KWAME NKRUMAH UNIVERSITY OF SCIENC E AND TECHNOLOGY - KUMASI

COLLEGE OF SCIENCE

DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY

THE EFFECTS OF FOREST DESTRUCTION ON THE COMMUNITY AND ABUNDANCE OF BUTTERFLIES IN THE BOSUMKESE FOREST RESERVE.

A THESIS SUBMITTED TO THE DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (ENVIRONMENTAL SCIENCE).

BY

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JULY, 2011

DECLARATION

CANDIDATE'S DECLARATION

I hereby declare that this thesis is the result of my own effort and that no part of this work has been presented for another certificate in this university or elsewhere.

Candidate's Signature: …… Date: ……..

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this theses was supervised in accordance with the guidelines on supervision of thesis laid down by the Kwame Nkrumah University of Science and Technology, Kumasi

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ABSTRACT

Despite substantial loss of natural forest in Bosumkese forest reserve by inhabitants, little is known on the effects of the massive habitat loss and degradation on its forest biota. To investigate the effects of anthropogenic disturbances, butterflies were surveyed in three forest types identified in the forest reserve namely, disturbed canopy (DC), and slightly disturbed canopy (SDC) and undisturbed canopy (UC) which was the control site for the study.

Questionnaire and interview schedules were the main instruments used in collecting data on the threat of human activities affecting the forest reserve. The data was analysed using Microsoft Excel and SPSS and the results presented in percentages and means. Samples of butterflies were carried out by the use of fruit – baited traps in a line transect selected in each of the study area as well as the use of walk –and –catch within the 1 kilometre zone in each forest type. The data collected was quantified in terms of the total number sampled and relative abundance, expressed in percentage. Species richness and diversity of the butterflies were analysed using Simpson's Diversity Index.

The demographic data revealed that anthropogenic activities in the area are male dominated (65%) with farming (70%) and chain saw lumbering (15%) being the main occupation of the people. These human activities in the forest have resulted in wanton destruction of the resources within the forest reserve. Consequently, the situation has affected the rainfall pattern of the area, rivers and streams, productivity of agriculture and biodiversity of the forest. The disturbed canopy had the largest number of butterflies (51) compared to the undisturbed canopy (31). However, the relative abundance of the butterflies in the disturbed area was largely Papilionidae which adapted well to the open area where the forest is of poor quality. On the contrary the study also revealed that most of the butterflies in the undisturbed canopy and slightly disturbed canopy were Nymphalidae which are mostly butterflies of forest of good quality. In terms of species richness, the undisturbed canopy had the highest species richness (14) and diversity (0.019) compared to the disturbed canopy which had the least of species richness and diversity that is 8 and 0.15 respectively.

It is recommended that butterflies should be use as a model to monitor the health of forest reserves and in addition there should be strict enforcement of forest laws by the law enforcement agencies to help steer our conservation efforts in the country.

DEDICATION

Dedicated to my father, Mr. Francis Addai of blessed memory and my mother, Mrs. Comfort Opoku for their financial and moral support.

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First and foremost, I thank the Almighty God for his protection and guidance throughout the preparation of this thesis.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Forest provides many social, economic and environmental benefits. In addition to timber and paper products, forest provides wildlife habitat and recreational opportunities, prevent soil erosion and flooding, help provide clean air and water and contain tremendous biodiversity. Forest is also an important defence against global climate change (Myers *et al.*, 2000).

Biodiversity underlines everything from food production to medical research. Humans the world over use at least 40,000 species of plants and animals on a daily basis and these resources are predominantly found on different structures of forest. Many people around the world still depend on wild species for some or all of their food, shelter and clothing. All of our domesticated plants and animals came from wild-living ancestral species. Close to 40% of the pharmaceuticals used in USA are either based on or synthesized from natural compounds found in plants, animals or micro-organisms (Swanes, 1996).

Forest provides a habitat for biodiversity by providing many ecological services in the form of ecological processes and life – fulfilling activities. Numerous species fulfil crucial ecological rules in our biosphere such as recycling nutrients, purifying water, producing oxygen, dispersing seeds and pollinating plants.

The economic argument for forest resources, initiated by conservationist Myers *et al.* (2000), emphasizes the importance of monetary value on ecosystem services as a realistic way of reinforcing the need for conservation. For example most of the butterfly sanctuaries

found in the various centres provides rich economic returns for the various communities. However, the only possible means of maintaining these natural assets stems from conserving the forest and the biodiversity.

In spite of the enormous benefits obtained from forest and its resources, large areas of the richest forest in the world have been cleared for wood fuel, timber products, agriculture, and livestock (Alonso *et al.,* 2001). These forests are rapidly disappearing.

In 2005, the FAO issued a report, titled, "Global Forest Resources Assessment 2005" on the status of the world's forest. Based on a five-year study the report found that forest areas throughout the world were continuing to decline at a rate of about 7.3 million hectares (18 million acres) per year, an area equivalent to Panama and Sierra Leone (FAO, 2005). In Ghana, more than two – thirds of the forest resources have been destroyed a situation which is very disturbing for ecosystem stabilization (Vernon *et al.,* 2003). Thus current phenomenon not only contributes to global warming but also affect the relative abundance of wildlife both vertebrates and invertebrates

According to Fermon, (2002) population increase, coupled with urbanization and industrialization over the years have led to over – exploration of these forest and their resources resulting in high deforestation, land degradation and floral and fauna disappearance.

Indiscriminate logging for industrial wood and more importantly the exploitation for firewood and charcoal are important causes of deforestation and depletion of the forest resource. Also clearing land for agricultural (slash and burn) purposes, overgrazing, annual bushfires and surface mining are among other factors contributing to increasing world haste to plan towards restoring the natural habitat (FAO, 1993).

Butterflies are among the best known insects of the world that are involved in pollinating plants (Robbins and Opler, 1996). Although Robbins and Opler (1996) noted that there are about 17,500 species of true butterflies (plus skippers) known on earth, butterflies comprise only 10 per cent of the insect order Lepidoptera (New, 1997a).

Recent environment conditions of butterfly communities in Europe have been affected by rapid economic development of the twentieth century. For example, the farming landscape has undergone profound changes with recent losses of many hedges that were planted over the past two hundred years (Pollard and Evershan, 1995).

In European conditions the main threats reported come from agricultural activities which affect 90% of threatened species, building developments (affecting 83%), increasing use of herbicides and pesticides (affecting 80%), and abandonment of agricultural land and changing habitat management (65%). The widespread loss and reduction in size of breeding habitats is affecting 83% of threatened species (van Swaay and Warren, 1999).

A wide range of human activities results in degradation of biotopes and loss of suitable habitats. Deforestation, peat extraction and management to improve the quality of cattle grazing (such as drainage, burning and chemical treatment) are main factors in Central Europe (Kudrna, 1986). Loss of habitats such as unimproved grasslands and wetlands has been particularly dramatic and has led to major declines of Lepidoptera in every European country (Kudrna 1986; Pollard, 1991, Rodriguez, *et al.*, 1994, New, 1997b, Dolek and Geyer, 1997, van Swaay and Warren, 1999, Balmer and Erhardt, 2000; Ricketts *et al*., 2001;).

Most previous studies on butterfly ecology have stressed the declining numbers and the increasing threat to survival due to progressive habitat destruction. In addition, the

extinction risk increased significantly with decreasing heterozygosis (Saccheri, *et al*., 1998) and extinction risk followed the widespread destruction of the habitat (Pollard, 1991).

In the UK the loss of flower-rich lowland grassland exceeds 97%, and 50% of broad-leaved woodland and 40% heath land within the last 50 years. That landscape alteration resulted in the reduction of many butterfly species. A recent review has shown that five of Britain's 59 resident species are now extinct (Warren and Gaston, 1997).

Other recent studies on butterfly ecology have shown that habitat loss and increasing isolation of the remaining habitat patches (habitat fragmentation) are the main causes of population decline in many groups of butterflies (Cleary *et al*., 2005).

Butterflies are good indicators of habitat quality as they respond rapidly to modification of vegetation. Many authors have documented the influence of landscape patterns on butterfly Communities (Schneider *et al.*, 2003; Natuhara *et al*., 1999).

Sparks and Carey (1995) found an influence of the floral composition on butterfly diversity. Schoonhoven *et al*. (1998) reported that tree species diversity and cover had a positive effect on butterfly species, but high proportion of large trees had a negative effect on butterfly species richness.

These trend of affairs is not different from the Tano South District in Brong Ahafo Region where forest resources are been destroyed at an alarming rate. The negative effects of the situation not only affect tree species but also the insect population particularly butterflies, hence the need to assess the impact of forest destruction on butterfly abundance and species richness in the Bosumkese Forest Reserve.

1.2 Statement of the Problem

Butterflies, like most forest dependent animals are good ecological indicators of the health of the forests they dwell. Likewise, the destruction of forest also has negative effects on the butterflies especially the numbers of species and their relative abundance in their respective ecosystem. The alarming rate at which the forest and its resources are being depleted has been a source of worry to conservation activist.

However, little or no attempt have been made to determine or quantify the effects or impacts of this unfortunate trend – forest destruction on the various biota especially the lepidopterans, particularly butterflies which offer a lot of benefits to both ecosystem sustainability and biodiversity.

Against this background, the study has become necessary in Tano District where the forest and its resources are being destroyed by chain – saw operators, slash and burn method of farming, intensive use of pesticides, surface mining and encroachment of forest reserves for human

This study was undertaken to determine the health of the forest using butterflies as a case study in the forest areas that have been destroyed as a result of the anthropogenic activities.

1.3 Justification of the Study

The Upper Guinean forests of Ghana are recognized as among the most biologically unique in the world because they harbour a wide diversity of plant and animal species, many of which are found nowhere else, but these are also among the most critically

threatened forests in the world Source (Larson *et al*., 2007). Only about 10-15% of original forest cover has not been destroyed and what remains is highly fragmented and degraded. With the exception of sacred forest groves, virtually no forest cover remains outside the boundaries of designated reserves (Allotey, 2007).

Insects are important in environmental assessment because of their dominance in terrestrial ecosystem, their short life cycles that can result in rapid population responses to disturbances, and their wide range of life style that makes them sensitive to changes in biotic and abiotic environment. Butterflies are extremely susceptible to unusual climatic conditions and certain species can be used to indicate certain environmental conditions. Butterflies are widely recognized as potentially valuable ecological indicator. Their presence can prove that habitats are suitable and indicate that certain conditions have been met. Certain butterfly species can be use to define environmental health simply by the presence of particular species. In contrasts, their absence may reflect declining health (Larson and Collins, 1998).

In this study, butterflies were chosen for monitoring because they have become a popular group for study. They are day flying and in relatively abundance; they are most conspicuous and relatively identifiable and frequently as ''flagship taxa'' in biodiversity inventory. Butterflies are often colourful and sensitive to rather suitable habitat and environmental changes. Any change in the forest can lead to changes in butterfly communities (Daily and Ehrlich 1995).

For example they are sensitive to changes in temperature, humidity, and light levels that are caused by habitat changes.

Changes in butterfly composition and abundance can point to suitable changes in forest habitat because the larvae have specialized host- plant requirements and adults are

important for studies that can reveal the stabilization or decline of butterflies' species population due to habitat destruction or loss of forest ecosystem.

1.4 Purpose and Objectives of the Study

1.4.1 General Objectives

The general objective of the study was to investigate the impact of forest destruction on the community and abundance of butterfly species in the Bosumkese Forest Reserve.

1.4.2 Specific Objectives

The specific objectives were to;

1. identify the anthropogenic activities that led to the destruction of forest resources.

2. examine the effects of the destruction on the people and the biodiversity in the reserve.

3. compare the number of butterfly species in the three forest types in the forest reserve.

4. assess the relative abundance and dominance of butterflies of the three forest types.

5. assess the species richness and diversity of butterflies in the three identified forest types in the reserve.

CHAPTER TWO

LITERATURE REVIEW

2.1 Concept of forest

A forest is defined as land with more than 10% tree cover of trees more than 5 metres tall usually with minimum size of 0.5 hectares. Forest is plant community, predominantly of trees or other woody vegetation occupying an extensive area of land. In its natural state, a forest remains in a relatively fixed, self-regulated condition over a long period of time. Climate, soil, and the topography of the region determine the characteristic trees of a forest (Myers *et al.*, 2000).

In local environments, dominant species of trees are characteristically associated with certain shrubs and herbs. The type of vegetation on the forest floor is influenced by the larger and taller plants, but low vegetation affects the organic composition of the soil. Disturbances such as a forest fire or timber harvesting may result in a shift to another forest. Human intervention is practiced to maintain some desirable forest types (Adams, 2009).

2.2 The State of Forest in Africa

With approximately 650 million hectares of forest (21.8% of the land area), Africa accounts for one sixth of the global forest cover (FAO, 2003). The Congo basin is home to the second largest contiguous block of tropical rain forest in the world (FAO/UNEP, 1981). Unfortunately, these forests disappear at alarming rates. Between 1990 and 2000, the annual net change in forest cover was -0.8%. This rate is based on losses or gains in the cover of

both natural and plantation forests. At the continental level, the rate is the highest in the world, and about twice as high as in South America (-0.4%).

Considering forest plantations, Africa accounts for only 4.4% of the global area. For every hectare reforested, the area deforested reaches 41 hectares. In view of this, there is growing consensus about the need to reduce deforestation, to use forests sustainably, and to establish forest plantations in order to meet the increasing demand for woody biomass (Miller and Kauffman, 1998).

Commercial plantation forests are designed to produce maximum yields of timber or fuel wood. This seems to preclude any environmental benefit in terms of biodiversity conservation. However, recent analyses have shown that forest plantations can be managed to harbour an important proportion of the former biodiversity without compromising economic benefits (Lamb, 1998). Different measures have been proposed to this end, including the creation of plantation species mosaics, embedding monocultures in a matrix of intact or restored vegetation, using indigenous species rather than exotic species, or preserving micro-habitats such as dead wood that are known to be particularly species-rich.

Despite the potential of tropical forest plantations for biodiversity conservation, only few studies have been completed (Davis *et al*., 2001; Lawton and Bignell, 1998; Watt *et al*., 1997). These studies have shown that plantations are not necessarily biodiversity deserts (Speight and Wylie, 2001) but that they can support a rich and varied fauna. The importance of tropical forest plantations for the conservation of wildlife and as nuclei for natural forest regeneration has been demonstrated in Madagascar (Goodman *et al*., 1996), Sri Lanka (Ashton *et al.,* 1993), Thailand (Elliott *et al*., 1998) and Australia (Tucker and Murphy, 1997).

Nevertheless, assuming that the current scenario persists, the predictions for the next two decades are very pessimistic (FAO, 2003). The scenario assumes that deforestation will continue more or less at current rates, forest plantations expand only in few countries, and that fuel wood remains the main source of energy. As a consequence, the loss of biodiversity is expected to continue. With only 10% of the original forest remaining and at an annual decline in forest cover of -1.26%, west African forests are particularly vulnerable to human disturbance (FAO, 2001).

In view of this and considering the exceptional concentration of endemic species, West African forests have been designated as biodiversity hotspots (Myers *et al*., 2000).

The Lama forest reserve in Southern Benin, one of the last remnants of natural forest in the Dahomey Gap (Sinsin *et al*., 2003), appears to be an exception to the regional deforestation trend and might serve as a model for future conservation programmes. Since 1988, the central part (Noyau central) covering 4,800 hectares has been under strict protection and the population living therein has been resettled. The forest is composed of a small-scale mosaic of remnants of natural or degraded semi-deciduous forest of variable size and successional stage (Specht, 2002). It is surrounded by teak (*Tectona grandis*) and fuelwood (mainly *Senna siamea* and *Acacia auriculiformis*) plantations, covering 7,000 hectares and 2,400 hectares, respectively. These plantations provide timber and fuelwood for the local, national as well as international market.

2.3 The State of Forest Cover in Ghana

The exploitation and utilisation of forest resources have for many years supported the Ghanaian economy and other development in the country. The forestry sector currently

contributes 6% to Ghana's Gross Domestic Product (GDP) and accounts for about 12% of foreign exchange earnings (Martin, 1997). In recent years, the state of Ghana's forest have come under continuous and increasing threat of over exploitation and degradation driven by various social, political and economic factors. According FAO (2005), Ghana's mean annual rate of forest deforestation between 1990 and 2000 is 1.7% and is one of the highest in the world exceeding the regional deforestation rate of Africa (0.8%), Asia (0.1%) and South America (0.4%). The current actual rate is not known but the rate of degradation and disappearance of forest resources is still a cause of concern in Ghana. Since the 1940s, more than 90% of Ghana's high forest have been exploited, Asibey and Owusu (1982). The timber industry alone has taken an annual saw milling capacity of about 5.2 million m^3, (Treue, 2003; Agyemang *et al*., 2003).

Green (1996) also revealed that Ghana at the beginning of the 20^{th} century had about 8.2 million hectares of high forest zone. However, this zone has for the past years been reducing at the rate of 75,000 hectares per annum or 2% to about if not less than 1.3 million hectares. It further reveals that presently, the forest estate comprises 1.7 million hectares of productive forest which is sustainably managed for timber production and supplies about 0.9 million hectares assigned to protected forest.

The current annual timber production is about 1.6 million cubic meters per annum whilst prescribed annual allowable cut of 1.0 million cubic meters is geared towards the maintenance and sustainability of the forest. The report further states that, the production of non timber forest products is estimated at 12.6 million cubic meters of which fuel wood account for 58%, charcoal 37% and electricity and telephone poles 5%.

Xah (2006) reported that due to the destruction and over exploitation of the forest, government spends over GHC 167,000.00 nationwide to restore 24075 hectare of forest

plundered by illegal chain saw operators and loggers in the past three years. He revealed that part of the amount was also used to plant avenue trees and parks in towns and cities to serve as windbreaks and provide shade. He concluded that if the rate at which the forest is depleted should continue this way, this amount will double if not triple in the years ahead and Ghana will be named 'green desert'.

2.4 Problems and Causes of Deforestation in Ghana

Addo (2003) stated that deforestation has for many years been the most serious problem inhibiting the sustainable management of the forest and its biota in Ghana. He reveals that it is a serious issue because of its cumulative effect on the life supporting aspects of the biological environment, affecting weather and climate, water supplies, soil quality and agricultural productions, and sustainability of timber and non timber forest products. Deforestation is complex and difficult to correct since it require social and economic policies that will address rural poverty, population growth, integrated land use planning and development, conservation of natural resources and sustainable forest management. All these needs will have to be met simultaneously with accompanying educational, health, infrastructural and other national expenditure (Addo, 2003). There are various causes of deforestation. Some of which include rapid population growth, under - developed and inappropriate agricultural technologies, weak law enforcement structure and poor legal system, bushfires, illegal activities of timber contractors and chainsaw operators, mining and social fabrics (Green, 1996).

2.4.1 Poverty and Environmental Degradation

The economies of developing countries depend on exploitation of natural resources and the livelihood of the population depends directly and indirectly on the exploitation of natural resources especially soil, water, forest, animals and fisheries. Poverty forces people to use available resources to the limit and often beyond. When survival is at stake, it may be perfectly rational to consume capital, which is future productive capital. Poor people enter into degradation of forest, giving their dependence on natural resource base. It is only when they have exhausted their arsenal of coping strategy and mechanisms including running down their own health if necessary that they are left with no option but to temper with their resource base. At that point, conservation of natural resources for future generations takes on a lesser importance, particularly when the poor cannot assume that their children will in fact benefit from such conservation (Dadzie-Mensah, 2002).

Destruction of forest has its roots in poverty, reinforced by rapid population growth, low of agricultural productivity, and unsuitable logging in order to earn much needed foreign exchange. In many areas of Africa, this situation exist today on the remaining forest, already high is likely to increase. It is in this context that the possibility of implementing adequate forest policies should be encouraged. The successful implementation of well defined national forest policies will largely depend on the prospects of alleviating poverty (Allotey, 2006).

2.4.2 Agricultural Expansion and Intensification

Agricultural expansion and intensification has been proposed by many as the only way that the earth copes with even minimal population growth. In an attempt to increase

food production to keep pace with the growing population, expansion onto new lands becomes necessary but has negative side effect of decreasing forest cover and biodiversity. In addition, unused potential agricultural land and forest cover could easily be exhausted by uncontrolled human occupation depleting the world of biodiversity, timber and genetic resources (FAO, 2000).

The pressure to maximize income has led most developing countries to adopt policies and practices that degrade biodiversity. With income tied up with servicing family debt, domestic investment resources are not available therefore; more forest land has to be cleared for production of cash crops for export and domestic use (Pearce, 1993).

Gormey (1997) revealed that in our part of the world almost everything is obtained in the forest. Rubber, cocoa and palm plantation can only be established by clearing very vast areas of forest. Other food crops are also cultivated in the forest regions. He stated painfully that over the last three decades, we have cleared and burnt millions of hectares of virgin forest, containing various diversities of flora and fauna to produce agricultural commodities for Europe and other markets.

2.4.3 Inappropriate farming practices

Some farmers and non – farmers chose not to care to sustain forest resources by practicing agro forestry because they had insufficient financial resources to embark on such exercise, (World Conservation Monitoring Center, 1992). Most small scale farmers will use their limited financial resources to cultivate food crops rather than planting trees which may take three or four years before they are able to reap benefits from their investments. In the

mean time they have to be able to finance daily needs which would otherwise have been met by farmers' income which is already inadequate (FAO, 2001).

2.4.4 Land Tenure and Tradition

Small holders who have had their access to wood resources on adjacent land no longer had similar access because of changes in traditional structure of land use rights. They now have to depend on their own land and more heavily for agricultural needs. In other cases, land owners may prefer to put their land to uses like infrastructure development than to tree planting for fear of tenants attempting to assert a personal claim to the land (FAO, 1995).

Matose (1994) observed that women in some villages in Kenya could nurse seedlings but only a male family member could plant trees. He further reveals that some landlords and tenant farmers fear that the government will take over their land and the trees as such they do not find tree planting a profitable venture after the land has been used. According to New (1998), the extent to which environmental degradation occurs is very high where communal land tenure exists, as it does not encourage conservation practices.

Spike (2000) mentioned that since all members of the community are free to use community land for their own uses without any central control, each takes as much as he wants, makes little or no effort to conserve or improve the land.

2.5 The need to conserve forest

2.5.1 Conservation of wildlife/ endangered population species

Hanson (1992) stated that the concept of what constitute an endangered population varies considerably. A population is said to be endangered when the chance of the survival in the wild is unlikely unless action is taken to conserve that population. She ascertained that there is no simple numerical level at which a population is defined as been endangered or eligible for consideration as a candidate for conservation. Rather, it is dependent on a number of factors: the actual number of animals; the rate of decline in the population size; the geographical range and the rate of reduction of that range, special threat from introduced species; rapid changes in environmental conditions including climate, predators and parasites. She concluded that the classification for endangered status is based upon the long term survival chance of the organism been considered. The survival chance can be estimated using population models, which incorporate all the relevant variables affecting the organism.

Abaidoo (1997) reported that to most people, wildlife refers to a few species of birds, mammals, reptiles, trees, shrubs, flowers, grasses and insects, many of which are part of the scenery and enhance the appearance of the landscape. He postulates that, for a long time many farming activities have been to the advantage of wildlife creating a diverse and attractive habitat suitable for a range of wildlife species. However, today the trend is to increase production to the maximum from land available, and to reclaim where feasible, with an increase in field size. This has resulted in the increased use of agrochemicals (pesticides, fungicides and herbicides) and chemical fertilizers. The excessive use of these chemicals can be detrimental to wildlife.

Wilson *et al*. (1992) observed that tropical forest provides habitat for an estimated 3 to 7 million species of plants and animals, the greatest variety of life occurring anywhere else on earth. He stated further that habitat destruction and alteration by human activities threatens the survival of many birds, butterflies and mammals, and if conservation measures are not taken, the population may fall below the critical population size which may lead to flora and fauna extinction.

2.5.2 Soil and water conservation

The Forest contributes tremendously to maintenance of soil fertility by controlling topsoil erosion, recycling of nutrients through litter fall, maintenance of soil physical properties, and avoidance of toxicities and decomposition of dead wood. Perry (1994) indicated that the forest prevents evaporation and desiccation during the prolonged dry season and this prevents the drying out of watersheds. The soil constitutes the reservoir for accumulation of water, thus reduction in water loss through run off is an integral part of soil conservation.

The organic matter from the decomposition of dead wood and animals improve the soil's physical, chemical and biological properties. The dense tree canopies on forested areas serve as ground cover that reduces the impact or the velocity of rain drops, thereby reducing the loss of organic matter through soil erosion (Longman and Jenik, 1990). Forest promotes more closed nutrients cycling by presenting separate cycles for nitrogen, phosphorus, potassium and other nutrients (Pancel, 1993). He is of the view that uptake and recycles consists of stores, flows within the system and gains and loses external to it. He explained that the nutrient stores are the trees and crop shoots and roots, plant residues, soil fauna, labile and stable soil organic matter. Pancel (1993) concluded that forest promotes

synchronization: helping to synchronize nutrients released with crop requirement by controlling quality, timing and manner of addition of plant residues.

2.5.3 Maintenance of Biodiversity

The direct and indirect interaction of plants and animals and their physical environment in an established natural balance of eco – existence is what has been referred to as the forest ecosystem. According to Dobson (1995) the various plants and animals species in the ecosystem constitute the forest biodiversity. The more varied the species of plants and animals, the richer the biodiversity. The forest provides habitats for numerous flora and fauna which generally retains biodiversity (Dadzie-Mensah, 2002).

SI/MAD (2003) reported that biological diversity is the wealth of life on earth, the millions of plants, animals and micro organisms, the genes they contain and the intricate ecosystems they help build into the living environment, animals and plant species are becoming extinct at an alarming rate due to the global deterioration of the natural environment. This particularly, the case for ecosystem such as tropical forest, coral reefs and wetlands that is rich in species. Although over 7000 kinds of plants have been grown or collected for food throughout history, only a tiny fraction of species with potential economic importance have been used and today a mere twenty of them supply 90% of the worlds food (SI/MAD, 2003). Biodiversity has had an important impact on the development of new medicine and also contributes to industry by providing such natural sources as rubber, natural starch, fats and oil and natural pesticides. The report concluded that while the importance of biodiversity to the world of work may seem remote, it may in fact provide important new breakthroughs particularly by means of biotechnology, which will help to meet the growing requirement of the world's population.

2.5.4 Aesthetic and Cultural Benefits

Gormey (1997) in his study on non-timber forest products in Southern Ghana noted that the forest features in all aspects of culture in southern Ghana, from language, history and politics to religion, medicine and art. In view of this, many communities have protected small areas of forests as their sacred grooves where their gods and their ancestors live. Trees have also featured throughout history. For instance, in the olden days in Ghana, some towns and villages developed under important trees (Osei, 2001).

The diversity of life on earth brings us many aesthetic and cultural benefits, and cultural diversity is closely linked to biodiversity. Millions of people enjoy hunting, fishing, camping, hiking, wildlife watching, and other outdoor activities based on nature. These activities provide invigorating physical exercise. The use of some rare plants and even animals usually with strange and unique features as media of communication to God has provided the spiritual satisfaction that the people enjoy. Observing and protecting nature has religious or moral significance for many people (Dadzie – Mensah, 2002).

2.5.5 Promotion of Eco – Tourism

Ecosystem is one of the fastest growing trends in the world wide tourism industry. The term eco – tourism has been defined in many ways and is generally used to describe activities, which are conducted in harmony with nature as opposed to more traditional tourism activities (Middleton and Hawkins, 1998). Comprehensively, they assert that eco-tourism as defined by the eco-tourism society is 'purposeful travel to natural areas to understand the cultural and natural history of the environment, taking care not to alter the integrity of the ecosystem while producing economic opportunities that make the

conservation of natural resources financially beneficial to local citizens (The International Eco-tourism Society, 1992). The resource conservation role was emphasized by Hawthrone and Abu-Juam, (1995) who described eco – tourism as 'a managed approach by the host country or region which commits itself to establishing and maintaining the sites with the participation of the local residents, marketing them appropriately, enforcing regulations and using the proceeds of the enterprise to fund the areas' land management as well as community development'. They further revealed that eco- tourism alone provides millions of dollars to countries with tourism sites such as parks, forest reserves, sanctuaries and other geographical interest. The monies accrued from the tourists may be used to carry out development projects in the host country thereby improving conditions of the people. In the light of this, many countries are developing tourism sites (Karen, 1989). They concluded that there seems to be general agreement that eco-tourism involves minimum density, low impact activity which can take place where there are natural sites or sufficient biological, cultural and geographical interests to attract tourists.

2.5.6 Research and Education

On global basis, the tropical forest biome has unsurpassed scientific and educational value. For example, the raw material for productive studies of plants and animals ecology is almost unlimited. In addition, many more medicines such as those that control diseases, relieve mental stress, or show promise to cure cancer, are derived from plants that grow in tropical forest (Osei, 2001).

Wilson *et al.* (1992) reported that, the loss of genetic diversity among domestic plants and animals is seen by some as a greater threat to human welfare than loss of species. He opined that the irreplaceable gene pools of many kinds of organisms are rapidly being

diminished. The tropical forests contain the parent species from which further research and experiment could be conducted to improve many of our present agricultural crops. Those wild species may be needed as genetic reservoirs from which new varieties of diseases and pests resistant crops can be developed. He revealed that as plant breeding has proceeded, the gene pool in crops such as rice and maize are becoming smaller. In Indonesia, 1500 local varieties of rice have disappeared since 1975, and nearly three-quarters of the rice planted today were developed from a single maternal plant. The conservation of species and genetic material is seen as offering practical benefits in terms of economic potential in agricultural and forestry, and in medicine (Wilson *et al*., 1992).

2.6 Status of Biodiversity in Ghana

There is lack of information on the full coverage of biological resources of the country. However, there are about 2,974 indigenous plant species, 504 fishes, 728 birds, 225 mammals, 221 species of amphibians and reptiles have been recorded (Allotey, 2007).

Endemic species include three species of frogs, the lizard and 23 species of butterflies. Sixteen per cent of Ghana's land surface has been set aside to conserve representative samples of natural ecosystem in the form of forest resources, natural parks and other wild life reserves including various traditional forms of conservation (Allotey, 2007).

Generally, knowledge and information on genetic diversity of various life-forms and organisms existing in the country are scanty, incomplete and inaccurate. Information on terrestrial ecosystem is greater and more complete than that of the marine and other aquatic systems (Allotey, 2007). Knowledge and information on species diversity of plants and animals and ecological processes within terrestrial habitats can be said to be fair to good. In

contrast, information on plants and animals of the marine and aquatic world and the processes that determine their resilience of such organisms is barely available. Very little is known about the entire microbial diversity to terrestrial, marine and aquatic ecosystem in the country (Allotey, 2007).

2.7 Threats to Biodiversity in Ghana

Threats to biodiversity in the region include bush meat trade, agricultural expansion, commercial logging, mining and extraction of non-timber forest products.

Ghana was once renowned for its extensive forests and wooded savannah, but the situation has changed drastically. Tropical moist forest originally extended over 145,000 km^2 of Ghana. By the turn of the century it was estimated that 88,000km^2 forests remained, occupying 35% of the total land area. Between 1938 and 1981 the area of closed forest in Ghana was reduced by 64% from 47,000km^2 to 17,200km^2 and open woodland declined by 37% from 111,000km^2 to 69,000km^2. By the mid 1970s, more than 90% of the country's high forests had been logged. The current area of intact forest is now estimated at between 10.9% and 11.8% of the original cover and 6.9% of the country's total area. The current rates of deforestation average 22,000 ha/annum or about 1.3% (Allotey, 2007).

2.8 Strategies to Conserve Biodiversity in Ghana

2.8.1 Empower People and Preserve the Environment

Martin (1997) stated succinctly that sustainability of our natural resources, biodiversity, landscape and wildlife will depend on giving the people knowledge and power to work out what is of the best of their interest to their society and its

natural environment. He continues that we should always be conscious of mankind's enormous potential for reflecting on the past and deriving from such reflection valuable lessons for the future. That must surely give cause for hope He further opined that the enormous environmental problems we face must be viewed from the perspective of realism. There are many influences not all of them are good, on human behaviours and we have to appreciate that people will not always do the ''right'' things so perhaps neither optimism nor pessimism is appropriate when considering our ecological future. The simple fact is that man is the earth's only problem and yet offers only possible solution.

Awuku-Ampaw (2007) revealed that matters affecting the Forest are many and complex. This situation has come about as a result of the complex nature of man. He went further to say that the myriad of issues about the forest the most mundane is destruction, and that is perhaps the ugliest part of man. He stresses that tidying up becomes Gordian knot to untie and this will mean letting policy as a tool affect reforestation, conservation, management, participation, etc. He is of the view that having geared policy at corrective measure, there is also the need to communicate intelligently to the youth the need to join in caring for the environment.

He believes that sensitizing the youth today marks the beginning of a long awareness call that the last tree must not die. He further indicated that the Forestry Department must supply all schools with tree seedlings for planting. That the President must declare deforestation a national disaster, that bye laws must be vigorously enforced, and that there is the need for instance environmental justice.

2.8.2 Creating Sustainable System of Energy Use

Efficient use of resources and renewable energy for use is seen as an option in ending the threat to forest conservation. Important step required for the

development of a sustainable energy system is the installation of clean, renewable alternatives to wood. The most likely renewable include solar energy, wind energy, biomass, hydro-power and geothermal energy (Hawthrone and Abu-Juam, 1995).

Manure, human waste, crop and other forms of biomass (organic waste) supply 14-19% of world's energy demand (Oliver *et al*., 1998)

The report revealed that in developing where firewood consumption is high, biomass may provide up to 90% of the total energy requirement in place of wood at lower cost.

2.8.3 Using Modified Tuangya Systems (MTS)

Agyeman *et al.* (2003) revealed that in the modified Tuangya system, farmers are essentially the owners of the forest plantation products, with the forestry commission, and land owners and forest adjacent communities are shareholders. All participants in the MTS , including farmers will be eligible for a share of benefit occurring from the plantation. The consultation process devices an equitable benefit sharing framework based on the contribution of the participant; farmers would carry out most of the labour including pruning, maintenance and tending; then receives 40% of the benefit occurring based on their outputs. They further stated that the forestry commission would contribute technical expertise, training for farmers to carry out their functions efficiently, equipments and tools, and would be responsible for stock inventory and auctioning or marketing of the products. The traditional authorities contribute land for project and they receive 15% of the benefit occurring. The forest – adjacent community who provides support services in the form of protection of the investment from fire and encroachment also benefits.

2.9 Habitat of Butterfly

In general, wooded habitats are more hospitable to moths, while butterflies prefer open, sunny settings (Larson and Collins, 1998). Butterflies may be found in flowery fields, meadows, and hillsides; along stream banks, roadsides, and the edges of woods; and in clearings, glades, and nature reserves. Large numbers of butterflies can be found in prairies, arctic and alpine tundra, and deserts following spring or summer rains (Sundunfu and Dumbuya, 2008).

Although the best way to see butterflies and moths is to visit places where human settlement has not greatly disrupted native habitats, the insects are also present in urban settings such as city parks, gardens, and vacant lots. Some gardeners plant flowers, herbs, and shrubs to attract colourful butterflies of a great variety of species (Larson, 1997).

2.10 Importance of Butterfly in the Ecosystem

The butterfly is a diverse insect, found in many colours and sizes. Worldwide, there are more than 28,000 species of butterflies, with about 80 percent found in tropical regions. The butterfly plays an important role in ecosystems, acting as a pollinator, a food source and an indicator of the ecosystem's well being (Brown *et al.*, 1991). They are also showy and charismatic and can elicit the emotional concern necessary to bring about conservation in the face of conflicting socio-economic priorities (Larson, 2006).

2.10.1 Pollination

Although not as efficient as bees, butterflies play an important role in pollinating flowers that open during the day. Butterflies tend to prefer big, colourful flowers that have a landing platform (labella) and gather pollen on their long, thin legs as they sip nectar from a flower (Emmel and Larson, 1997).

2.10.2 State of Ecosystem

Butterflies are excellent models for evaluating the status of natural communities in degraded landscape especially where knowledge is needed to help steer conservation efforts in the survey area. They show a wide range of sensitivity to environmental changes and are tightly intertwined with ecological systems as both consumers and food items and are easily collected and identified (Larson *et al.*, 2007). Butterflies have annual life cycles (transforming from egg to adult in a year), requiring that the same conditions be present every year for new eggs to mature. That makes butterflies especially sensitive to climate change, such as pollution and habitat loss, and causes them to be more responsive than birds, plants and other species with longer life cycles. Therefore, an abundance of butterflies usually indicates a healthier ecosystem (Addae -Wireko, 2008).

2.10.3 Migration

Many butterfly species, like the Monarch and the Painted Lady, migrate over long distances, as many as 3,000 miles. These migrations allow for pollination across long distances and have increased human interest in the species (Sparks *et al*., 2005).

2.10.4 Prey

Butterflies can provide a rich source of food to predators such as birds or mice. Some butterfly species, like the Monarch, carry toxins that serve as a defence mechanism and are dangerous for some predators to ingest (Thomas, 2005).

2.10.5 Restoration

Butterflies contribute to ecosystem restoration because they supply pollination and a source of food. Increased butterfly populations may indicate an increase in plant diversity and other pollinator groups within restored areas (Thomas, 2005).

2.11 Economic Importance of Butterfly to humanity

Moths (and, to a lesser extent, butterflies) are a major component in many food chains because they are so numerous. Many songbird and bat populations depend in large part on moth caterpillars and adults for nourishment. Certain human cultures also harvest caterpillars for food (Baz and Garzia, 1995).

Lepidopterans are also an important part of many countries' economies. The cultivation of domestic silk moths for the fibre in their cocoons has been a major industry in Asian countries for many centuries. When unravelled, each silk moth cocoon yields hundreds of meters of strong, durable silk fibre that absorbs colours beautifully and weaves into a soft, glossy fabric (Kunte, 1997). More recently, butterfly farming to provide specimens for collectors and live pupae for butterfly houses has become an important source of income in tropical countries, particularly Papua New Guinea and Costa Rica (Forester *et*

al., 2009). Eco-tourism by butterfly watchers has become common in developing countries, especially Mexico. There, tourists drawn by the over wintering monarchs provide a source of income for local residents who might otherwise log the trees where the butterflies roost during the winter. Perhaps the greatest economic and ecological importance of lepidopteran comes from their worldwide function as pollinators of crops and wild plants (Humpden and Nathan, 2010).

Only a few butterflies are considered destructive. The moth damages cabbage, broccoli, and related crops. The caterpillar of the giant swallowtail butterfly, known as the orange dog, feeds on citrus plants and sometimes damages commercial citrus crops. Many more moths than butterflies are regarded as pests (Tiple *et al.*, 2011). The caterpillars of some moths attack grain and other stored food. The larvae of clothes moths make holes in clothing made of wool and other natural fibres. Cutworms destroy the roots of many different crops, including cabbage, corn, cotton, and tomatoes. Spruce budworms strip the needles from spruce and other conifer trees, and codling moths destroy apple crops (Pullin, 1997). Tent caterpillars make ugly webs in ornamental trees. Many lepidopteran pests are species that have been introduced to a new area by humans and grow into large populations because they lack natural enemies in their new home. The gypsy moth, native to Europe, was accidentally introduced into New England during the late 1860s. Since then, gypsy moth caterpillars have caused widespread damage, devouring the leaves of trees in parks, gardens, and woodlands throughout North America (Wood and Gillman,1998) although some moths are destructive pests; many more species are benign or beneficial to humans.

2.12 Threat to butterfly Biodiversity

Human activities such as farming, logging, and development threaten many butterfly and moth species. The Xerces blue, the first North American butterfly to die out because of human activities, became extinct in San Francisco in 1943 (Lovejoy *et al*.,1986). It gave its name to the Xerces Society, the international organization for conservation of rare invertebrates and their habitats. Today, several West Coast butterflies related to the Xerces blue are endangered due to human population growth (Conservation International, 2001). Other endangered lepidopterans in the United States include the Oregon silver spot, native to oceanfront habitats that have been developed for human use; the Uncompahgre fritillary, which lives in the San Juan Mountains of Colorado and is threatened by livestock grazing and, perhaps, by global warming; and Schaus' swallowtail, at risk due to coastal development and heavy use of pesticides to control mosquitoes in Florida. In tropical rain forests, where lepidopterans reach their highest diversity, logging and burning to clear forests for agriculture place many different species in jeopardy (IUCN, 2011). Queen Alexandra's birdwing, the largest butterfly in the world, is gravely endangered because of the destruction of forests on the coast of Papua New Guinea for timber and oil palm plantations (Wood and Gillman, 1998).

The annual migration of monarch butterflies is a threatened phenomenon. Logging and development threaten the monarch's winter roosts in Mexico and California. Meanwhile, the butterfly's North American breeding grounds are being destroyed to build roads, houses, and shopping malls. Pesticides kill milkweed, the plant monarch caterpillars depend on for food, and also kill the monarchs themselves (Tiple *et al*., 2006).

He further stated that, at higher elevations, they observed clear upward shift in the ranges of species, consistent with the influence of global warming. Taking together, these

long term data revealed the interacting negative effects of human – induced changes on both the climate and habitat available to butterfly species in California. The research conducted by Addai-Wireko (2008) recommended that the traditional focus of conservation efforts on more specialized and less dispersive species should be broadened to include entire fauna when estimating and predicting the effects of pervasive stressors.

CHAPTER THREE

MATERIALS AND METHODS

3.1 The Study Area

The study area, Bosumkese Forest Reserve is located about 28km East of Sunyani, Ghana and covers a total area of 138km^2 (Fig 1) . The reserve is within the semi-deciduous South East forest zone (Swanes *et al.*, 1997) and has a mean annual precipitation of between 900 mm to 1500mm, with two well defined seasons, a rainy season from April to October and dry season from November to March. There are two rainfall peaks-May/June and September/October. However, long period of drought are normal in December and January.

The Bosumkese Forest Reserve lies approximately between latitude 7˚.00N and 7˚15N and longitude 2˚05W and 2˚30W. The reserve shares approximately 2.56km of boundary with the Aparapi shelterbelts and nearly 2.08km of boundary with the Amama shelterbelts which in turn shares 1.76km of boundary with the Asukese Forest Reserve.

The Bosumkese Forest Reserve is drained by the tributaries of the Amama, Tano, Denden and Aparapi Rivers. Years of over exploitation in the forest Reserves have resulted in the reduction of the canopy of the forest. Human pressure on the ecosystem is evident from the various farms around the reserve, collection of non-timber forest products and its logging history and ever increasing demand of timber products have actually reduced' the beauty of the forest reserve over the years.

Fig.1: Study area and compartment design

UC= Undisturbed canopy

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SDC= Slightly disturbed canopy

DC= Disturbed canopy.

3.1.1 Compartment Designation.

Bosumkese Forest Reserve is divided into 84 compartments. These compartments have three designations based on their canopies, namely open canopy, where only selective logging are allowed under the strict forest laws and regulations, closed canopy where little or no human activities is allowed to take place, such as sacred places and finally disturbed canopy where the forest has been destroyed or near destruction due to the activities of the inhabitants of the area.

These blocks are managed by the Forestry Services Division (FSD) under the Ministry of Lands and a Natural resource which is located at Bechem the capital of the Tano District in the Brong Ahafo Region. Many floral and faunal studies have been conducted in the blocks. However little or no studies have seen conducted on these blocks on the butterflies abundance, species richness and diversity.

The study area was divided into three areas namely; undisturbed canopy (UC) slightly disturbed canopy (SDC) and the Disturbed canopy (DC)

1. The undisturbed canopy: This area is covered by forest trees of economic importance interspersed with under storey herbs and shrubs. The average relative humidity of the area is about70% with average daily temperature of $28^{o}C \pm 1$

Common trees found in the area include *Triplochiton scleroxylon* (Wawa), *Khaya senegalensis* (Mahogany), *Ceiba pentandra* (Ceiba), *Militia excelsa* (Odum), *Terminalia ivorensis* (Emire) and other traditional trees. There is little or no human activities in this Forest Reserve hence the canopy is well closed.

(2) The slightly disturbed canopy is the area that has been specifically allocated for the lumber operations or selective logging. *Khaya senegalensis* (Mahogany), *Tectona grandis* (Teak), *Ceiba pentandra* (Ceiba) among others are the most common trees. The relative humidity is around 60% with the temperature averaging $32^{o}C \pm 1$.

(3) Disturbed Canopy: This area has been widely cultivated for agriculture purpose. The vegetation structure is mainly herbs, shrubs and *Chromolana odurata (L.)* The notable among them is the Cassia for reclamation, Teak is meant for re-forestation of the area. The area has been subjected to years of exploitation of the forest trees by chainsaw operators and hunters. The relative humidity is about 60% with the average temperature of $36^{o}C \pm 1$.

3.2 Sampling of the anthropogenic activities of the inhabitant

3.2.1 The Target Population

The main target group of this research was the people living along forest reserves in the Tano District. The study was designed to cover the villages /communities surrounding the forest namely Bosankro, Bomaa,Nsuapim, Dwenese, Breme and Ahyiem

The total population of the villages is estimated to be over 5500.

3.2.2 The sample and sampling procedure

In other to get a sizable number of respondents to represent the entire area, forty people from the villages were randomly selected. Simple random sampling was used to select the respondents so as to ensure fair representation of the population. This means each member of the population had an equal chance of being included in the sample. In the

process ten (10) individuals were selected from each of the four villages in the forest reserve.

3.2.3 The Instrument and Data Collection

Questionnaire and interview schedules were the main instruments used in collecting data on anthropogenic activities of the people in the Bosumkese Forest Reserve. They were made up of closed ended and open-ended items. Community focus group discussions were also utilized to elicit information from the people and their views on the subject were captured as part of the data collected.

The questionnaire covered four (4) main areas namely;

a) Demographic characteristics such as sex of the respondents, age of the respondents, the number of years spent by the respondents in and around the forest, the level of education of the respondents, and the occupation of the inhabitants.

b)The human activities that are destroying the forest in the area using five point likert scale ranging from 5 = very strongly agree, 4 = strongly agree, 3 = agree, 2 = somewhat agree,

1= somewhat disagree, 0 = disagree.

c) Perceived effects of the destruction on the community.

d) The perceived ways of minimising the effects in the community using the likert scale 5= strongly agree, 4 = agree, 3 = somewhat agree, 2 = somewhat disagree, 1 = disagree.

3.2.4 Administration of the Instrument /Questionnaire

The researcher administered all the questions personally. Respondents were assured that all responses would be strictly treated as confidential. They were therefore not required to give their names. The selected villages, the Forestry Department and the Reserve area were visited to have personal contact with the people before administering the questionnaire. The visit took place in the morning and afternoon depending on the respondents schedules.

On the part of the respondents, who had no formal education and therefore could neither read nor write they were personally interviewed. The items on the questionnaire were translated them into Akan language (Twi). The respondents were visited three (3) times to establish rapport and book appointments before administering the questionnaire. It took two weeks to visit all earmarked places to administer the questionnaire/interviews.

3.3 Data collection on the butterflies

3.3.1 Site selection

A one (1) kilometre long transect was selected from each of the three blocks stated under the compartment design. This selection was carried out under the guidance from the forest guards. Sampling of the butterflies for the study was carried out along the transect at 25 metres interval in each block which was randomly selected with the point of entry and accessibility in the area taken into consideration.

3.3.2 Butterfly sampling

A cylindrical trap of at least 90cm in height was prepared to capture the butterflies. This height was used to minimize the escape of the butterflies once they enter the trap as recommended by (Barlow *et al*., 2007).

Four different traps were set in each of the transect lines in all the blocks by hanging the trap nets on supports or shrubs and within 0.1m and 1m from the ground level (Bossat *et al*., 2006).

Traps were baited with different attractants such as pulverised, fermenting banana, flowers, and fermented fruit covered in a rubber bucket two days prior to each collection. The first day of the week for collection was used to set up the traps. This included the hanging of the traps from ropes attached to branches of trees and or shrubs. However, anytime a butterfly was captured, the baits were replaced with fresh one. The trap stations were labelled as treatment, T_1, T_2, T_3, T_4 etc. The prepared bait was mixed with fresh palm wine for maximum attraction of the butterflies and to speed up the fermentation process. Grease was improvised for tangle foot which was applied to the ropes to prevent ants from descending on the traps.

Baits were then put in plastic plates and placed in the trap to complete the procedure.

In addition to this, walk and catch method using butterfly nets was employed within one kilometre line transect in each of the study area. With this, any butterfly observed and caught within the catchments area was counted.

Data were collected monthly for six months and for each month, sampling was replicated two times beginning from October 2010 to March 2011. Butterflies of West Africa (Larson, 2005), an identification guide was used for identifying the species.

3.3.3 Parameters Studied

At the end of sampling and counting of butterflies the following parameters were studied.

1. the total number of butterfly species and families were examined using an identification guide and index,' Butterflies of West Africa' (Larson, 2005).

2. Relative abundance of the butterflies with respect to the:

   i) Habitat preference.

   ii) Dominance across all the three forest types at the Bosumkese Forest Reserve

These were calculated using the formula

1) Relative Abundance $= \frac{\text{The number of individual butterflies}}{\text{The total number capture at each forest type}} \times 100$

2) Relative Dominance $= \frac{\text{The number of individual butterflies}}{\text{The total number butterflies sample in all the areas}} \times 100$

Simpson's Index (D) measures the probability that the individuals randomly selected from a sample will belong to the same species (or some category other than species).

$$D = \sum \frac{n(n-1)}{N(N-1)}$$

n = the total number of organisms of a particular species

N = the total number of organisms of all species

The value of **D** ranges between 0 and 1. With this index, 0 represents infinite diversity and 1, no diversity. That is, the larger the value of D, the lower the diversity.

3.4 Data Analysis

The data collected on the anthropogenic activities of the people living in and around the forest reserve were analyzed using Microsoft Excel and Statistical Package for Social Science (SPSS) version 16, 2010 and the results presented in percentages and means for interpretations

Data collected on butterflies, species diversity were quantified in terms of abundance and species richness. Abundance was calculated as the total number of individuals of a species hence the butterflies were counted in each block while species richness was estimated as the total number of species observed (Goetz *et al*., 2007) or the number of species in a sample (Whittaker *et al.*, 2001) this was analyzed using Simpson's diversity index (details in appendix E).

CHAPTER FOUR

RESULTS

4.1 Demographic Information of Respondents

4.1.1 Gender distribution of respondents

Out of 40 individuals that were interviewed, 26 (65%) of the respondents were males, whilst 14 (35%) were females as shown in Table 1.

Table 1: Gender of Respondents

Sex	Frequency	Percentage (%)
Male	26	65
Female	14	35
Total	40	100

4.1.2. Age distribution of respondents

The results of the age distribution of the respondents are shown in Table 2. Large number of the respondents (19) representing 45.5% were above 45 years. Fourteen (14) of the respondents (35%) were between the ages of 35 to 44. However, only three (3) of the people that were interviewed representing 7.5% were between the ages of 15 and 24 (Table 2).

Table 2: Age distribution of the respondents

Age categories	Frequency	Percentage (%)
15 - 24	3	7.5
25 - 34	4	10
35 - 44	14	35
Above 45	19	47.5
Total	40	100

4.1.3: The number of years that have been spent by the respondents in and around the Forest Reserve.

Sixteen (16) of the respondents (40%) have been living in and around the forest area between 21and 30 years whilst 15 respondents representing 37.5% have lived in the area between 11 and 20 years. Only 2 out of the total accounting for 5% have lived in the area between 31and 40 years, as shown in the Table 3.

Table 3: The number of years spent by the respondents around the Forest Reserve

Duration	Frequency	Percentage (%)
01 -10	7	17.5
11- 20	15	37.5
21- 30	16	40
31- 40	2	5
Total	40	100

4.1.4 The Level of Education of the Respondents

The results on the level of education of the respondents are shown in Table 4. It was observed that majority of the respondents have had formal education, 57% have had basic education with only 8% educated to the secondary school level (Table 4). Fourteen (14) of the respondents, 35% had no formal education at all.

Table 4: Education level of the Respondents

Educational level	Frequency	Percentage (%)
No formal education	14	35
Basic elementary	23	57
Technical/Secondary	3	8
Tertiary	-	-
Total	40	100

4.1.5 Occupation of the Respondents

A large number of the respondents depend on the forest for their livelihood as shown in Table 5. Twenty-eight (28) of the respondents (70%) had been engaging in farming as their source of livelihood. Six (6) out of the total representing 15% lived on chain-saw lumbering to earn a living. Only 5% of the respondents were artisans.

Table 5: Occupation of Respondents

Occupation	Frequency	Percentage (%)
Farming	28	70
Hunting	4	10
Chain – saw operation	6	15
Artisans	2	5
Total	40	100

4.2: Human activities that is disturbing Bosumkese Forest Reserve.

Majority of the respondents considered slash and burn method of farming and chain-saw activities as the main factors that are destroying the forest reserve with the scores of 4.95 and 4.90 respectively. Many again indicated that logging is also on the increase in the forest reserve scoring a mean of 3.0. According to the respondents burning the bush for game, hunting, illegal mining and human settlement were the least human activities in the Forest reserve area (Table 6).

Table 6: The activities of humans that are disturbing Forest Reserve.

Activities	Mean score
Slash and burn	4.95
Chain saw operation	4.90
Selective logging	3.0
Burning for game	1.0
Illegal mining	1.0
Human settlement	1.0

Scale: very strongly agree = 5, strongly agree = 4, agree = 3, somewhat agree = 2,

Some what disagree = 1, disagree. = 0

4.3: The effect of forest destruction on the community

Seven (7) of the respondents (17.5%) stated that destruction of the forest affect the rainfall pattern, 35% attributed the extinction of most wildlife and biodiversity to the destruction of forest. Eleven (11) out of the total (27.5%) said, the destruction has led to the drying up of water bodies whilst, 20% responded that the problem has led to shortage of food as a result of poor yield (table 7).

Table 7: Inhabitants view on the effect of forest destruction

Effects	Frequency	Percentage (%)
Extinction of wildlife	14	35
Changes in weather	7	17.5
Dry of water bodies	11	27.5
Shortage of food	8	20
Total	40	100

4.4: suggested ways of preventing the destruction of Bosumkese Forest Reserve.

All the respondents scored (5.0) that there should be strict enforcement of the forest laws. A mean value of 4.82 was scored for the provision of alternative livelihood for those living in and around the forest reserve. The respondents replied that monitoring the activities of the forest guards and modernizing agriculture could be some of the means of preventing the destruction of the forest reserve scoring a mean value of 3.62 and 3.09 respectively. However, the respondents considered that the punishment given to offenders of the forest laws should be considered the least ways of preventing forest destruction (Table 8).

Table 8: Inhabitants view on preventive measure of the destruction of Bosumkese Forest Reserve.

Perceived preventive measures by inhabitants	Mean score
Strict enforcement of forest laws	5.0
Provision of alternate livelihood	4.8
Monitoring the activities of the forest guards	3.6
Modernising agriculture	3.1
Punishing the offenders of forest regulation	1.0

Scale: very strongly agree = 5, strongly agree = 4, agree = 3, somewhat agree = 2, somewhat disagree = 1, disagree=0

4.5: The number of butterfly count in the forest types in Bosumkese Forest Reserve.

A total of 119 individual butterflies were collected from October 2010 to March 2011(Table 9). Thirty-one (31) were captured in the undisturbed forest canopy (UC) representing 26% of the total (Fig 2), 37 individuals (31%) (Fig 2) were collected in the slightly disturbed area (SDC) whilst, the disturbed canopy recorded the number of 51 individual butterflies accounting for 43% of the total number captured over the period.

Table 9: Number of butterfly species in the three forest types

Forest type	Number of butterflies counted
Undisturbed Canopy (UC)	31
Slightly disturbed Canopy (SDC)	37
Disturbed Canopy (DC)	51
Total	119

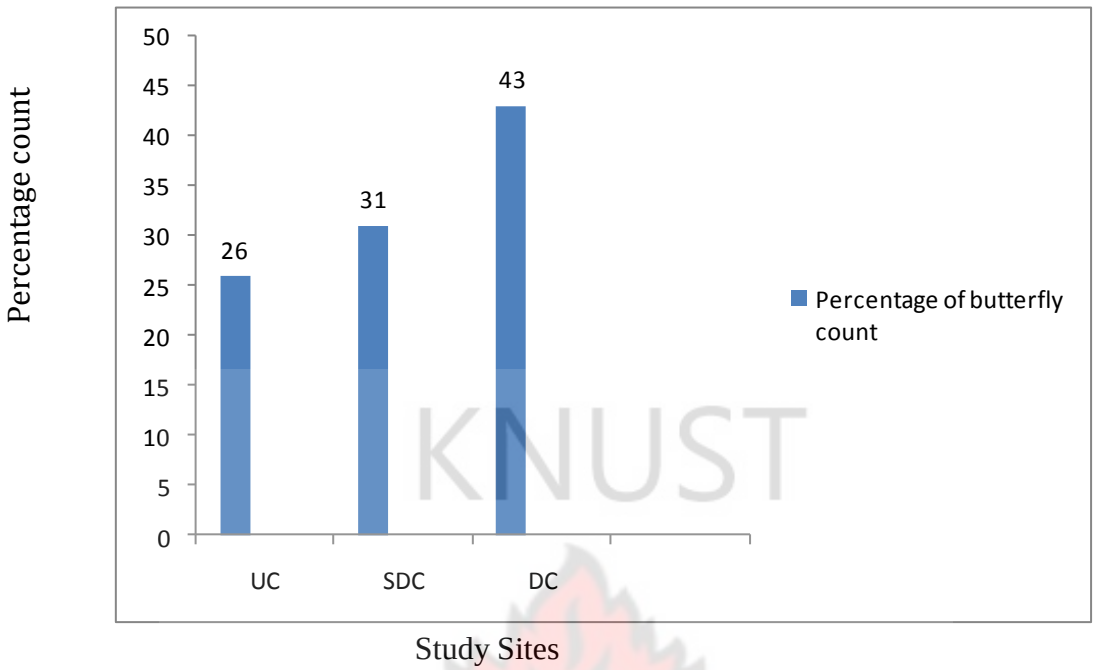

Fig.2: Percentage of butterfly count in the three (3) forest types.

4.5.1: Distribution and number of butterfly families collected

The number of butterfly families collected is given in Fig 3.

A total number of five families were identified along the three transects of the forest types studied. The family Nymphalidae had the largest number accounting for 51 individuals across all the three forest types. The Hesperiidae family was the least recorded butterflies (5) during the study period (Fig.3). The undisturbed forest zone recorded three (3) families of butterflies namely; Nymphalidae, Pieridae, and Hesperiidae. A total of thirty-one (31) individuals (Appendix C) made up of fourteen (14) species were captured in the UC (Table 11). Of this number nineteen (19) butterflies were identified as Nymphalidae whilst nine (9), and three (3) were from Paeridae and Hesperiidae families respectively. The slightly disturbed forest zone recorded four (4) butterfly's families (Appendix C). Out of this, thirty- seven individuals made up of ten (10) species (Table10) were sampled.

Twenty-three of them were Nymphalidae, which constitute the largest number of individual butterflies trapped in this zone, 10 were pieridae, 2 were Hesperiidae and 2 were Lycaenidae (Fig 3).

The disturbed forest canopy recorded four (4) butterflies' families. They were Nymphalidae, Papilionidae, Pieridae and Lycaenidae. A total of eight (8) species made up of fifty-one (51) individuals were identified in this zone. Out of this, the Nymphalidae had the largest number (16), whilst Lycaenidae recorded the least number of individual butterflies (8). Papilionidae and Pieridae however, accounted for fifteen (15) and twelve (12) individual butterflies respectively.

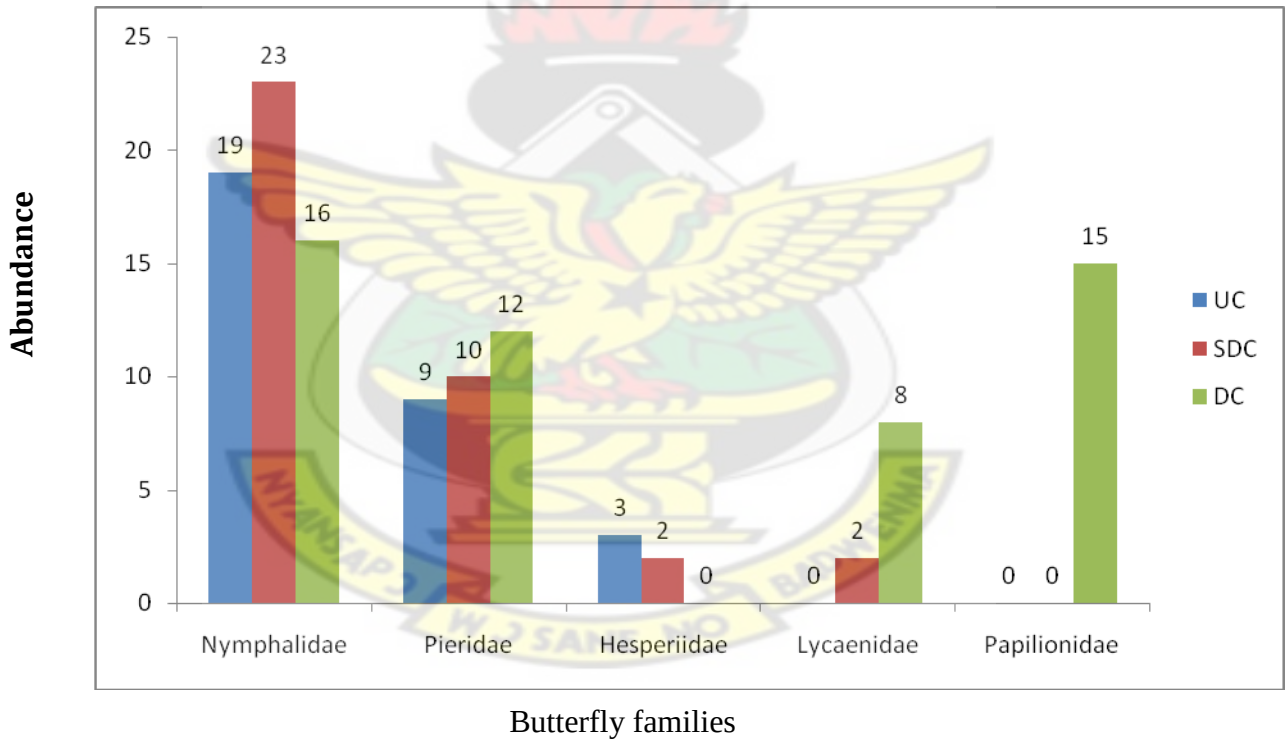

Fig. 3: The distribution and abundance of families of butterflies identified in the three forest types in Bosumkese Forest Reserve

4.5.2: Monthly distribution and abundance of butterflies in the three forest types

The monthly distributions of butterflies sampled over the six-month period are presented in Figure 4 and Appendix D. In the undisturbed forest zone the largest number of six (6) individual butterflies each was captured in the months of December, 2010 and January, 2011. The month of March recorded the least number of butterflies (4). The number of individual butterflies captured in the slightly disturbed canopy (SDC) fluctuated over the sampling period (Fig 4). The months of October, November and March, 2011 recorded seven (7) individual butterflies each (Appendix D). Five (5) individual butterflies each were trapped in the months of December 2010 and January 2011. The disturbed forest area recorded the largest number (14) of individual butterflies in the month of October. The least number (4) of butterflies were, however, trapped in the month of February (Fig 4 and Appendix D).

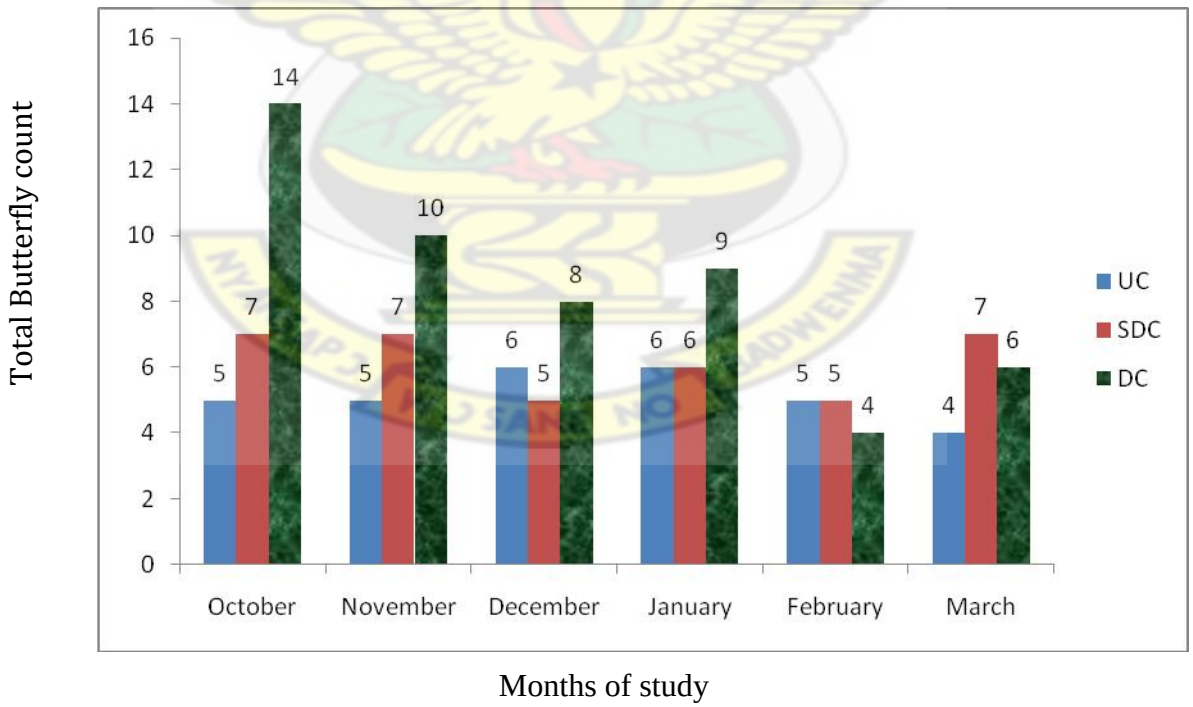

Fig. 4: Monthly distribution and abundance of butterflies in the three forest types.

4.6: Relative abundance of butterflies

The relative abundance of butterflies is shown in Table 10 and the number of individual butterflies used for calculation is in Appendix B. Among the entire individual butterfly species recorded at the undisturbed canopy, *Neptis nysiades (L.)* was the most abundant (22.5%). This was followed by *Mylothris atewa (L.)* (19.4%) and *Bicyclus dorothea (L.), Psuedopotia paradoxa (L.), Bicyclus italus (L.) and Pentila hewitsonii* (L.) were equally represented in abundance (6.5%). However, *Charaxes cynthia Cynthia (L.), Abantis tanobia (L.), Melphinia malthina (L.), Eagaris decostigma (L.), Amaurina hecata ,hecate (L.), Eupheadra zampa (L.), Catopsilia florella (L.) and Pseudacraea eurytus (L.)* recorded the least of abundance of 3.2%.

With regard to the slightly disturbed canopy (SDC), *Mylothris atewa (L.)* was the most abundant (24.3%), followed by *Euryphura chalcis* (L.) (21.6%) with *Neptis nysiades (L.)* accountig for 18.9%, *Charaxes Cynthia (L.)* recorded 10.8% with *Eagaris decastigma (L.), Stempfferia dorothea (L.) and Pseudacrae euryptus (L.)* recording equal abundance of 5.4% over the same period. *Amauris hecate hecate (L.), Euphaedra zampa (L.)* and *Catopsilia florella (L.)* however, recorded the least abundance of 2.7%.

In the disturbed canopy (DC), *Papilio dardanus* (L.) was the most abundant (29.4%), followed by *Anthene wilsoni* (L.) (15.7%) with *Amaurina hecate hecate (L.)* recording the least of abundance of 1.9%. *Catopsila florella (L.) and Colotis equippe (L.)* had the same number of abundance accounting for 13.7%. However, *Neptis nysiades (L.) and Euphaedra zampa (L.)* recorded abundance of 7.8% and 9.8% respectively.

Table 10: Distribution and relative abundance of butterflies in the three forest types

Families and individual species	Relative abundance (%)		
	UC	SDC	DC
NYMPHALIDAE			
Amaurina hecate,hecate (L.)	3.2	2.7	1.9
Bicyclus italus (L.)	6.5	-	-
Bicyclus dorothea (L.)	12.9	-	-
Euryphura chalcis (L.)	-	21.6	-
Euphaedra zempa (L.)	3.2	2.7	9.8
Charaxes cynthia, Cynthia (L.)	3.2	10.8	11.7
Neptis nysiades (L.)	22.5	18.9	7.8
Psuedacraea eurytus (L.)	3.2	5.4	-
Pentila hewitsonii (L.)	6.5	-	-
HESPERIIDAE			
Abantis tanobea (L.)	3.2	-	-
Melphina malthina (L.)	3.2	-	-
Eagaris decastigma (L.)	3.2	5.4	-
PIERIDAE			
Paseudopontia paradoxa (L.)	6.5	-	-
Catopsilia florella (L.)	3.2	2.7	13.7
Colotis euippe euippe (L.)	-	-	13.7
Mylothris atewa (L.)	19.4	24.3	-
LYCAENIDAE			
Stempffera dorothea (L.)	-	5.4	-
Anthene wilsoni (L.	-	-	15.7
PAPILIONIDAE			
Papilio dardanus (L.)	-	-	29.4
Total	100	100	100

NB. Scientific names of butterflies were authored by Larson, T.B. (2005)

4.6.1 Dominance of butterflies across the three forest types.

Five (5) butterfly species namely *Charaxes Cynthia (L.), Amauris hecate (L.), Neptis nysiades (L.) and Euphaedra zampa (L.)* (Nymphalidae) and *Catopsila florella (L.)* (Pieridae) were found in the three forest types (Table 11). *Neptis nysiades (L.)* showed greater dominance in the both undisturbed canopy and slightly disturbed canopy (5.88%) as

against 3.40% in the disturbed area. However, *Charaxes*, *Catopsilia* as well as *Euphaedra* and *Colotis* were more dominant in the DC canopy recording 5.04%, 5.88% and 4.20% respectively.

Pentila hewotsonii (L.), Bicyclus italus (L.), Bicyclus dorothea (L.) (Nymphalidae*),Psuedopontia parodoxa* (L.) (pieridae) , *Abantis tanobia (L.), Melphina malthina (L.)* (Hesperiidae) were unique species recorded at the undisturbed canopy and these species showed evenness in abundance between 0.84 to 1.70% (Table11).

Two butterfly species *Stempfferia dorothea (L.)* (Lyceanidae) (1.70%) and *Euryphura chacis (L.) (*Nymphalidae) were unique in the slightly disturbed zone in the reserve. *Papilio dardanus* (L.) which was the most dominant among all the species (12.6 %) was found in the DC. *Anthene Wilsoni (L.) and Colotis euippe (L.)* were found to be the unique species in the disturbed canopy.

Again from the table, three species namely *Eagaris decastigma (L.), Mylothris atewa (L.)* and *Psuedacraea eurytus* (L.) were common in both the undisturbed canopy and slightly disturbed canopy.

Table 11: The distribution and the dominance of butterflies' species in the three forest types.

FAMILY	Dominance in the three forest type (%)		
	UC	SDC	DC
NYMPHALIDAE			
Amaurina hecate,hecate (L.)	0.84	0.84	0.84
Bicyclus italus (L.)	1.70	-	-
Bicyclus dorothea (L.)	3.40	-	-
Euryphura chalcis (L.)	-	6.72	-
Euphaedra zampa (L.)	0.84	0.84	4.20
Charaxes cynthia, cynthia (L.)	0.84	3.40	5.04
Neptis nysiades (L.)	5.88	5.88	3.40
Psuedacraea eurytus (L.)	0.84	1.70	-
Pentila hewitsonii (L.)	1.70	-	-
HESPERIIDAE			
Abantis tanobea (L.)	0.84	-	-
Melphina malthina (L.)	0.84	-	-
Eagaris decastigma (L.)	0.84	1.70	-
PIERIDAE			
Paseudopontia paradoxa (L.)	1.70	-	-
Catopsilia florella (L.)	0.84	0.84	5.88
Colotis euippe euippe (L.)	-	-	4.20
Mylothris atewa (L.)	5.04	7.60	-
LYCAENIDAE			
Stempffera dorothea (L.)	-	1.70	-
Anthene wilsoni (L.)	-	-	6.72
PAPILIONIDAE			
Papilio dardanus(L.)	-	-	12.60
TOTAL	26	31	43

NB. Scientific names of butterflies were authored by Larson, T.B. (2005)

4.7: The Species Richness and Diversity in the Bosomkese Forest Reserve

Species richness and diversity are presented in table 12.

The undisturbed canopy had the highest number of species richness (14) whilst the disturbed canopy recorded the least number of butterfly species (8). In terms of diversity, the undisturbed canopy displayed greatest diversity of butterflies' species (0.09). However the results showed that the disturbed canopy had the least butterfly diversity (0.15). NB: details of the table below can be found in appendix E.

Table 12: Species richness and diversity of the butterflies in the Bosumkese forest Reserve between December, 2010 and March, 2011.

Parameter	**UC**	**SDC**	**DC**
Species richness	14	10	8
Diversity	0.09	0.12	0.15

The value of **D** ranges between 0 and 1. With this index, 0 represents infinite diversity and 1, no diversity. That is, the larger the value of D, the lower the diversity

CHAPTER FIVE

DISCUSSION

5.1: Demographic Information .

The study revealed that most of the respondents were males (65%) as compared to 35% females. This trend may be due to the fact that most of the activities undertaken in the forest required people that are strong and active in exploiting the natural resources around them. Traditionally, there are some activities like plantation farming, logging and hunting in the forest which are solely for men. MASDAR (1997) revealed that Ghanaian cultures which usually required properties such as land and capital that are handed over to males in the family account in part for the small number of women in production or farming enterprise. The large numbers of males in the area are involved in the clearing of the forest for farming, cutting of trees for charcoal burning, lumbering and firewood.

Most of the respondents were older people with the average age of 45 years. This may be attributed to the land acquisition and tenure system in Ghana which is mainly by inheritance. For the sake of posterity and for the next generation to benefit from an asset such as land, the inhabitants have decided to live there for the entire life until these properties thereof are properly bequeathed to the next generation. Against this background their sources of livelihoods are greatly tapped from the forest and the resources available in it.

The study revealed that the people living in and around the forest reserve are traditionally farmers who could just occupy any land available to them without any course to the laws regarding the land acquisition in the country. This was confirmed by Hawthrone (1996 who stated that the unsustainable trend of the forest and its resources is greatly linked to the socio-cultural phenomenon existing in Ghana and therefore advocates for the change in the

procedures in land acquisition to make them more legitimate. The level of education among the people in and around the forest reserve area is significantly low. Bull (1982) stated that about 70% of rural farmers in developing countries lack formal education. This development accounts for the high rate of destruction in the forest reserve resulting from high level of poverty in the area. This has affected the peoples' ability to adhere to the standard way of managing natural resources like forest in a sustainable manner.

Majority of the respondents were subsistence farmers whose mode of farming is shifting cultivation and slash and burn. According to the Ministry of Environment and Science (2002) many farmers defy all orders and intrude the forest with the belief that the land belong to their ancestors hence they can cultivate any portion available to them. The study further revealed that chain-saw operation and fire hunting are on the increase within Ahyiem and Dwenese section of the forest reserve. Holbech (1998) confirmed this when he stated that commercial bush meat exploitation is widespread in most countries leading to the extinction of some animals' species or reducing the population of other animals to such low level that they may go extinct in the coming decades. Allotey (2006) revealed that deforestation has its root in poverty and reinforced by population growth and unsustainable development of agricultural production. Most of the hunters interviewed admitted that sometimes they hunt in the forest reserve without permission, mainly by shooting and trapping.

5.2: Human activities that are disturbing Bosumkese forest reserve

Slash and burning type of agriculture and chain-saw operations were ranked highest among the anthropogenic activities carried out by the respondents in and around the forest reserve (mean score 4.95 and 4.90 respectively) (Table 6)

This phenomenon conforms to that of Hunter (1999), when he observed that the livelihood of more than half of the economically active population in the developing world would directly depends on the environment through agriculture, as well as animal husbandry, hunting, fishing, forestry and foraging. Willott *et al.* (2000) also confirmed that a clear issue of much concern is the widespread illegal harvesting of forest resource. This hampers any strategies seeking to reduce over-exploitation, forest degradation and to ensure sustainable forest management. Hawthrone (1996) described the trend as a disaster when he quantifies the number of commercial tree species that are destroyed due to the activities of peasant farmers. According to him many commercial tree species that supports millions of biodiversity have been exploited to such an extent that they have become threatened. However, according to the District Forestry Commission (2009), most of the people in the areas like Bomaa, Brosankro and Breme are basically into selective logging particularly in the Forest Reserve. The study again revealed that activities such as illegal mining and human settlement are very low hence their impact on the Forest may not be significant (mean score for both 1.0).

5.3: The effects of forest destruction on the community

The study confirmed that, wanton destruction of the Forest Reserve have resulted in the extinction of wildlife (35%). This was revealed by the inability of the respondents to get game meat from the forest. Sayer *et al.* (1992) concluded that, the forest zone has been the

subject of worse damage resulting in extinction of the wildlife and materials of cultural value. Treue *(*2003) also revealed that, all herbivorous insects show some degree of host selectivity hence when the hosts are threatened the biodiversities are also threatened. Again, the situation has affected the water bodies so much so that most of rivers and streams dried up easily before the commencement of the dry season due to erratic rainfall pattern in the depleted areas of the forest reserve. Also intensive cultivation of the land along the river bodies particularly the Tano River has polluted the water with chemicals making it almost impossible for drinking. This was observed by Hayward and Ogantoyinbo (1987) that rainfall has dropped from 2000mm at Cape Three Point to 1200mm in Takoradi and to 900mm in Accra at the border of Dahomey Gap due to rapid destruction of the forest. According, IUCN (2011), most water bodies in Ghana are polluted through chain-saw operation and illegal mining, FAO (2001), confirmed that by far the greatest worry to humanity especially, the developing countries has been in the area of access to potable drinking water which emanates from unsustainable use of forest resources particularly trees. According to the respondents there has been a significant reduction in food production in the area. Miller and Kauffman (1998) observed that $^{4}/_{5}{}^{th}$ of the nutrients of the soil are in the vegetation, the soil lack nutrients and becomes eroded and unproductive within a few years of being cleared or logged. This demonstrates that, the destruction of the forest would have negative effects on the performance of crops leading to shortage of food. This is a clear admonition that the depletion of the forest can affect both the micro and macro nutrients that support plant growth and productivity. The study also revealed that, the destruction of the forest has affected the state of weather pattern in the area. According to the Ghana Metrological Services (2008), the sharp increase in temperature and erratic nature of rainfall has been highly associated with the changing trend of forest regime in the area over the decade. Walter, (2008) stated that rain forest vegetation holds vast reserve of carbon, when

trees are burnt or cut and left to decay, the carbon is release into the atmosphere and this is second largest factor contributing to the green house effect and its consequent climate change. Ulrich and Buszko, (2004) also observed that, the extent of degradation in the Amazons Forest over the last decade would affect the world's net climate that will make life particularly people along the coast more threatening.

5.4: Ways of Minimising Human Activities that Cause Destruction to Forest Habitat

Considering the effects mentioned by the respondents the problem could be addressed with strict enforcement of the laws on forest. Lynne (2008) observed that, the only way to deal with the phenomenon of forest depletion is to strengthen the institutions that enforce the laws and fight poverty particularly in developing countries. This underscores ideas revealed by the inhabitants that, there should be an alternative livelihood programme to offer employment other than depending on the forest for livelihood. This idea conforms to that of Fermon (2002) who stated that the solution to over dependency of the rural communities on the forest reserves is to provide an alternative life that would redirect their attention on the forest and its resourses.

FAO (2001) observed that poverty and lack of political will among the leaders especially in the developing countries underscores their inability to resolve the problem of deforestation. According to Brown (1997), poverty especially in the developing countries makes it almost impossible to implement regulations on our natural forest and this underpins why little headway is made towards preventing deforestation. Against this background, it is the incumbent on the government to strengthen the area of decentralization in order to fully empower the local people to become more resourceful in the communities (IUCN, 2011).

Another alternative way of minimizing the destruction of the forest reserve is to modernize agriculture through provision of logistic and capacity building to enhance the skills of the farmer living in and around the Forest Reserve. This would make them cultivate the forest on a more sustainable basis. Poorter *et al*. (1996) observed that once the farmers and the local people are equipped with life-sustaining skills greater percentage of the forest would be saved from destruction.

5.5: The effect of forest destruction on the number of butterflies sampled in the three forest types in the Bosumkese Forest Reserve (BFR)

The disturbed canopy recorded the largest number of butterflies (43%). This clearly shows that their preferred habitat may be the disturbed type of vegetation. Most of the butterfly species preferred open areas where the temperature is relatively high especially during the early part of the day (Larson, 2005). Comparing the three canopy types, the Disturbed canopy seemed to reflect the habitat preference for most of the butterflies in the Afro tropical forest regions of West Africa as suggested by Dumbrell and Hill (2005) that butterflies prefer areas where the temperature ranges between 28^{o}C– 33^{o}Cwith optimum humidity. The least number of butterflies recorded in the Undisturbed was as a result of high moisture content and its associated low temperature (average 27^{o}C) which is only preferred by some of the species that are adapted to those conditions. According to Larson (1997), most of the butterfly species during the early days of African history were recorded in the tropical rain forest areas but due to changing trends of the nature of the forest most of the species are near extinction or have gone into extinction particularly in the sub-Sahara African countries including Ghana. This phenomenon might have affected the numbers of butterflies in the undisturbed areas of the reserve.

Basset *et al*. (1998) also indicated that with the destruction of the natural habitat, many of its animal goes extinct; 'we are loosing approximately 100 species per day'.

Slightly disturbed canopy recorded more butterflies than the undisturbed canopy but lesser than the disturbed canopy. This may be attributed to environmental preference by the butterflies. They appear to prefer the undisturbed canopy and slightly disturbed canopy than the disturbed canopy.

5.5.1 Number of Butterfly Families Sampled

The number of species of butterflies belonging to Nymphalidae family was more than the other four (5) butterfly families identified during the study in the Bosumkese Forest Reserve. This might be due to the wide range of adaptations as well as wide environmental preference of Nymphalidae within the Forest floor of West Africa. Piriedae, Papilionidae and Hesperiidae followed in the order of abundance with Lycaenidae being the least abundant. Most Nymphalidae are fruit feeding butterflies hence their large number in the Bosumkese forest reserve (Larson, 1994a).

Larson (2005) estimated that approximately 900 butterfly species occur in Ghana and most of these were identified to belong to the Nymphalidae. This explains the larger number of them in the Forest Reserve.

Addae-Wireko (2008) also indicated that Nymphalidae are the widely known butterfly species in Ghana. Larson (1997) again attributed this trend of occurrence of Nymphalidae to the fact that in the other families, the butterflies are strictly associated to particular types of plant species which makes them plant Species – specific'.

5.5.2 Distribution of butterfly species over the sampling period

Substantial numbers of butterflies' specimens were recorded in the month of October. This may be due to favourable environmental conditions during the period as most of the butterflies that had gone into diapauses become active again (Larson, 2007).

Koh (2007) also assigned the large number of butterflies in the early part of summer to the level of light intensity which is most preferred by butterflies. The number fluctuated during the sampling period due to instability in the weather and the unexpected high level of rainfall especially in the month of December and January (2011) which are traditionally considered as the peak of the dry season in Ghana. Consequently, the number kept on decreasing in the month of February due to frequent bush fire especially in the Derma area where the disturbed canopy was located.

5.6 The distribution and relative abundance of butterflies in the three forest types in the Bosumkese Forest Reserve.

Most of the butterfly species sampled in the closed canopy are classified as the forest type of butterflies that tolerate forest conditions. Larson and Collins (1998) stated that *Pentila sp, Bicyclus sp, Abantis sp, Melphina sp and Psuedopontia sp* are greater in numbers in the forest of good quality.

Neptis nysiades was found to be the most abundant in the undisturbed canopy (Table10). Larson (1995a) indicated that, this species is not particularly common in wet rain forest areas but is most frequently found in semi-deciduous forest system preferring rather open area or secondary growth in wetter forest regions. *Mylothris atewa* was first discovered within the Atiwa range in Ghana. Larson (1994a). Most *Mylothris atewa are* forest butterflies, but some penetrate into the Guinea savannah along rivers and only handful is savannah-adapted. Occasionally, they may be found on flowers but are fruit

feeding butterfly. This explains why they were more dominant in the Undisturbed and slightly disturbed canopies. *Bicyclus dorothea* also shown dominance in the closed canopy and this conforms to that of Larson (1994a) who stated that most of these species are attracted to fermenting fruit and sap oozing from damage trees, sometimes clogging up banana-baited butterfly trap, but they do not visit flowers. He also confirmed that they are adapted to the forest of good canopy.

Euryphura chalcis was abundant in the Slightly disturbed canopy area of the reserve (21.6%). Their dominance was no surprise as this butterfly species prefers dry-forest condition but quickly migrates to the deep forest area when the area is cleared (Larson 1995a). They are strictly forest type of butterfly.

Papilio dardanus was most abundant in the Disturbed canopy than any other species even though *Anthene sp, Colotis sp, Catopsila* and *Charaxes sp* were equally abundant in the same area

All these butterflies especially *Papilo sp, Anthene sp* and *Colotis sp* are categorically labelled as savannah butterflies (Larson, 2001*). Papilio sp* are species of butterflies that are always specialised in degraded habitats and open spaces where the land is most cultivated. Larson (2006) stated that though found in all types of forest, it does not penetrate the wetter forest types. It is mostly found in drier forests, but is now probably most common in the garden shrubs of major towns and in agriculture areas with trees and crops (Larson, 1994c).

5.6.1 The effect of forest destruction on the distribution and butterfly dominance in the three forest types in Bosumkese Forest Reserve.

Five genera namely *Charaxes, Amaurina, Neptis, Euphaedra* and *Catopsilia* are butterflies that were found to tolerate a wide range of environmental conditions; hence they are described as ubiquitous species (Larson, 2005). They can survive in both open and close forests whether dry or rain forest even though *Catopsilia, Euphaedra* and *Charaxes* were more dominant in the Disturbed canopy.

The forest habitat seems to provide conducive habitat for *Pentila hewontsonii (L.), Bicyclus italus (L.), Abantis tanobia (L.), Psuedopontia paradoxa (L.) and Bicyclus dorothea (L.).* These species thrive best in dense undergrowth where it may be difficult to capture them (Lewis, 2002) hence the smaller numbers collected/trapped. However, *Colotis euippe (L.), Anthene wilsoni (L.)* and *Papilo dardanus (L.)* were very much adapted to the disturbed canopy hence their dominance over other species.

They have been found to thrive well in the drier regions of the North transition between forest and savannah which explains their presence in Ghana (Larson, 1995b).

According to Larson (1994c), *Papilio sp* and *Colotis sp* for example cannot penetrate forests of good quality where the moisture content is high hence; they are purely savannah butterfly species.

A.wilsoni thrives well in much drier forest of the Northern Ghana and was first observed around Nandom in the Upper West Region of Ghana (Larson, 1994c).

Euryphura chalci were more abundant and unique than *Stempfferia dorothea* in the slightly disturbed canopy. *Euryphura chalci* can tolerate and adapt well to the forest of secondary growth and more importantly open and drier forests than the *Stempfferia sp* which only adapt when the primary forest is cleared (Larson, 1995c).

Most of the species that thrive well in the undisturbed canopy also have the tendency to survive in the slightly disturbed canopy. This may be due to the similarity in the conditions prevailing in the two areas within the forest reserve that undisturbed and slightly disturbed canopies. On the contrary, due to wide differences in environmental conditions, *P. dardanus,C.euipe and A. wilsoni* were not observed in the undisturbed and slightly disturbed canopies.. This was because most of the species observed in disturbed canopy can only be observed on even a brief walk through agricultural lands and village forest zones, though the species –composition differs from locality to locality. Very few would ever been encountered within the forest of good quality (Larson, 1994c).

5.7 The effect of forest destruction on species richness and diversity in the three forest types in the Bosumkese Forest Reserve.

The undisturbed canopy recorded high species richness and consequently high diversity in the butterfly species. This was due to the heterogeneous nature of the vegetation in the undisturbed canopy which attracted butterflies of different species. Over the years the decrease of closed forest has led to a huge growth in secondary habitats, ranging from laterite – almost rock-like soil with hardly any vegetation to derived savannah, various combinations of mixed agriculture, and finally tree crops such as cocoa and kola nuts. In such areas butterfly diversity has decrease considerably and true ubiquitous species have thrived, while some savannah elements of butterflies have invaded. However, a small number of species have greatly benefited and are now much more common in West Africa than they ever were (Larson, 2005). This explains why species richness as well as diversity was much lower in the disturbed areas than the undisturbed canopy. The species diversity was therefore directly related to species richness of a locality (Hamer *et al*., 1997).

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Summary and Conclusion

1. The inhabitants living around the Forest Reserve are male dominated hence most of the activities pursued by the people are male oriented such as hunting, farming, chain-saw operation. However, a few of the inhabitants are artisans.
2. The various human activities that pose threat to the Forest Reserves are basically slash and burn agriculture and chain-saw operation in the Forest Reserve.
3. The destruction of the forest reserve have affected the weather situation in the area, extinction of wildlife, drying of water bodies and shortage of food due to poor yield among others.
4. The inhabitants suggested that strict, enforcement of the forest laws, providing alternative livelihood for the people living around the forest and modernizing the methods of agriculture and among the way forward to safeguard the integrity of the Forest Reserve.
5. Undisturbed Canopy recorded the highest species richness and species diversity compared to the other two forest types studied within the Bosomkese Forest.
6. Butterflies were more abundant in the Disturbed canopy; however, most of the species were *papilionidae* which only adapt to forest of poor quality.

6.2 Recommendations

1. The people living in and around the various forest reserves should be educated in order to build their capacities to take up other jobs rather than encroaching the Forest Reserve for their livelihood.
2. The law enforcement agencies and other stakeholders should ensure strict enforcement of forest laws in order to maintain the biodiversity of Forest Reserve.
3. Alternative livelihood programmes such as snails and grasscutter rearing, bee-keeping, soap making etc in other to provide livelihood for the people living in and around the Forest Reserve
4. Butterflies are good indicators to monitor our forest hence should be continually be used in assessing the integrity of the Forest Reserve.

5. Due to seasonal variation of some tropical butterflies, it is recommended that the six-month study period should cover both wet and dry season in order to provide more balance estimate of the species diversity of the study area. .

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APPENDIX A

Questionnaire for inhabitants in Bosumkese Forest Reserve

The purpose to this questionnaire is to discover the anthropogenic activities of the people living in and around the forest reserve .This is for academic purpose and that every information given will be treated as very confidential. Please answer the items as much as you know:

Tick or supply the appropriate answers:

A. Background of respondents

1. Gender

a. male [ ]

b. female [ ]

2. Age distribution

a. Below 20 [ ]

b.20 – 25 years [ ]

c. 26 -35 [ ]

d. 35 – 45 [ ]

e. 45 above [ ]

3. How long have been living in the present area

a. 1 – 10 years [ ]

b. 10 - 20 years [ ]

c. 21 – 30 years [ ]

d. 31 – 40 years [ ]

e. 41 – 50 years [ ]

4. Educational level.

a. No formal education

b. Basic /elementary

c. Technical /secondary

d. Tertiary

4. What is your occupation?

a. Farming [ ]

b. Chain – saw operator [ ]

c. Hunting [ ]

d. Artisans

Other (please specify)……..

B. Causes of forest destruction

4. What are the underlying causes of forest destruction?

	5	4	3	2	1	0
Shifting cultivation						
Illegal mining in the forest						
Chain – saw operation						
Burning for game						
Poverty						
Hunting						
Logging						
Human settlement						

Scale: Very strongly agree = 5, strongly agree = 4, agree = 3, somewhat agree = 2

somewhat disagree = 1, disagree = 0

C. Effects of forest destruction on the community

5. In what way has the forest degradation affected this community?

Tick if the following are the effects of the above on the forest reserve

a. Extinction of wildlife [ ]

b. Change in rainfall pattern [ ]

c. Dry up of water bodies [ ]

d. Decline in yield of agricultural products [ ]

Others……

……

……

D Suggested preventive measure

6. Indicate the extent to which you agree or disagree to the following statements on the ways of preventing forest destruction in the reserve.

Preventive measures	**5**	**4**	**3**	**2**	**1**
Strict enforcing of forest laws					
Creating alternative source of livelihood for inhabitants.					
Punishing the offenders of the forest law					
Encouraging alley cropping					
Modernizing agriculture					
Monitoring the activities of the forest guards					

Scale: Strongly agree = 5, agree = 4, somewhat agree = 3, somewhat disagree = 2, disagree = 1

APPENDIX B

BUTTERFLIES SAMPLED THEIR ABUNDANCE

BUTTERFLY SPECIMEN	ABUNDANCE
Amaurina hecate	1
Bicyclus italus	2
Charaxes cynthia Cynthia	1
Abantis tanobia	1
Melphina malthina	1
Pentila hewitsonii	2
Eagris decastigma	1
Pseudacraea eurytus	1
Pseudopontia paradoxa	2
Bicyclus dorothea	4
Mylothris atewa	6
Neptis nysiades	7
Euphaedra zampa	1
catopsilia florella	1
Charaxes cynthia Cynthia	6
Euphaedra zampa	5
Neptis nysiades	4
Catopsilia florrela	7
Papilio dardanus	15
Amaurina Hecate	1
Colotis equippe	5
Anthene wilsoni	8
Eagris decastigma	2
Amaurina Hecate	1
Pseudacraea erytus	2
Mylothris atewa	9
Neptis nysiades	6
Catopsilia florella	1

Euryphura chalcis	8
Stempfferia dorothea	2
Charaxes cynthia Cynthia	4
Euphaedra zampa	2

APPENDIX C

DISTRIBUTION OF BUTTERFLY FAMILIES

FAMILY	UC	SDC	DC
Nymphalidae	19	23	16
Hespaeriidae	3	2	0
Lycaenidae	0	2	8
Papilionidae	0	0	15
Pieridae	9	10	12
Total	**31**	**37**	**51**

APPENDIX D

MONTHLY DISRIBUTION AND ABUNDANCE OF BUTTERFLIES

Months of collection	Transect 1/ UC	Transect 2/ SDC	Transect 3/ DC
October	5	7	14
November	5	7	10
December	6	5	8
January	6	6	9
February	5	5	4
March	4	7	6
Total	31	37	51

APPENDIX E

SIMPSON'S INDEX OF DIVERSITY

UNDISTURBED CANOPY

Species	No. of species	n-1	n(n-1)	n(n-1)/N(N-1)
Amaurina Hecate	1	0	0	0
Bicyclus italus	2	1	2	0.002150538
Charaxes cynthia cynthia	1	0	0	0
Abantis tanobia	1	0	0	0
Melphina malthina	1	0	0	0
Pentila hewitsonii	2	1	2	0.002150538
Eagris decastigma	1	0	0	0
Pseudacraea eurytus	1	0	0	0
Pseudopontia paradoxa	2	1	2	0.002150538
Bicyclus dorothea	4	3	12	0.012903226
Mylothris atewa	6	5	30	0.032258065
Neptis nysiades	7	6	42	0.04516129
Euphaedra zampa	1	0	0	0
catopsilia florella	1	0	0	0
Total	**31**			0.096774194
N -1	**30**			
N(N -1)	**930**			

DISTURBED

Species	No. Of species(n)	n-1	n(n-1)	n(n-1)/N(N-1)
Charaxes cynthia cynthia	6	5	30	0.011764706
Euphaedra zampa	5	4	20	0.007843137
Neptis nysiades	4	3	12	0.004705882
Catopsilia florrela	7	6	42	0.016470588
Papilio dardanus	15	14	210	0.082352941
Amaurina hecate	1	0	0	0
Colotis euippe	5	4	20	0.007843137
Anthene wilsoni	8	7	56	0.021960784
TOTAL (N)	**51**			**0.152941176**
N(N-1)	**2550**			

SLIGHTLY DISTURBED CANOPY

Species	No. of species	n-1	n(n-1)	n(n-1)/N(N-1)
Eagris decastigma	3	2	6	0.004504505
Amaurina hecate	1	0	0	0
Pseudacraea erytus	2	1	2	0.001501502
Mylothris atewa	8	7	56	0.042042042
Neptis nysiades	6	5	30	0.022522523
Catopsilia florella	1	0	0	0
Euryphura chalcis	8	7	56	0.042042042
Stempfferia dorothea	2	1	2	0.001501502
Charaxes cynthia cynthia	4	3	12	0.009009009
Euphaedra zampa	2	1	2	0.001501502
Total (N)	**37**			0.124624625
N-1	**36**			
N(N-1)	**1332**			