachers. The minimum fine was thirty Ghana cedis for one poacher. The modest fine was fifty Ghana cedis and was imposed on 27 poachers (Fig.4.17).

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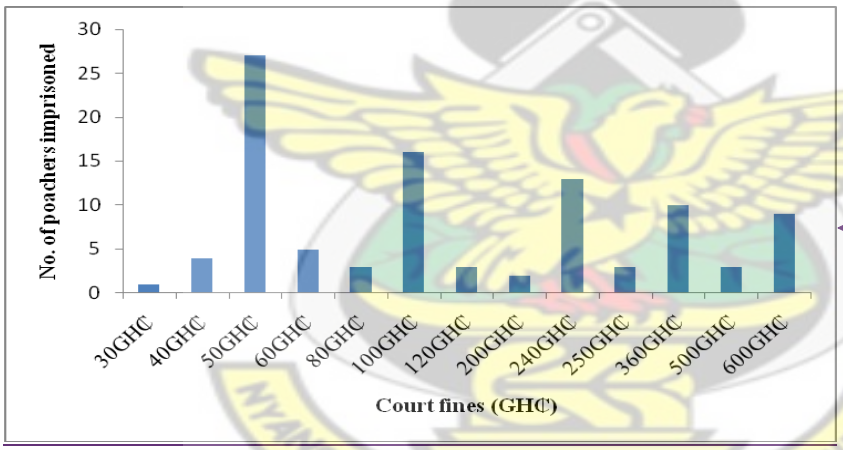

Figure 4.17. The distribution of fines and prison sentences.

Similarly the maximum prison term sentence was 108 months and was heavily

imposed on one notorious elephant poacher from Larabanaga community. The least and modest sentence were 3 months and 6 months and was imposed on 3 and 20 poachers respectively (Fig.4.18). There was an overall difference in the proportion of fines to prison and other sentences between 2003 and 2008 (χ^2=25.43,df=10,p=0.005).

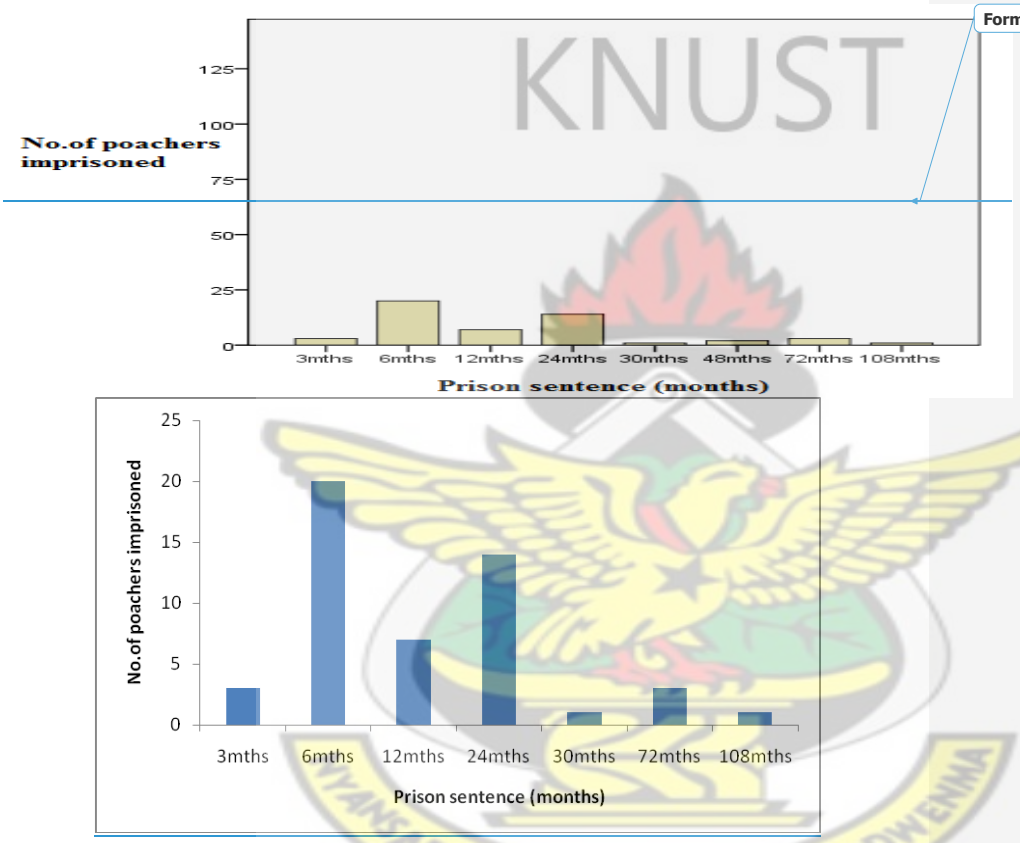

Figure 4.18 . The distribution of fines and prison sentences.

There was amarked increases in the fines and prison sentences delivered during 2003-2008.The general trend of prosecutions is steep increase in court fines from 2003 to 2004,a gradual and minor decline to 2006,increasing again up to 2008 (Fig.4.19).

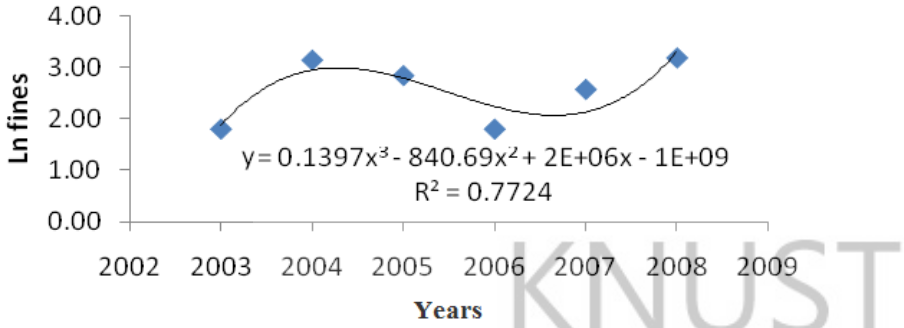

Figure 4.19. Trends in court fines between 2003-2008.

The third degree polynomial gives a highly significant fit,with much as 77.20% of the variance explained by the model

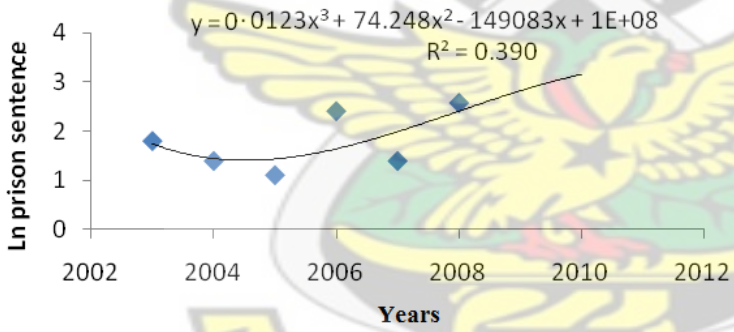

Figure 4.19. Trends in terms of prison sentences over the years (2003-2008).

There was a gradual decline in prison terms from 2003 to 2005, a sharp increase to 2006, a dip in 2007 and steep increase in 2008 (Fig.4.19).The trend is that there was a decline up to 2005 and a general rise up to 2008.

4.5. Trends in illegal activity in relation to patrol effort and abundance of large animals in Mole National Park.

Illegal activities were encountered throughout the entire study period. The frequency with which serious offence indicators (camps, animal carcasses, gin traps etc) were encountered varied less in different seasons than encounters of poachers. That is observation of poaching camps, poaching paths and fresh carcasses in the wet and dry seasons isn't much compared to encounter with poachers.

The model of encounters with poachers showed consistent pattern of change within the ranges of the park from 2003-2008. Poachers arrested initially increased steadily from 2003 (n=24, 11.8%) to 2004 (N=43, 21.1%) and decreased gently through 2004-2007 and peaked in 2008(n=39, 19.1%) (Table 4.1).

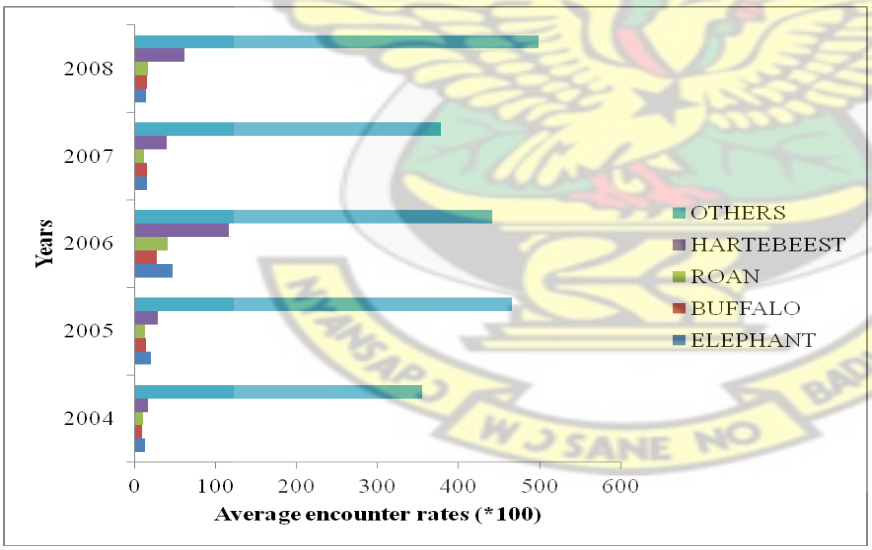

Figure 4.21. Trends in cummulative animals encounters.

Animal sightings by patrols showed increasing trend in some animals over the study period (Figure 4.21). Other animals composed all animals (medium to small animals excluding small mammals) with the exception of those that are included in the analysis.

The increase in sightings of almost all the animals in 2006 could be attributed to the effort put in by patrol staff as a result of support with logistic incentives. The construction of four satellite camps in the northern part of the park improved patrol coverage with remarkable reduction in patrol bias. The 2006 mammals' sightings did not differ much with aerial survey conducted by IUCN with support from Northern Savannah Biodiversity Centre.

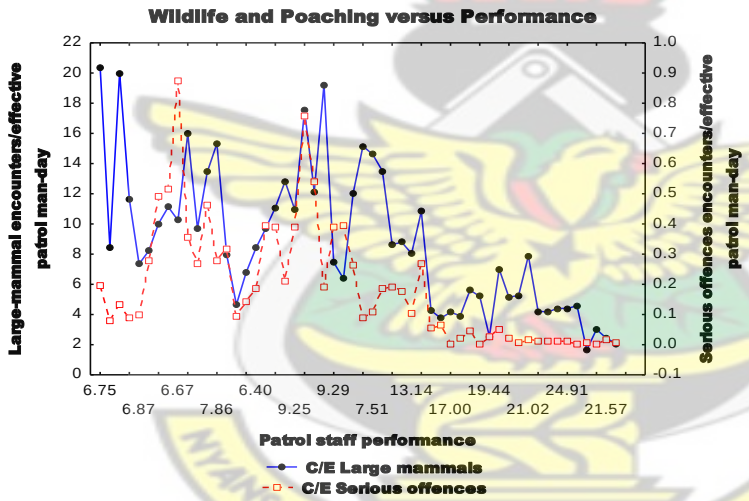

Figure 4.22. Patrol performance in relation to encounters with serious offences between 2003-2008.

Patrol staff performance influences the encounters with illegal activity and large mammals. That is when patrol effort improves, illegal activity declines and wildlife increases (Fig.4.22). Reduction in encounter rate of illegal activity with corresponding increase in

wildlife encounters is the ideal relationship that is expected. From the above pattern, it showed that as serious offences decrease the number of large mammals' encountered increase which fit perfectly with the ideal relationship.

The data on wildlife encounters from 2004 to 2006 were corrected in order to accommodate the change in patrol coverage within the period and was used to construct a dual axis graph showing the trends in patrol staff performance in relation to encounters with illegal activities/serious offences (Fig. 4. 22).

The general trend of staff performance, encounters with illegal activities and wildlife as observed from the data analysis is that since 2006, patrol staff performance sharply increased to astonishing average of 20.56 in 2008 as against the minimum standard average of 15 effective patrol days per staff per month.

Poaching has been at acceptable levels (34.39%/year) since 2007 with wildlife numbers increased by 3.85%. Large mammal encounter rate increased gradually from 2004 and peaked in 2006 and gentle decline from 2007-2008(Fig.4.23).

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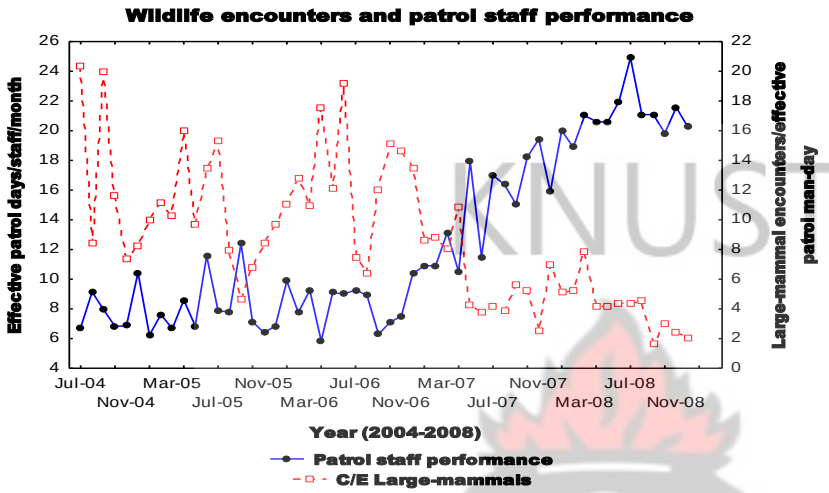

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Figure 4.23. Wildlife encounters and patrol staff performance.

Patrol effort and abundance of animal had somewhat different effects upon the distribution of each index of illegal activity. The variables illegal activity, animal abundance and patrol effort were not normally distributed hence a natural log transformation was applied and it considerably improved the distribution. Simple linear regression of illegal activity on mammal sightings tend to show a fairly strong significant relationship ($p<0.0001, R^2=0.565$, Adjusted $R^2=0.556$) (Fig.4.24). Large R (=0.751) value indicates a strong relationship between illegal activities and mammals sightings. Illegal activity in terms of poaching of animals is highly depended on the distribution of animals. The model showed that about 56.5% of variation in mammals sighting is explained (Figure 4.24).

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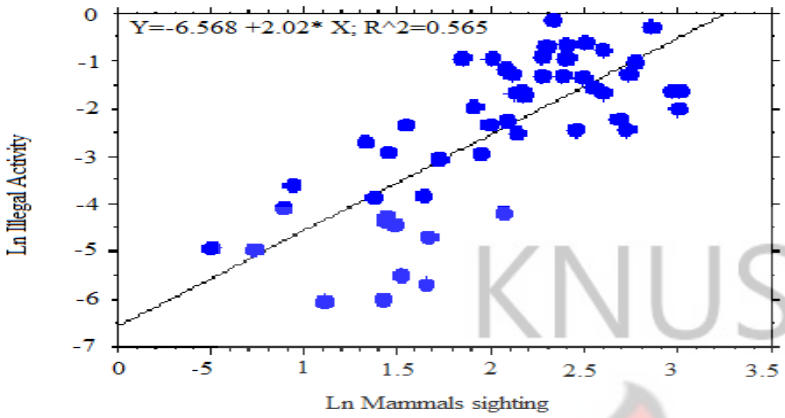

Figure 4.24. Relationship between encounter with illegal activity and level of large mammals.

There was a stronger negative relationship between illegal activity and patrol effort (Fig.4.25).The adjusted R2 value of 0.475 indicates a weak relationship. About 48.4 % of the variation in the patrol effort is explained by the model. As patrol effort increases illegal activities reduces as is expected in any successful law enforcement monitoring (Fig.25).

Multiple regression of illegal activity on both patrol effort and mammal encounter rate also showed that mammal sighting ($R=0.711$;$R2=0.505$;Adjusted $R^2=0.490$ $P<0.0001$) is a variable useful in predicting incident of illegal activity (Figure 4.26).In addition the adjusted R^2 value of 0.603 indicate a fairly strong overall relationship between illegal activity and the two independent variables (patrol effort and mammals encounter) ($R=0.786$;$R^2=0.618$;Adjusted $R^2=0.603$; $p<0.0001$).

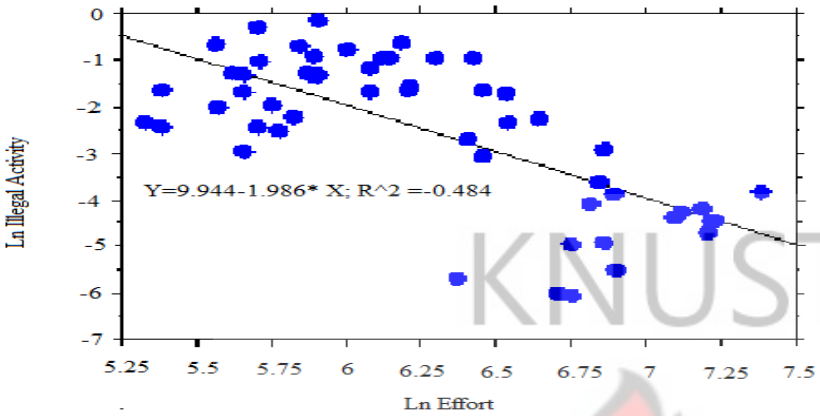

Figure 4.25. Relationship between encounter with illegal activity and level of patrol effort.

Patrol effort had a fairly negative effect upon rates of animal sighting ($R=0.711$;$R^2=0.505$;Adjusted $R^2=0.603$; $p<0.0001$) (Fig.4.27). Even though patrol effort increased in each year, sighting of large mammals showed a decrease in the park due to high poaching over the previous years.

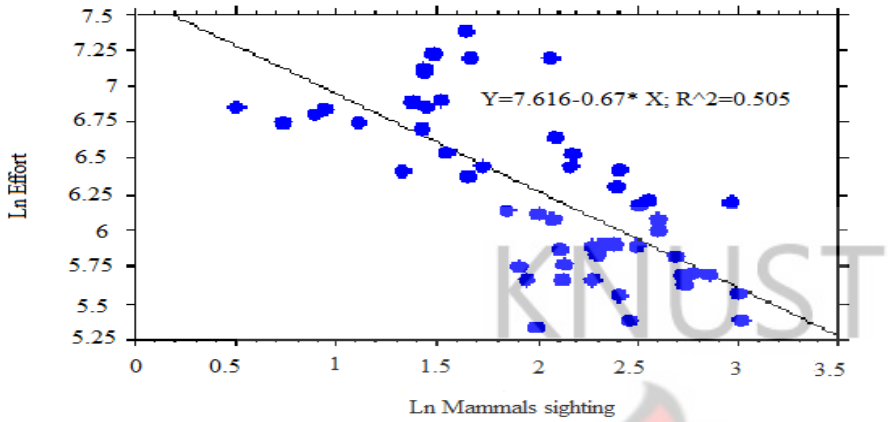

Figure 4.26.Relationship between mammals encounters and patrol effort.

The p-values for both simple ($p<0.0001$) and multiple ($p<0.0001$) regression analysis between the response variable (illegal activity) on the predictor (effort and mammals sightings) variables showed a small value ($p<0.01$).

4.6. Temporal and Spatial distribution of illegal activity in relation to patrol path and animal sighting in Mole National Park.

The temporal distribution of poaching incidents is shown in Table 4.12.The results showed that 53% of the incidents occurred in the park during the dry season and 47% in the wet season.

Table 4. 4 Seasonal record of poaching incidents (2003-2008)

Season	Poaching incidents	Percentage
Dry	78	53
Wet	69	47
Total	**147**	**100**

Figure 4.27 depicts the temporal pattern of poaching incidents and poachers arrested. Poaching incidents show an increasing trend from November (the beginning of the dry season) with a high peak in March and a gradual decrease from April to October. Similarly number of poachers arrested shows a gradual increase from November and peaked in March and a dip in April and maintained until a slight rise in September. The least number of poachers were arrested in October. (Fig.4.27).

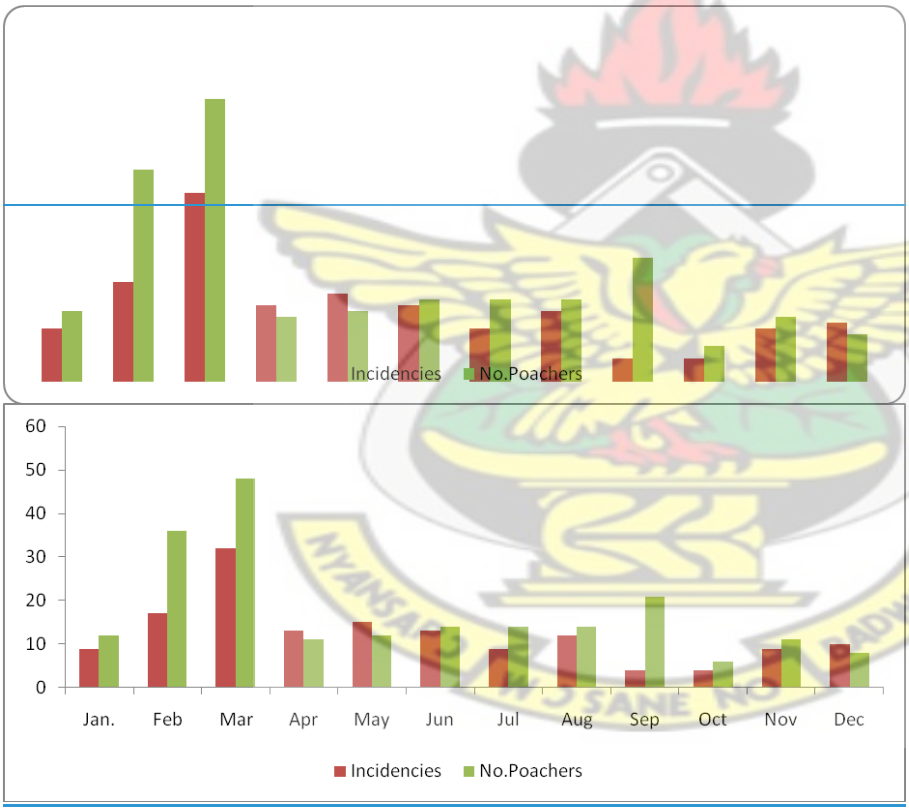

Figure 4.27. Monthly records of poaching incidents between 2003-2008.

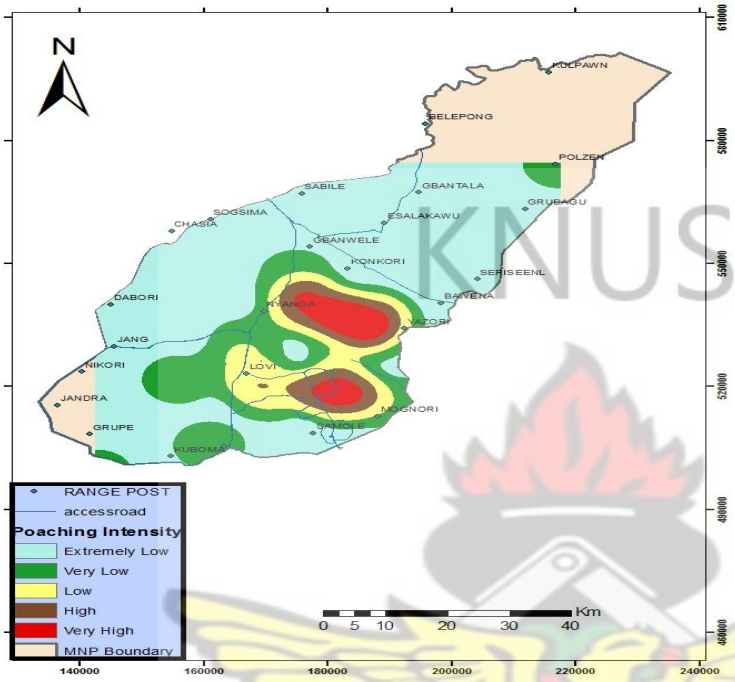

Figure 4.28. Spatial distribution of poaching intensity in Mole National Park(LEU MNP,2006).

Figure 4.28 shows the occurrence of poaching intensity within the park from 2003-2008. Poachers were arrested at different location with varying intensity within the park. Invariably the poaching intensity spots are areas that harbour most of the wildlife. The south-eastern and south western parts of the park recorded the highest (42.6 %; n=87) and least number of poachers arrested (17.2%; n=35) respectively The eastern and western parts recorded 21% and 19.1% number of poachers arrested respectively.Very high poaching was observed from around the south –eastern and extremely low poaching around south-west, west and the entire northern parts of the park (Fig.4.28).

The highest density of the arrested poachers was from Larabanga (Figure 4.29). Most of the poachers arrested came from communities that are less than 15 km to the park boundary. Eighteen communities each had between 1 and 3 arrested poachers.

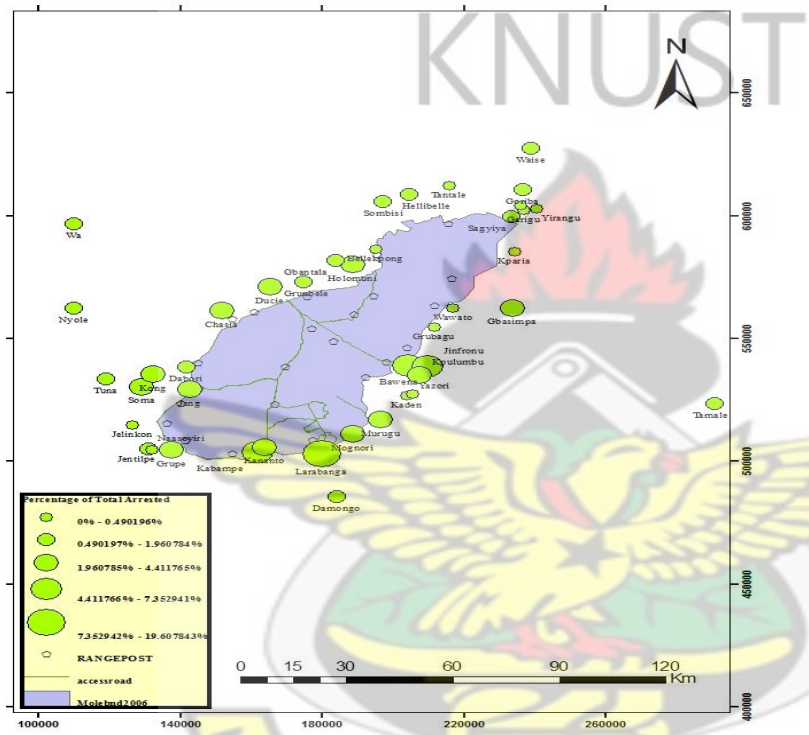

Figure 4.29. Origin of arrested poachers in MNP between 2003-2008 (LEU MNP,2008)].

4.6.1. Temporal and spatial distribution of illegal activity, patrol path, patrolled areas and wildlife sightings in Mole National Park, using Management Information System (MIST) software.

The patrol path covered 75% of the park within ten months with the northern part of the park fairly well covered compared to previous years (Fig.4.30.).The patches between patrol paths are mostly hilly areas without water and harbours extremely low wildlife numbers and as such less patronized by poachers.

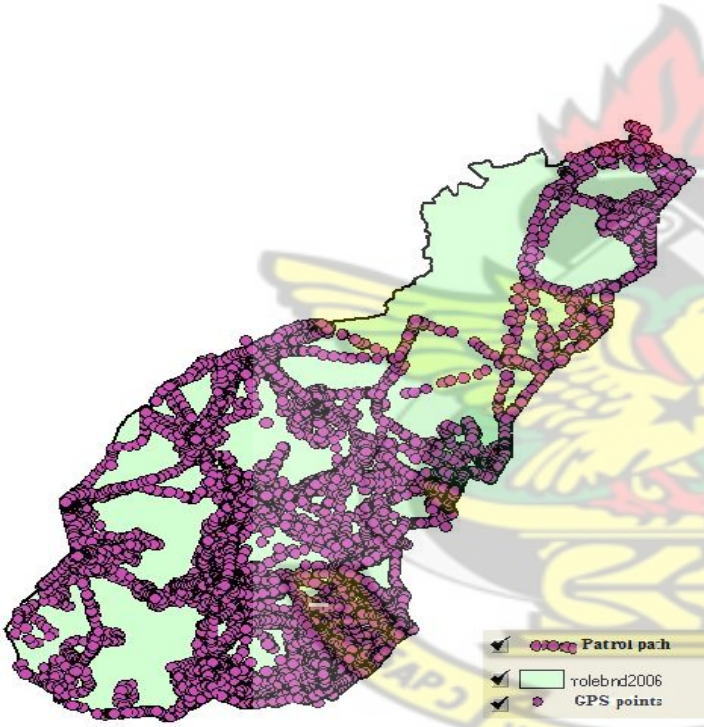

Figure 4.30. MIST patrol path for the period January-October 2004 (LEU MNP,2004)

The query wizard window in MIST-GIS interface was used to create a map depicting areas patrolled by only one range of the park. The wizard has the capability of separating

patrolled areas by each of the four ranges from that of the total area patrolled in the park within a period. With the filtering tool imbedded in the query wizard, area patrolled by South-East Range (Samole) for the period of January-October 2008 was separated from the entire patrolled area covered within the same period in park (Figure 4.31).

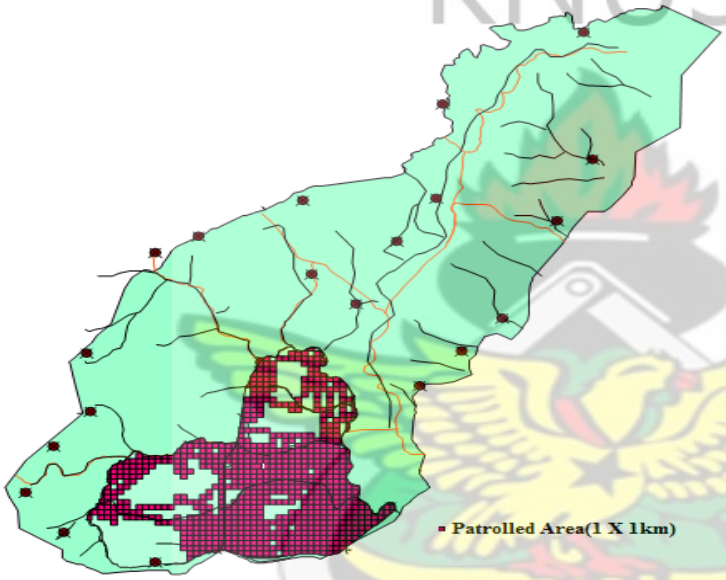

Figure 4.31. MIST patrolled areas for the period January -October 2008 (LEU MNP,2008)].

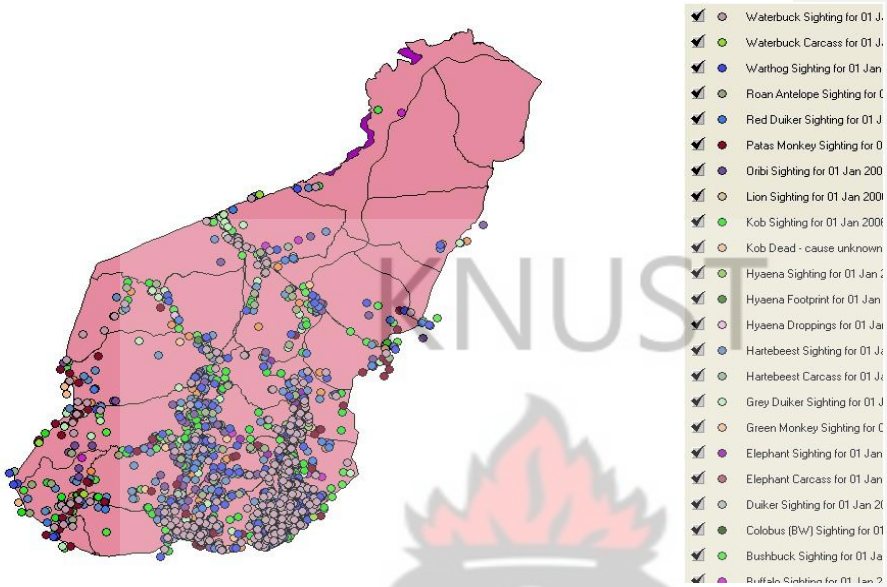

Figure 4.32. MIST mammals observation in dry season (January-October 2008)(LEU MNP,2008)].

For the purpose of comparison mammal observation and encounters with illegal activities maps were created for the dry season for the period January-October 2008 (Fig.4.32 & 4.33).

The illegal activities pattern followed almost the same areas that mammals were encountered except the north-easternmost part. This part is the Kulpawn marshy plains which harbours the Hippos and some population of wildlife. This area is accessible only four months annually.

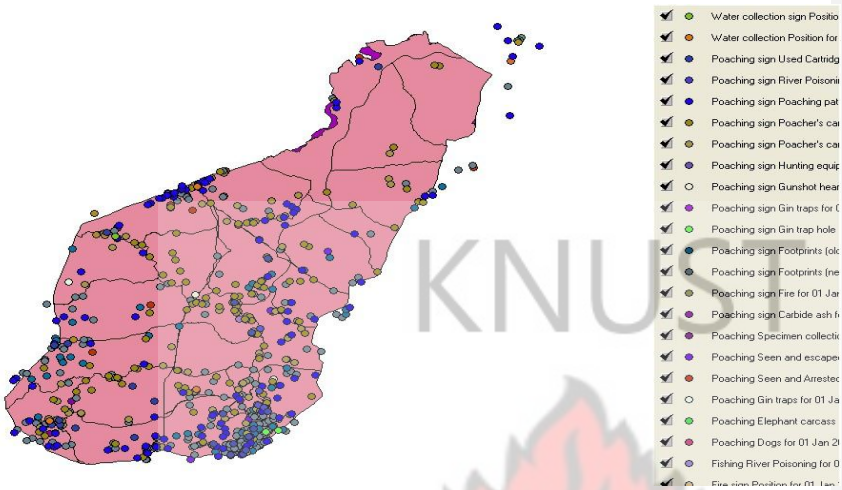

Figure 4.33.MIST illegal activity in dry season](LEU MNP,2008).

CHAPTER FIVE

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5.0 DISCUSSION

5.1. Poaching in Mole National Park

The findings of the study revealed that there is a seasonal difference in occurrence of poaching in Mole National Park (MNP).Generally hunting success as observed in the northern regions varied with the method used and the season of the hunt. That is to say hunters using guns and who hunt in dry season stand a high chance of success than those who use bows and arrows, cudgels and gin traps. About 25% (out of 147 events) of poaching events occurred in the month of March (Table 4.1).This is the month which mark the peak of the dry season where animals are concentrated around major rivers and water holes in the park. These rivers and water holes are Lovi, Nyanga, two dams at park headquarters, Kumsah pools and cluster pools around Asibey loop. Poaching is high during the dry season because most of the farmers have little farm work and as such engage in hunting in the park.

The results revealed that most of the poachers were arrested in 2004 (Figure 4.1).This could be attributed to the bonus system that was introduced under the Wildlife Division Support Project (WDSP) that motivated law enforcement staff to efficiently and effectively conduct patrols to reduced poaching to acceptable levels. In contrast, in 2003 a staff audit was carried out under the WDSP where some law enforcement staffs were earmarked for retrenchment and were used for alternative duties. This resulted in reduction of effective patrol staff density by 60% which implied only 50 patrol staff were available to cover the entire park of 4,800 $km^{2.}$ The result of this constraint is that the park was covered by patrols once every three months (quarter) instead of once a month as a standard (Jachmann, 2006].

5.2. Profile of arrested poachers

The study wanted to know the arrested poachers background which will help reveal the various communities they came from, age, occupation, ownership of firearm used in poaching, time of poaching, common hunting areas in the park, hunting group size and poaching excursion duration.

Poaching within and around protected areas (national parks) is largely a function of accessibility of the area by illegal hunters (Hamisi, 2008,Toxopeus, 1996). The study results revealed that most of the poachers arrested came from communities with good access roads and distance to the park boundary from 10 to 40 km. "It has been found out that poachers used bicycles, motorbikes and vehicles from distances beyond 7 km to communities that are close to the park where they are led by other poachers to enter the park (E.Bawhsu,pers. Comm.)." Larabanga ,a community which is located less than 7 km from the park, recorded the highest number poachers arrested during the study (Table 4.9).The analysis as shown in the table showed that few poachers came from communities further away from the park boundary and with majority of poachers originating from communities located less than 10 km. The south eastern section of the park borders the Larabanga community farms where there is constant movement of wildlife between farms and the park. Poachers take advantage of this uncontrollable situation and set gin traps in their farms and along the park boundary in order to poach these marauding animals (carnivores, kob, warhogs, patas monkey and baboons.). It is not unusual that patrol team remove on an average eight (8) gin traps a day along the boundary and in nearby farms. A male old lion was trapped in 2005 in one of the farms near the park boundary and was killed by the villagers. It was observed that these poachers set the gin traps late in the evenings and regularly check them usually early in the mornings and late afternoon to ensure that the trapped animals do not break the anchor of the

trap and escape or do not die without it being slaughtered as in the Muslim practice and hence become unsuitable for consumption by people of the Muslim faith.

It is clear from the above that communities close to protected areas contribute to poaching activities in terms of killing the animals Activities such as agriculture engaged by farmers create human-wildlife conflicts.

Arrested poachers educational level revealed that 95% had not attained any formal education and the rest having had some basic education from middle/junior secondary school. Only one poacher a professional (Hospital Administrator) representing 1% had tertiary education. Their levels of education presuppose that most of them are illiterates and had no qualifications to merit opportunity of being employed in the formal sector and thus employment by the park authorities was not possible.

The age range of arrested poachers was 18 to 60 years and with an average age as 35 years. This suggests that poaching as an illegal activity in the park cuts across age class. The results revealed that 31.9% (n=65) of the poachers arrested were within the age class 31-39 (Figure 4.2).This class if they had educational qualification would merit an opportunity of being employed by the park authorities.

In the rural set up the youth is mostly composed of this age class and as such are the sole source of labour to assist in farming and other economic ventures. During the dry season there is less farm work as such they turn to engage in poaching which can fetch them some cash and meat. Also in the absence of any gainful employment in the above situation the youth turn to indulge in any activity that is rewarding in terms of monetary gains without any regard to the risk involve.

The main thrust of the occupation of arrested poachers is agriculture (farming and livestock husbandry) as, their source of livelihood. Subsistence farming is the predominant system that is practiced in most of the fringe communities of the park (Table 4.3).The main crops produced are both cash and food crops that include sorghum, millet, guinea corn, maize, cassava, cowpeas, sweet potatoes, yams, beans, groundnuts and cashew nuts. Apart from subsistence farming poachers were also engaged in other economic activities like petty trading, traditional healing and fishing. The porters of the poachers were mostly unemployed and depended on their parents. They embark on any activity that will benefit their parents and as such it is not therefore surprising that most of the arrested were porters of the parents who were poachers. The age class with the highest number of poachers arrested was subsistence farmers. This implies that during the dry season there is less farm work and as such they turn to engage in poaching which can fetch them some cash and meat.

There is a general perception that wildlife poachers adjust their behaviour and take a decision to account for the likelihood of their detection and arrest in the park by patrol staff. Poudyal (2005) in his study of poaching of one-horned Indian rhinoceros in Royal Chitwan National Park (Nepal) found out that poaching increase in the park as poachers became familiar with the anti-poaching efforts and adapted to the techniques used by the enforcement personnel. There is evidence in Mole National Park that poachers know what the law enforcement staff would do at any time especially with regards to how they will do it and when(time) and at location in the park that they conduct patrols and with this information they increase their success in poaching without being captured. This information usually is divulged to the poachers by friends who are within the enforcement unit for a fee or meat.

From the above discussion time of the day of poaching and the lunar cycle has an influence on the effort put in anti-poaching patrols which are usually planned along these

temporal dimensions. The results revealed that 53% of the poachers arrested were in the afternoon and 4.9% were arrested at dawn (Figure 4.3). This pattern corresponds with the time that the patrol staffs are most active and when poaching takes place.

The moon phase of the lunar cycle is significant in hunting. It has a significant influence on animal behaviour which poachers capitalize on as a result of their long experience in hunting. Animals are more active at certain phases of the moon as in elephants. Dickinson (1985) noted that elephants seemed to be more active around the time of a new moon than at full moon. The above hypothesis was confirmed by the fact that there was a significant difference between the two phases (Wilcoxon matched-pairs signed –ranks test =2.801, P<0.01) by Barnes *et al* (2003) in a study of crop raiding by elephants around Kakum Conservation Area. Most of the animals in Mole are ungulates (grazers) which are mostly pursued by poachers any time of the day. According to Murray, 1992 ungulates (deer, elks, sheep, moose and cattle) feed according to the specific moon times. This implies that these grazers feed in a haste to reduce exposure to danger (from poachers and other predators) then retreat to safety for cover to "bed and chew the cud". The pattern of poaching from the study found that the time of poaching and the lunar cycle has a correlation. Most of the poachers were arrested in the afternoon of day time and at the time that moon was in the waning phase or last quarter phase (Table 4.4). The waning phase of the moon is a week following the full moon phase and it is when the moon is decreasing in size. Quarter-Moons peak overhead (and underfoot) during low-light periods of sunset and sunrise. Inadvertently ungulates use the reduced light as cover and are more comfortable with their surroundings during early and late "Moon times" associated with these phases (MoonConnection.com,2011).

The above observation entails that poachers take advantage of the full moon as means to convey the carcasses of the animals they have killed. They also use the full moon to transverse to areas of high concentration of animal and lay in wait for the moon to set in which is usually around dawn and they shoot at them. The few poachers that were arrested at dawn had no relationship with the phase of the moon but time of the day. This is the time gin traps are checked to ensure that the trapped animal does not escape and also they usually will not expect to meet patrol staff around that time.

In the context of hunting the implements use, facilitate people ability to kill wild animals. This entails the use of simple implements to sophiscated firearms to kill animals which , ranged from gin-traps, cudgels, catapult, cutlasses, machetes, dead fall traps, single and double barrel shotguns, simple rifles and semi-automatic (G3, SLR and AK 47) rifles (Asibey,1978).The type of weapon the poacher possess determine the type of animal they are likely to kill. Rifles are meant to kill big game (elephant, all kinds of antelopes, bucks etc.) whilst snares and gin traps and dead falls are used for killing grass cutter and medium size animals.

The people living in the fringe communities are in the poor income class with incomes below GH¢ 70 (700,000 old cedis) a year or GH¢5.80(58,000.00) a month or GH¢ 1.90 (1,900 old cedis) a day (A Rocha, 2007). Going by these figures averagely, most people are considered extremely poor and would not be able to acquire a firearm (SB Shotgun) which cost between GH¢ 200 and GH¢300 .Ownership of firearm by the arrested poachers varied in four categories as indicated (Figure 4.6).Out of the poachers arrested 41.5% did not possess a firearm and they were mostly the "carriers or porters "of the hunters they were arrested with. Poachers that owned the firearms (30.9%), once in their life time travelled and lived in Southern Ghana to undertake menial jobs in cocoa plantations and use their earnings

to purchase the firearm. The study also revealed that bush meat mongers also supply firearms and ammunitions to some poachers. These poachers as part payment system for the firearm and cartridges sell the meat of the animals they kill to the meat monger at a price less thatof the firearm and cartridges advanced to them.

Ammunition was mostly purchased from local markets and shops in towns such as Sawla, Damongo, Tuna, Daboya, and Kundugu. Bush meat traders also supply ammunition to poachers. Usually the poachers sell the animal to the trader less the cost of cartridges advanced to him. The hunters modify most of the cartridges to improve the chances of killing larger animals. They make slug cartridges, by removing the light shot and adding heavier cast slugs embedded in resin.

The channels of disposal of the meat by poachers are through bush meat traders who come from Southern Ghana to buy and transport to the south. Few traders from the local communities transport bush meat to the big cities in the south. Damongo market was identified as an outlet for large quantities of bush meat and with Techiman and Kumasi the main hubs for the trade (Figure 4.6). It was observed that processing of bush meat by poachers was unwholesome because of the number of days they stay in the bush and the care given to the meat.The objective of law enforcement in protected areas is to reduce illegal wildlife use to acceptable limits within a certain period set by management (Jachmann, 2007). In order to achieve this objective it needs adequate budgetary allocation for law enforcement operations. It therefore suffices to state that the number of poachers arrested in a protected area is being influenced by funding ploughed into the anti-poaching operation within that area.

The results indicated that over the years 2003-2008 two hundred and four (204) poachers were arrested by the law enforcement unit and with an appropriate amount of US$71,003 as operational cost during the WDSP project phase (2004-2006). Hence, the average cost of capturing a poacher by the law enforcement unit during the period is equivalent to US$348 poacher^{-1}, which is far lower than the cost of similar law enforcement exercises in the continent (Jachmann 2008; Jachmann 1998;Glover 1982; Jachmann 1997).

The group size of poachers and patrol staff has a linear relationship. For a successful arrest on encountering a group of poachers usually depends on the ratio of law enforcement officers to the poachers. That is a successful arrest usually involves twice as many law enforcement officers as poachers (psychological effect). In contrast the hunting group size of poachers has an influence on the hunting success in the case of big game. Hunting success in terms of number of game killed (No_k) by hunting group size decreases as the group size increase. For a group size of poachers between 1 and 4 number of game that can be killed successfully (1-4) during an expedition is 118 (No_k=118) and No_k=21 for hunting group size of 5 or more. The explanation of the relationship is that with large group size more animals sightings is expected but this has a negative effect in the sense that noise and smell of group warn animals ahead before their arrival. With small group this effect is minimized and the animals can be effectively stalked to a close distance and shot at. Overall, 57.8% poachers arrested were in group size of 1-2 distributed seasonally as 72 and 46 representing dry and wet seasons respectively (Table 4.5).The high figure for the dry season is because it is a period which coincide with the time that farmers are less busy in their farms and as such decide to indulge in poaching for food, meat, or money etc.

The analysis of the study found out that the number of days spent in the park poaching showed trends across the seasons of the year (Table 4.5).Generally the trend observed was

that 61.3% poachers were arrested in the dry season and spent just between two to three days in the park. Marks (1977) in a study of hunting behaviour of valley Bisa in Zambia noted that during the dry season months of May to October, the accessibility of water becomes a crucial environment variable influencing the daily movement of wildlife. Similarly in Mole National Park during the dry season of January to April some of the major rivers, pools and dams are the main sources of water (focal points) which influence the daily movement of most wildlife species. Hunting tactics by poachers revealed that short duration of time is spent around water holes where hunting success is usually high. The hunting tactics according to arrested poachers usually employed were lying –in-wait behind constructed hides for the game at water holes and ambushing constantly used trails of animals to waterholes or salt-licks. Soon as they kill an animal it is processed and smoked and taken away to the nearby bush meat market. During the rains (May-October), as the animals disperse from the water holes, the duration of poaching decreases with few of them lasting 2 to 4 days in the field. This is a period when most poachers are busy in their farm and has little time to engage in poaching. Poachers arrested during this period were those that had taken poaching as a sole carrier. It was also observed that poaching duration of between 1-4 and 5 or more days came from villages at distances of less than 10 km and greater than 20 km respectively.

5.3. Correlates of motivational factors of poachers arrested.

In the context of this study poaching is the illegal taking or possession of game animals and fish, non-game, and protected, threatened, or endangered fish and wildlife species (Bramwell, 1988). It is an unlawful practice in which an animal is hunted illegally mainly for subsistence and commercial reasons. The repercussions of poaching are that biodiversity is lost and also due to illegal wildlife trade, various species of birds and animals are on the verge of total extinction in the world at large. (www.bestindiansites.com).

Poachers have different motivations for what they do, among which are for; food, strictly a monetary profit, securing valuable trophies and for the thrill of seeing how many animals they can kill in a given time frame in competition with others (Bawa and Menon ,1997). Studies of the incentives to get involved in illegal activities have suggested that (a) a rise in the probability or stricter punishment (b) a fall in profits from illegal activity or (c) a higher opportunity cost of an illegal activity due to economic opportunities elsewhere reduce the level of illegal activities (Poudyal, 2005;Cook 1977 cited in Millner-Gulland and Leader-Williams 1992a.).

The study categorised motivational factors of poaching as; poverty, food, medicinal and others. Responses in relation to poverty from poachers were mainly focused on; farm size, type of crops grown and household size, availability to health and educational facilities and annual income as parameters to measure poverty. Poverty was the prevalent factor that motivates most of the poachers arrested (52.5 %) (n=107).There was strong positive relation between poverty and poachers arrested ($p<0.05$, r- 0.5336) (Table 4.10).Tradition and food as motivational factors for poaching were fairly related to poachers arrested, whilst medicinal and other factors were insignificantly related.

Most of the arrested poachers came from communities that are really poor farmers/hunters and whose livelihoods are threatened by unsustainable natural resource exploitation. The major source of income of the arrested poachers is agriculture. A base line socio-economic survey in six communities within two CREMAs revealed that the mean annual income was GH¢ 54.9 and GH¢ 49 (A Rocha 2006, 2007).These figures though not very comprehensive, give an indication of the level of poverty within these communities. A poverty diagnostic report of the National Development Planning Commission (NDPC 2003), looking at components of the Ghana Poverty Reduction Strategy in 2006, pegged the

extremely poor as people with incomes below 70Gh Cedis (700,000 old Cedis) a year or 5.8 Gh Cedis (58,000 old Cedis) a month or 1,900 Cedis a day. If these figures are anything to go by, then averagely, people in fringe communities of Mole National Park are considered extremely poor.

The study found out that most poachers were poor peasant farmers engaged in crop farming with little or absolutely no other source of cash income for the household. Their farm size range between 1-2.5 acres of farm lands.

Traditionally wildlife has always been used as a source of protein by most people in tropical Africa with the possible exceptions of some nomadic pastoralists (Pullan,1981).Three decades ago, about 70% of Ghanaians ate bush meat (Asibey, 1970;1974) but now the quantity of bush meat has dwindled resulting in a bush meat crisis in the country (Aalandong, 2005). Food as a motivating factor for poaching fairly correlated the number of poachers that were arrested ($P<0.05, r=0.3319$).The poachers attested to the fact that they are poor and as such see bush meat as the only source of animal protein and acknowledged that they sell some of the meat to maintain their families.

Traditionally hunting was once the activity of the Gonja people and other ethnic groups that live in the fringe communities of Mole Park. Some of the tribes had hunting grounds in the park controlled by the chief or earth priest and to which people go for group hunting usually after the "fire festival". Since group hunting is illegal, the practice of hunting in communal lands has seized. It is not unusual to find out from the study that some people in the communities because of traditional beliefs still annually sneak to these traditional hunting grounds in the park to get some wild animal for rituals. Some hunters acts as security guards for the communities and provide medicinal items from wild animals.

5.4. Categories of illegal activities committed by arrested poachers in Mole National Park

The gradual increase in number of arrested poachers during 2003-2008 was as a result of motivation and dedication among the law enforcement staff. Each of the staff on average spent more than 18 days actively patrolling on in the bush under difficult conditions away from home and their families.

The study identified serious offences such as hunting for bush meat for commercial purposes and possession of single barrel shotguns as very widespread in all the years (Figure 4.11, 12 & 13). Studies on bush meat survey in northern Ghana noted that the hunters used various types of weapons and about 90% of them use shot gun for hunting in recent times (Aalangdon, 2005). In contrast, few poachers armed with rifles were arrested for elephant poaching and came from distant communities to the park. A total of two elephant tusk were confiscated from a notorious poacher during the study. Traditional method of hunting by use of gin traps is a common practice by hunters who could not afford a shot gun .Fifty-seven gin traps of varied sizes were confiscated during the study .The hunting group size of between 1-2 poachers were identified to be prevalent over the years (Figure 4.10).The poachers identified for elephant poaching were of a group size of seven which is far lower than commercial elephant and Rhino poachers in Luangwa valley in Zambia (Leader-Williams *et al*,1990) .

Food (bush meat) was one of the reasons noted as a motivation for poaching in the park. The animals killed by poachers during the study ranged from small to large size. Two hundred and seventy-two wild animals were killed and which belong to 28 wildlife species (Figure 4.14). Medium to large size animals such as; Warthog, Kob, Bushbuck Waterbuck, hartebeest, buffalo, Roan antelope, etc were killed by use of shot guns and rifle. The bush

meat was for local consumption and for sale to take care of their families. Small mammals (bats and grass cutters) were persecuted most, for their meat is cherished by many people in both rural and urban areas in the country. Endangered species such as lion, elephant, Nile crocodile etc were poached for ivory in the case of elephant and bodies parts (skins) for medical and rituals purposes.

The distribution of poachers within categories of illegal activities (offences vs. classes) showed a significant difference and as such the hypothesis that there is variation between the arrested poachers and illegal activities is proven. Probability value is above 0.05 which statistically showed that the distribution of arrested poachers within the different categories of illegal activities is significantly different from random. The bases for variation are the type of firearm use and type of offence committed and the hunting group size.

5.5. Trend in prosecutions and convictions (penalties) of arrested poachers in Mole National Park

The law enforcement initiative (2003-2008) in Mole managed to reduced poaching to acceptable levels (- 34.39%/year on average) over the years (Jachmann, 2008).Effort in terms of staff performance increased to an average of 20.56 effective patrol days/staff/month in 2008 (Figure 4.23) which contributed to the decline in encounters with illegal activities as stated above. On average patrols in the field were made up of four to five and at times more during extended patrols which last for eight days out of camp. More than five men for external patrol is because of the possibility of encountering armed elephant poachers and at times a large group of hunters.

Poachers arrested were escorted to the police at Damongo to prefer charges against them and put before court and at some instances the wildlife staff appeared in court as

witnesses. Wildlife offences charged where according to those prescribed in L.I.710 and L.I.685 and the all the amendments. Delay in court cases was observed as a common practice in Tamale court. In Ghana the law stipulate that criminals are to appear in court in the district where the offence was committed. In the case of poachers arrested this rule at times was violated due to the peculiar nature of the location of the courts within reach of the park. Poachers arrested far north of the park are tried in Damongo or Tamale court instead of Walewale court the reason being accessibility and cost involved.

The general trend in types of prosecution from judgments of poaching cases varied in proportions between court fines and prison sentences over the years (Figure 4.17 and 4.18 and 19). Magistrates assisted the efforts of law enforcement to curb poaching at the barest minimum by imposing heavy fines and long prison terms. Most of the Magistrates that handled poaching cases use their discretion to fine or convict poachers above what is prescribed in the Legislative Instruments (L.I.s) and which depends on the gravity of the offence. However, some magistrates misinterpret the intentions of wildlife laws which from circumstantial evidence supports that they were ignorant of them and that explained low fines and prison sentences delivered to poachers prosecuted in 2003 (Figures 4.17 and 4.19).Clearly, it was noted that heavy fines do not deter notorious poachers who hunt for bush meat traders because these meat mongers paid the fines. There was a marked increases in the fines and prison sentences delivered by court with a high maximum fine of GH¢600 imposed to nine poachers. Similarly the maximum prison sentence was 108 months and was heavily imposed on one notorious elephant poacher from Larabanga community in 2004 (Figures 4.17 and 4.20).The steady increase in court fine between 2007 and 2008 was as a result of a change in the system of awarding fines .Fines were awarded on penalty unit bases with one (1) penalty unit equivalent to the current daily wage pertain in the country. Magistrates

during the same period gave mandatory fine GH¢300 as the minimum and five to six years prison sentences for elephant poachers and those who are second offenders. It was observed from the analysis of prosecutions that magistrates distinguished between poachers that had killed an elephant and large mammals in the range of hartebeest to buffalo and those that had committed other offences in terms of severity of sentences delivered. On the contrary, studies showed that magistrate courts that handled poaching cases in Zambia did not distinguish between elephant/rhino poachers and other offences in terms of severity of the sentences (Leader-Williams 1990).

Arrested poachers knew very well that ,the Mole National Park was a no go area for anyone to go in to hunt.They are also aware that ones need a license to enable hunting in the off reserves/bushes in their communities. Most of the poachers (63%) were charged with four offences. With the exception of 1.47 % the rest (98.53%) of the poachers were charged for unauthorized entry into the park without permission (L.I.710) which is the principal law guiding all PAs in Ghana (Figures 4.15 and 4.16).

The overall variation in proportions of fines to prison sentences and other punishment showed a significant difference between the two variables (Poisson distribution) and also from the relation of sentence to offence committed by the poachers and can be concluded that the type of offence committed determines the gravity of the sentence delivered by the court.

5.6. Trends in illegal activity in relation to patrol effort and abundance of large animals in Mole National Park

In Ghana the objectives for the protected area system are to conserve wildlife resources and biodiversity, but as a result of failing law enforcement programmes the rapid depletion of these resources has sharply reduced availability of protein in the form of bush

meat, loss of biodiversity and an impoverished environment in general (Jachmann 2006). Law enforcement programmes in protected areas in Ghana were on ad hoc basis coupled with insufficient funding to enable them achieve the objectives of conserving the resources in them. In the latter part of 2004 Management Information System (MIST) introduced in Mole to enable efficient and effective monitoring of law enforcement activities with regards to encounters of illegal activities and animals. In July 2004 Wildlife Division with support from SNV-Ghana introduced a monitoring system in six protected areas (Jachmann 2006).The main objective of the monitoring systems is to improve law enforcement and boost wildlife numbers and to prevent further loss of biodiversity.

Field staff patrol the protected areas to enforce wildlife laws and to deter offenders. Arresting of poachers and putting them before the law court is a deterrence measure to ward off potential offenders of the wildlife laws. Patrol effort has a considerable effect upon the distribution of illegal activity and mammals (Leader-Williams 1990; Leader-Williams. 1996; Jachmann 2008; Jachmann 2008). Poachers in Mole National Park avoided areas in the park that were heavily patrolled and seek areas with large concentration of animals. Over the years of study patrol effort varied in level relative to encounters with illegal activity and mammal's. Hence it is not surprising that encounters with illegal activities change consistently leading to reduction of poaching to an acceptable level since 2007 with corresponding increase in wildlife numbers. This pattern shown and coupled with circumstantial evidence supports the hypothesis that the true wildlife trend in Mole may approach that of patrol performance (Jachmann, 2008).

During the transition from camp system of law enforcement strategy to the range system between 2005 to 2007 there was poor patrol coverage of the park. The northern part was fairly patrolled as such poachers had a field day to poach with impunity. That is there

were patrol bias and that affected records of encounters with wild animal in the north. Generally staff densities in the park were too low to cover the entire park in each month and as such the assumption of temporal and spatial consistency in patrol coverage was thereby violated.

The situation to improve coverage received some intervention by construction of a sub-range camp to accommodate ten field patrol staff located at northernmost tip of the park and this was towards the end of 2008. It is also clear from the study that poaching in the park is a year- round occupation by some members of the fringe communities and as such law enforcement effort in patrols are planned according to the poaching seasons. A major problem in Mole is that the park is large with relatively few patrol staff to undertake law enforcement duties. In a survey of manpower relative to overall size of protected areas in different African countries in 1980, staff: area ratios varied from one man per 580 km^2 to one per 7 km^2(Boshe 1989; Cambell, 1987; Bell 1985;Bell 1983). At the time of the study staffing level in the Mole park was one patrol staff per 96 km^2 instead of one staff to 28 km^2 as standard for parks with key stone species like elephants. In spite of the low staffing densities and other constraints illegal activity has been lowered to acceptable level.

The relationship between patrol effort and encounters with illegal activities and mammal observations (Figures 4.25 & 4.26) can be used to predict the effort that it would have been necessary to prevent poaching of large mammals. The low p-value for regression analysis between response variable (illegal activity) on predictor (effort and mammals sightings) variables means it is unlikely that the observed discrepancy would occur by chance. This value is well below 1 and it can therefore be inferred that patrol effort and mammals encountere rate significantly affect the distribution of illegal activity. Intuitively the null hypothesis that there is no significant effect of the predictor variables on the response variable is rejected.

To achieve optimal population of mammals that is by curbing poaching, it would be prudent to increase staff numbers which will correspond with increase in patrol effort. This situation will create relative safety refuge areas where there were few animals initially and which will induce some animals from less safe areas to move into. Patrol effort can be improved in protected areas with low staffing densities by increase in patrol coverage which includes reducing patrol size, increasing patrol time (effective patrol days/staff/month) spent in the field and using helicopters or light aircrafts (Boshe, 1989;Bell, 1986b). These options will involve inputs such as well armed and trained patrol staff with logistical support, better servicing and provision of good vehicular and mechanical support (Leader-Williams 1990;Tatham, 1988). Regrettably all the three options mentioned at times are less readily affordable or available in most protected areas in African countries which are already lacking infrastructural inputs (funding) in terms of resource allocation to law enforcement programs. Law enforcement effectiveness in Mole National Park employed the method of using intelligent information from informants as practiced in most African protected areas, which leads to arrest of more poachers outside the park. By this method law enforcement effectiveness is achieved by maintaining a balance between adequate patrols in the field and arrest of poachers through intelligence information from informants from the figne communities.

5.7. Temporal and spatial distribution of illegal activity and animal sighting

The high number of poaching incidence in the dry season (Figure 4.27) from February to March could also be attributed to traditional festivals and mass funeral rites performances (demand for bush meat) in the fringe communities of MNP. Most of the poachers arrested during the study attest to this. Poaching varied with intensity within the park which is determined by a range of actors such as availability, food, water, cover for safety and

frequency of patrols in prime areas of animal concentration. Very high intensity of poaching occurred in the south eastern part of the park and with low intensity in the south western and most of the northern section of the park (figure 4.28) These areas are Samole beat, along Lovi and Nyanga rivers, Hegga satellite camp representing few of some of the high intensity and Kulpawn, Gbantala, Kuboma camps beats as low intensity poaching spots. Very low poaching around the Polzen waterfalls is as a result of constant presence of patrol staff during the dry season which is the only time it is accessible. Also the rugged terrain also discourages poachers to risk walking to the area.

However, very low poaching observed around prime areas for high wildlife concentration could be attributed to regular patrols to these areas throughout the years(Baltussen *et al*. 2008; Garshong *et al.* 2008; Hamisi., 2008).

The kernel density distribution map of origin of arrested poachers (Figure 4.29) as indicated depicted communities that are potential threat to the park in terms of poaching intensity. Management of the park can strategize patrols by identifying these communities by looking at the frequency of poaching, the number of poachers arrested or other illegal activities committed by the inhabitants of a respective community and also by locating how far the communities are from the park.

5.8. Use of MIST to show spatial display of patrol path, patrolled areas, illegal activities and mammal observations.

As part of improving the capacity and effectiveness of law enforcement in reducing poaching of wildlife in Mole National Park, MIST was introduced in 2004 alongside the Wildlife Division law enforcement adaptive monitoring system. MIST Patrol-based monitoring has the distinct advantage of providing regular and rapid information on illegal

activities and patrol staff performance. The patrol path and patrolled area maps (Figure 4.30 & 31) aid in patrol deployment and monitoring of staff performance (Appendix K). MIST output maps can be used to create competition between the four ranges in the park. Maps showing areas recently patrolled enable law enforcement to prepare two weeks patrol operation plan.

A credit achieved with MIST is the spatial display of the illegal activity and mammals encountered during patrols by use of data gathered using GPS (Figure 4.32 & 33).Maps showing wildlife distribution gives information on the status of key wildlife species in the park in terms of population structure (sex ratio and number of young animals).

The results illustrated above depict explicitly illegal and mammals observations for eight months in 2008 (Jan-October).This time period is adequate to give an indication of how patrol data is displayed over the months in 2008. Patrol data from 2004-2008 can also be processed by MIST to give an indication of how the phenomena is recurrent over the years. The variation in encounters with illegal activity and wildlife in different areas and seasons within a year may help to inform the park management which time of the year is poaching at its peak and low levels (Appendix I & J). Map showing the illegal activities are used for pro-active deployment of patrols.

Consequently a seasonal or patrol schedule can be developed base on these observations (Appendix G).With the above interpretation of spatial and temporal patterns of poaching events, output maps (Table 4.6,Figures 4. 27, 30, 31,32 & 33) especialy the illegal activity and mammals distribution maps will aid the law enforcement unit to be more practical and strategic in staff deploymentuse. These maps depict potential areas of poaching especially illegal activities map (Figure 4.33) which is useful to patrol staff. In conclusion MIST output maps produced during the studyperiod would be helpful in decision making

especially on how best to direct law enforcement patrols by giving pre-determined GPS coordinates to cover areas of importance.

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CHAPTER SIX

6.0 GENERAL CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

The study was undertaken in Mole National Park, Ghana to determine the trends and dynamics of poaching. The work was broadly motivated by a desire to better understand the trends in poaching and motivational factors that inspire inhabitants of fringing communities to indulge in poaching and also look at how MIST software can be used to improve law enforcement patrol effort that will reduce poaching incidence to acceptable levels in MNP and finally assess the likelihoods of detection, punishment, and repeat offence of arrested poachers. In this concluding chapter, the key findings of my study are summarized and highlights of some important recommendation and direction for future research are provided.

6.2.Conclusions

Based on the research questions amd hypothesis,it can be concluded from the study as follows:

Research question 1: *What is the inspiring factor for poaching?*

To investigate the inspiring factor of poaching, a total of two hundred and four (204) arrested poachers enumerated through questionnaire categorised the factors as; poverty, tradition, food, medicinal and others.The five predictor variables were used to test for significance in explaining motivational factors of poaching in Mole National Park.Among the five predictor variables,poverty to food and medicinal had statisticaly significant negative relationships.However poverty had a statistical significant positive relation with poachers arrested.Thus the null hypothesis was rejected.

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Research question 2: *What type of illegal activity do the offenders engage in and where do they originate from?*

The type of illegal activity poachers engage in are hunting by use of firearm, gin trap and –poisoning.Most of the poachers arrested during the study came from the 27 fringe communities of Mole National Park..Larabanga which is located less than 7km from the park boundary had the highest number of poacher arrest 19.6% (n=40).

A G-test analysis of frequency of arrested poachers distributed within categories of illegal activities (offences vs classes) showed that the distribution is not significant.Thus the null hypothesis is true or accepted.

Research question 3: *What is the trend in prosecutions over the years (2003-2008)?*

The study relevealed that there was a marked increasing in the fines amd prison sententeces delivered during the 2003-2008,The general trend of prosecutions was a steep increase in court fines from 2003 to 2004, a gradual and minor decline to 2006, increasing again up to 2008.Similarly there was a gradual decline in prison terms from 2003 to 2005, a sharp increase to 2006, a dip in 2997 and a general rise up to 2008,The highest fine was GH₵600.00 and prison terms of 108 months respectively.In the same way the lowest fine was GH₵30.00 and prison terms 3 months repectively.

Research question 4: *What are the relationships among illegal activiies, patrol efforts and large mammals?*

To investigate the relationships among the three independent variables ,simple linear and multiple regression analysis was performed to test for their significance in explaining the relationships.Simple linear regression of illegal activity on mammal sightings showed a statistically significant fairly positive relationships.On the other hand multiple regression of

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illegal activity on both patrol effort amd mammal encounter rate also showed that mammal sighting is a variable useful in predicting incident of illegal activity.In the null shell the overall relationships between illegal activity and the two independent variables had statistically significant positive relationships. Thus the null hypothesis is false and rejected.

Research question *5:* *Is there a relationship between the spatial distribution of illegal activity (poachers arrested) and the origin of arrested poachers?*

The GIS based map produced in this study identified poaching intensity spots within the park from 2003-2008.The poaching intensity spots are areas that harbour most of wild animals.The kernal map of the park with fringe communities showed that most of the poachers arrested came from communities that are less than 15 km to the park boundary.

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The general conclusion is that the objectives of the study has been achieved with the following:

1. The study has increased knoledge of motivation factors of poachers in MNP.
2. The origin of arrested poachers and their profile is now well known.
3. The extent to which the court upholds wildlife laws in relations to type of offences are known.
4. Effective time spent by payrols and motivating factors that leads to sucessful arrest of offenders are known.
5. A MIST map of the distribution of illegal activity and large mammal's abundance has been produced.
6. Patrol effort and wildlife abundance effects upon the distribution of each category of illegal activity has been established.

7. A MIST map of the distribution of illegal activity and patrol path has been produced and could be used as model for law enforcement unit in planning new anti-poaching strategies.

6.3..Recommendations

Inhabitants of fringe communities of Mole National Park indulged in poaching because of poverty and meat(food) to supplement their income and protein needs. The research needs mentioned in this section are not based on the study alone but also on the literature reviewed as the review informed the thoughts that led to urgent needs for research into poaching trends and dynamics.

It is believed that park management, students and other stakeholders will find the needs indispensable and will try to delve into some of them that might help solve prevalence of poaching in the park. It is expected that study of aspects of poaching as an issue that has bedeviled protected areas in most African countries may result in finding solutions to it.

Some of the study areas are:

- How population growth in the fringe communities of Mole National Park lead to poaching in the park;
- Community involvement in the management of the park from the inception of CREMA Concept to today and how it impact on the level of poaching by fringe communities;
- The effectiveness and relevance of wildlife laws and policies in the country today.
- Measuring and Mapping threats to wildlife in Mole National Park
- Analysis of Bush Meat markets in northern Ghana.

- Effectiveness of Law enforcement techniques for apprehending poachers in Mole National Park
- Study of Hunters and traditional methods employed in hunting wildlife in fringe communities of Mole National Park.

Based on the above findings of the study and suggested areas for future study it is therefore strongly recommended that the following activities should be undertaken;

1. 1.Patrol staff need to intensify patrol operations in the wet season as in the dry season.
2. 2.To have a uniform ground coverage of the park,patrol staff should be deployed to Kparia sub-range camp on three months rotational basis to enable them cover the northern part of the park.
3. 3.It is suggested that advocacy for Law enforcement agencies especially the judiciary should be stepped up to enable them understand the management of the problems created breaching forest and wildlife laws.
4. 4.It is strongly recommended that the park management through the CREMA concept should advocate with NGOs for alternatives livelihood support programs in the fringe communities.In this way conservation and utilization of wildlife resources will be kept within sustainable limit

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APPENDENCIES

Appendix A:Patrol Instruction Sheet

Date…….Range……MNP GPS Serial No……MIST Patrol ID……...……

1. OBJECTIVE

1.1 Detection of illegal activity
1.2 Wildlife distribution and abundance
1.3 Other……

2. ROUTE (Task)

2.1 Assemble at……date……..……

2.2 Deploy from……..date……..

To reach……date……

Waypoint Number: Start……. Waypoint number: End……

Details of law enforcement effort

Date	Time start	Time end	Time	Activity

Summary of observations

Illegal activity

Description	Classification	Numbers	WPT No	Sub sector

Wildlife Observation

Species	Numbers seen	WPT No	Sub sector

Other……
……
……
…….

Appendix B: Arrested Poachers Data Capture Form A

INFORMATION FROM THE ACCUSED **Data Capture Form No.** _____

DATE:				
SURNAME:				
CHRISTIAN NAMES:				
AGE:				
ID NUMBER:				
OFFENCE:				
AREA HUNTED IN:				
GRID LOCATION (GPS)				
ANIMAL KILLED:	YES		NO	
IF YES, CROSS REF. PREVIOUS DCF NUMBER/S:				
DO YOU WORK?	YES		NO	
IF YES, WORK'S NAME, ADDRESS & TEL NO:				
IF NO, HOW DO YOU GET MONEY FOR FOOD?				
REASON FOR HUNTING INSIDE THE PARK:				
	DOGS		SPEARS	

METHOD OF HUNTING:	SNARES/TRAPS		FIREARMS	
	FIREARM TYPE			
WHERE DID YOU OBTAIN THE FIREARM FROM?				
TIME OF INCIDENT:	DAY		NIGHT	
	MORNING		D/ MOON	
	MIDDAY		L/MOON	
	AFTERNOON			
WHAT ANIMAL DID YOU COME IN TO POACH?				
NAMES OF PEOPLE YOU WERE HUNTING WITH:	1		DCF No.	
	2		DCF No.	
	3		DCF No.	

	4		DCF No.	
	5		DCF No.	
CONTRAVENED SECTION:				
WAS HE CHARGED?	YES		NO	
WHICH POLICE STATION?				
WHO LAID THE CHARGES?				
NAMES OF WITNESSES WHO GAVE STATEMENTS:	1			
	2			
	3			
	CR No.		CASE No.	
COURT CASE DATE:				
WAS THE CASE				

REMANDED:	YES			NO		
IF YES, REMANDED DATES	1			2		
	3			4		
	5			6		
WAS THE ACCUSED CONVICTED?	YES			NO		
WAS THERE A REPORT WRITTEN ABOUT THIS INCIDENT?	YES			NO		
IF YES, CROSS REF. REPORT NUMBER:						

Appendix C: Wildlife Guards on muster parade at park HQ

Appendix D: Poachers with fire arms and their booties

Appendix E: A male Kob caught in a Gin

Appendix F: Classes of poaching activities recorded by patrol staff

Seen or seized (current poaching) **Serious Offence**	**Minor Offence**
Armed poachers seen – escaped	Poisons synthetic (into water)
Porters (carriers) seen – escaped	Poisons natural (into water)
Poachers camps (occupied)	Fishing by legal methods
Armed poachers arrested	Medicinal plants
Porters or unarmed poachers arrested	Fuel wood extraction
Domestic hunting dogs seen	Thatch Grass removal
Shotguns	Fruit products removal(Shea nuts & Dawadawa)
Rifles	Honey hunting
Shot gun cartridges	Weaving materials
Rifle cartridges	Hunting with domestic dogs
Gun shots	Wire snares
Gin traps	
Deadfall traps	
Animal poached (by species)	
Meat recovered <2kg	
Meat recovered 3kg-10kg	
Meat recovered 11kg>	
Poached elephant – Carcass 1	
Poached elephant – Carcass 2	***Signs***
Poached elephant – Carcass 3	Poachers tracks(foot prints
Poached animal (by species)	Gin trap holes

	Spent cartridges – shotgun
	Spent cartridges – rifle
	Poacher's camps – shelters
	Poacher's camps - meat racks

Appendix G: Monthly patrol schedule

DATE	GROUP I	GROUP II	GROUP III	GROUP IV
1ST-6TH	Extended Patrol	Local Patrol	Extended Patrol	Local Patrol
7TH-12TH	Local Patrol	Extended Patrol	Local Patrol	Time Off
13TH-18TH	Time Off	Local Patrol	Extended Patrol	Extended Patrol
19TH-24TH	Extended Patrol	Time Off	Local Patrol	Local Patrol
25-END	Local Patrol	Extended Patrol	Time Off	Extended Patrol
TOTAL	2 Extended 2 Local	2 Extended 2 Local	2 Extended 2 Local	2 Extended 2 Local

Appendix H: Casual Interview with Notorious poacher and his carriers

On the 16th of September 2003 I Seidu Kotoma asked my brother Zakaria Yakubu and my son Sule Seidu to accompany me to the park to hunt any animal I could find. We therefore set off in the evening about 3:30pm into the park. We arrived at my hunting area called ***GONZIN (SE 3)*** *around 5:30pm and we hunted in vain because the area was wet and bushy. There are watercourses and salt licks in the hunting area where animals frequent quite well particularly in the dry season. The next morning we searched for animals to kill but all in vain. We therefore decided to return home. Just about getting to the park boundary, we heard hands up. We ran helter skelter but luck was not on our side so the wildlife staff arrested all of us. I am a farmer and use to hunt occasionally. I have ever been arrested in the park before in about three years back. I have decided to stop hunting and want to settle at Damongo where I have even parked almost all my belongings and farmed this year. One of my five sons has qualified to Senior Secondary School and I needed money to immediately to pay for his school fees. Since my maize and cassava are not yet matured for harvesting, I went into the park to kill any animal particularly bushbuck, to sell and get quick money to pay school fees. We buy ammunition from Sawla vehicle that carry traders to Damongo market on Saturdays. Ammunition cost cedis 3,000.00(GH¢0.30).I made the three slugs. I emptied the pellets from a cartridge case then melted them in an empty milk tin into a big ball. I then divided the big ball into nine balls that is good for killing bigger antelopes like roan, hartebeest, as well as buffalos. It is not easy to shoot and kill an animal with the cartridges we buy because the pellets are too small and lightweight to enter the skin of bigger antelopes. I inherited the shot gun from my*

late father. We mostly send the meat we get from hunt in the park on bicycles to Sawla to sell to either chop bar keepers or bush meat mongers. One lump of sizeable bush meat sells at cedis 25,000.00(GH¢2.50) and could get about five to six lumps from mature bushbuck. There are many bush meat mongers and hunters in Kabampe but they don't buy meat from Grupe. I know of two hunters in Grupe but they are both old and no longer hunt. We enter the park to hunt either at dawn or in the evening around 4:00pm which period the wildlife staffs are at camp. According to Zakaria Yakubu he accompanied his brother to hunt so that he could get money to fare himself to follow up his application he submitted to the park for recruitment. On the other hand, Sule accompanied his father so that they could get money to pay for the school fees of his brother.

Appendix I: MIST Mammal report

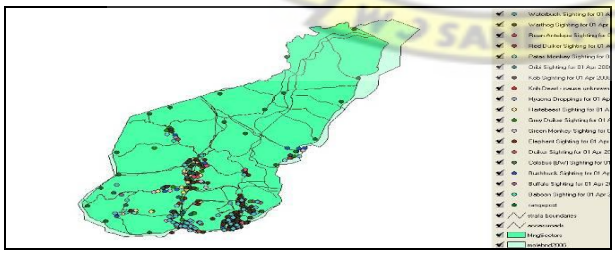
Mole National Park Ground Patrols

MIST Mammal Report
4/1/2006 : 5/1/2006
Report Date: 5/31/2007

Patrol days	%Field=PATROL_DAYS%	**Total distance**	1390.15

Paid	Management sector	Observation	Observation code	Total count	Total per km	Total per km per days	Adult males	Adult females	Total young	Males to females
MNP		Baboon	Sighting	490	0.35		0	0	0	0
MNP		Buffalo	Sighting	382	0.27		0	0	0	0
MN		Bushbuck	Sighting	115	0.08		0	0	0	0

P										
MNP		Colobus (BW)	Sighting	2	0		0	0	0	0
MNP		Duiker	Sighting	1	0		0	0	0	0
MNP		Elephant	Sighting	193	0.13		0	0	0	0
MNP		Green Monkey	Sighting	168	0.12		0	0	0	0
MNP		Grey Duiker	Sighting	28	0.02		0	0	0	0
MNP		Hartebeest	Sighting	497	0.35		0	0	0	0
MNP		Hyaena	Droppings	1	0		0	0	0	0
MNP		Kob	Dead - cause unknown	1	0		0	0	0	0
MNP		Kob	Sighting	1141	0.82		0	0	0	0
MNP		Oribi	Sighting	32	0.02		0	0	0	0
MNP		Patas Monkey	Sighting	72	0.05		0	0	0	0
MNP		Red Duiker	Sighting	19	0.01		0	0	0	0
MNP		Roan Antelope	Sighting	176	0.12		0	0	0	0
MNP		Warthog	Sighting	262	0.18		0	0	0	0
MNP		Waterbuck	Sighting	228	0.16		0	0	0	0



Appendix J: MIST Illegal Activities report

Ghana Wildlife Division
MNP Illegal Activities Ground Patrols
1/1/2005 : 1/1/2006
Report Date: 1/7/2006

Area	Observation	Type	Observations/km	Total	Sector
MNP	Encroachment	Cultivation	0	6	
MNP	Encroachment	Grazing	0.01	206	
MNP	Encroachment	Trespassing	0	3	
MNP	Fire sign	Position	0	1	
MNP	Fishing	River Poisoning	0	1	
MNP	Poaching	Dogs	0	8	
MNP	Poaching	Elephant carcass	0	2	
MNP	Poaching	Gin traps	0	10	
MNP	Poaching	Seen and Arrested	0	28	
MNP	Poaching	Seen and escaped	0	30	
MNP	Poaching	Specimen collection	0	1	
MNP	Poaching sign	Carbide ash	0	31	
MNP	Poaching sign	Fire	0	1	
MNP	Poaching sign	Footprints (new)	0.02	578	
MNP	Poaching sign	Footprints (old)	0	88	
MNP	Poaching sign	Gin trap hole	0	6	
MNP	Poaching sign	Gin traps	0	1	
MNP	Poaching sign	Gunshot heard	0	6	
MNP	Poaching sign	Hunting equipment	0	10	
MNP	Poaching sign	Poacher's camp (new)	0	83	
MNP	Poaching sign	Poacher's camp (old)	0	151	
MNP	Poaching sign	Poaching path	0	131	
MNP	Poaching sign	River Poisoning	0	7	
MNP	Poaching sign	Used Cartridges	0	32	
MNP	Water collection	Position	0	4	
MNP	Water collection sign	Position	0	1	
	count = 26		avg = 0.00	sum = 1426	

Appendix K: MIST Ranger reports on staff performance.

Ghana Wildlife Division
MNP:Ranger Reports Ground Patrols.
1/1/2005 : 12/31/2005
Report Date: 1/7/2005

Number of Patrols	**671**	**Average Days on Patrol**	**1.62**
Patrol Days	**1088**	**Average Nights on Patrol**	**0.62**
Patrol Nights	**417**	**Average Patrol Size**	**3**
Total Distance(km) Patrolled	**19865.85**	**Average Patrol Distance(km)**	**29.61**
Costs / km Patrolled	**0.00**		

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Id	Name	Patrols	Days	Nights	Distance (km)
MNP226861824	Abdulai,Jeramoah	1	1	0	8.28
MNP201954660	Abdulai,Newton Seidu	25	45	20	768.93
MNP201959250	Abu,Mahama	35	45	10	772.48
MNP201955681	Abubakari, Abdulai	12	21	9	380.23
MNP202025956	Abubakari,Osman	28	65	37	919.68
MNP201956705	Abudu,John Saaka	55	64	9	753.42
MNP226862403	Abutu,Yoori	6	9	3	155.63
MNP201961853	Acheriwura,Paul	17	49	32	1505.53
MNP201955089	Adamu,Charles Lange	13	29	16	537.34
MNP201954483	Adjei,Fibri	23	44	21	724.61
MNP201956112	Adjimbaruk,Daniel	92	126	34	2387.88
MNP201958056	Adjongbah,Christopher	45	58	13	654.47
MNP201954347	Akologo,Ernest	12	43	31	759.2
MNP204562800	Akwesi,Baah Michael	34	71	37	1143.63
MNP201959303	Alaja,Baba Mahama	22	30	8	797.57
MNP202370324	Alhassan,Kalima Salia	90	122	32	1693.48
MNP226861463	Alhassan,Mashahudu	3	7	4	103.38
MNP202025702	Alhassan,Thomas Iddrisu	13	26	13	541.28
MNP202025744	Ampah,Akwesi	28	61	33	1011.87
MNP202026903	Apetu,Ebenezer	6	18	12	1181.6
MNP203360190	Aumbilla,Abambila	76	92	16	1201.96
MNP201954597	Baba,Adams	19	39	20	549.25
MNP201958923	Badong,Simon	19	43	24	763.68
MNP190450953	Bagnaaba,Seidu	17	31	14	623.45
MNP204562845	Balangtaa,Cletus	6	6	0	207.92
MNP201954717	Bayon,Telli	20	28	8	496.09

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MNP201956057	Dakubo,Ala-menga	20	35	15	664.55
MNP203363126	Danaba,Bani Eric	79	113	34	1809.26
MNP201958439	Dekumwuni,Solomon	57	84	27	1217.12
MNP201958477	Duada,Zakaria	50	70	20	971.58
MNP202025869	Dunaba,Seidu	13	32	19	541.28
MNP201955560	Dziwornu,Paul	8	40	32	1091.8
MNP226862219	Gazari,Alex Mahama	1	1	0	8.28
MNP203363997	Gbamanga,Kojo	11	21	10	305.27
MNP201959560	Geli,Tindana	11	48	37	919.01
MNP201958532	Haruna,Latif	16	50	34	1205.54
MNP201959477	Hashim,Haruna	26	52	26	719.39
MNP201955609	Iddisah,Abu	17	50	33	1679.51
MNP201954798	Iddrisu,Abdul-Karim	19	55	36	935.07
MNP202026852	Issifu,Aduku Josiah	5	15	10	261.34
MNP201955240	Issifu,Awudu	18	54	36	1346.86
MNP202026002	Jahini,Bahanyaw	41	56	15	693.8
MNP201955292	Jakpa,Tumedaa	81	115	34	2371.83
MNP202025247	Karaba,Kodjovi	75	90	15	1922.77
MNP201958243	Kipo,Daniel	33	48	15	730.3
MNP201958174	Kipo,Forah	8	19	11	252.17
MNP201954957	Koji,Salia	21	45	24	891.99
MNP201959704	Kubueri,Wekem David	87	111	24	1203.52
MNP202025302	Kumah,Isaac.K.	28	55	27	862.69
MNP201959204	Kunfu,Alhassan Clement	22	46	24	1895.2
MNP202025555	Kwabena,Iddrisu	16	49	33	917.06
MNP202025404	Kwasi,Oppong Isaac	29	75	46	1698.42
MNP201953988	Labare,James	17	37	20	561.03
MNP213467355	MELIBA,HAPPY	19	26	7	360.87
MNP201954911	Mahama,Ibrahim	41	75	34	1504.94
MNP201956593	Mahama,Issifu	40	46	6	818.52
MNP201957964	Mahama,Mumuni Daniel	14	45	31	1270.28
MNP201958859	Mahama,Nuhu	18	41	23	737.81
MNP202025502	Mahammed,Adam Bani	25	53	28	974.96
MNP201959617	Majeed,Alhassan	16	60	44	1600.31
MNP201956635	Mbeamah,Alhassan	21	40	19	738.76
MNP202026150	Mbugri,Williams	58	79	21	1154.72
MNP202026288	Mohammed,Yussif	19	54	35	656.19
MNP201959076	Moshie,Albert Kipo	28	57	29	864.34

MNP201955454	Munaba,Dari	48	58	10	755.18
MNP201955499	Musah,Badewu	12	37	25	504.26
MNP202026101	Nuadom,Kipo	2	6	4	72.27
MNP202025457	Nyadia,Yakubu	60	88	28	1347.57
MNP202026963	Onyar-Dery,Matteaw	1	1	0	17.07
MNP202025800	Pasor,Abubakari	20	54	34	1034.47
MNP202025356	Pasor,Yakubu	9	34	25	824.01
MNP201954410	Pozung,Donatus	25	71	46	1715.71
MNP202025198	Saaka,Kasim Calous	22	58	36	1847.78
MNP201955158	Sanduobo,John Azigizaga	17	45	28	608.12
MNP201954168	Sarpong,Isaac	1	3	2	35.89
MNP201958125	Seidu,Abu	17	59	42	1143.32
MNP202025913	Seidu,Kasim	21	62	41	778.85
MNP226861284	Seidu,Mahama Sakara	2	2	0	36.23
MNP226861399	Seidu,Zackaria Francis	1	1	0	8.01
MNP204562713	Sulemana,Yahaya	20	62	42	2045.1
MNP201954549	Sulemana,Zakaria	12	27	15	404.04
MNP202026203	Tahiru,Abubakari	58	78	20	1019.18
MNP226862460	Tanko,Timonty	3	7	4	89.7
MNP201954094	Ware,Zakaria	2	16	14	375.56
MNP202026055	Wayo,Alex	11	23	12	395.52
MNP201958595	Wepiah,Awedoba Peter	86	99	13	1169.21
MNP226862087	Wepiah,Kaba	3	3	0	33.91
MNP202025598	Yahaya,Duada	36	55	19	1224.49
MNP201961905	Yahaya,Mahama	16	56	40	2030.8
MNP201954850	Yussif,Adama	27	66	39	1198.03
MNP201954231	Yussif,Ibrahim	2	15	13	260.82
MNP201956551	Zieche,Robert	50	68	18	977.75
	count = 92	sum = 2409	sum = 4369	sum = 1960	sum = 80954.03

Appendix L: Chi-Square table of time of arrest of poachers and the lunar cycle

	Value	df	Asymp.Sig. (2-sided)
Pearson Chi-square	19.278[a]	9	0.023
Likelihood Ratio	17.242	9	0.045
No of Valid Cases	204		

a-5 cells (31.3%) have expected counts less than 5.The minimum expected count is 1