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Diversity, Distribution and Habitat Association of Small Mammals in Ene Proposed National Park Oromia Regional State, Western Ethiopia

A thesis submitted to the Department of Zoological Sciences, School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the requirements for the Degree of Masters of Science in Biology

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ABSTRACT

The present study was carried out to investigate small mammal species distribution, diversity and habitat association in Ene proposed National Park, Western Ethiopia. This study was conducted during September 2018 to October 2018, the study area was observed and classified into for habitat types based on the topography and vegetation types. These were mixed woodland, woodland, riverine forest, and grassland were differentiated. Each habitat type was classified into blocks. Representative samples of rodents and insectivore were taken from each habitat type by using live trapping in all the four habitat types of small mammals. Data were collected in the morning (7:00 –8:00 hrs) and in the afternoon (17:00 –18:00 hrs). During the trapping months six rodent species and one insectivore species were recorded. The trapped rodent species were *Crocidura sp, Arvicanthis niloticus, Desmomys harringtoni,*

Myomys albipes,Acomys cineraceus, Mus musculus and Lemniscomys barbarus, The diversity of small mammals varied among the four different habitat types. During October, woodland habitat appeared to be a choice for most of rodent species encountered in the study period. This habitats had the highest diversity index with Shannon-Wiener Index (H'=1.66) and evenness (E=0.798). The second diversified habitat was riverine forest (H' = 0.87) and (E=0.485).Mixed woodland habitat was the third diversified habitat (H'= 0.743) and (E=0.462). The lowest diversified habitat was the grassland habitat (H'=0 .83) and (E=0.399), During September the more diversified habitat was woodland (H'=1.31) and (E=0.632), followed by riverine forest (H'=1.015) and(E=0.63). The third diversified habitat was mixed woodland (H'=0.732) and (E=0.528) and the least diversity was observed in grassland. The most common species of rodent species in the study area were *Myomys albipes* and *Desmomy s harringtoni* . Among the four habitat type, Simpson's similarity index showed that the highest species similarity was between woodland and riverine forest (SI=0.67) and the least species similarity was between riverine forest and mixed woodland (SI= 0.66) during October. During September, more species similarity was between grassland and riverine forest (SI=0.64) and the least species similarity was between grassland and woodland (SI=0.65).

1. INTRODUCTION

Rodents are the most diverse groups of mammals (Vaughan, 2000) they show great diversity in their ecology, morphology, physiology, behavior and life history strategies (Nedbal, 1996). They are well adapted to a wide range of environments (Nowak, 1999). Rodents are also the most diverse and abundant among mammals in African (Afework Bekele, 1996b). There are 84 species of rodents in Ethiopia (Afework Bekele and Leir, 1997) of the total rodent species of the country 21% are endemic. The unique topography and wide range of climatic conditions are reasons for diverse biological resources in Ethiopia (Hillman, 1993). Rodents are better adapted to the afro-alpine environment than large mammals due to their ability to avoid temperature fluctuation by hiding themselves in their burrows (Marino, 2003). There are rodents that can only survive in a narrow altitudinal range whereas others are altitude generalists (Mukinziet al.,2005) .Rodents show habitat preferences and this mainly is dependent upon the vegetation type and life history strategies (Fitzherbert et al., 2007).

The mammalian fauna of Ethiopia is composed of 277 species out of which rodents have the greater share both in diversity, distribution and endemism(Hillman,1993).The higher prevalence of mammalian endemism in Ethiopia is attributed to the unique topography(extensive high ground)and associated climate and vegetation. Absence of sufficient food and ground cover largely determined the number of individual rodents in certain area. The loss of ground vegetation leads to loss of cover and food supply for small mammals thereby decreasing rodent diversity but increase predation risk (Hoffmann and Zeller, 2005).

Rodents represent one of widely distributed and successful groups of vertebrates. Their evolutionary success can be easily seen from their species number that accounts for more than 40% of mammalian species.(Mac Donalu 1984). Utilization of capability of a wide ranging food is the reason for their success. The economic and ecological significance of rodents is far reaching. Some rodents nursery and house hold furniture, some others are involved in disease transmissions and destruction of insects. Rat- borne disease have taken more lives than all wars and revolution put together in the last millennium (MacDonalu 1984).

Rodents like moles and ground squirrel helping in changing texture of soils. Genetic and biomedical researches use rodents such as guinea pigs, rats and mice as their principal laboratory animals. Therefore, this study was aimed at obtaining primary information on the distribution, diversity and habitat association of small mammals of Ene Proposed National Park, Weastern Ethiopia.

1.1. Statement of the Problem

Ene is a newly proposed National Park in Oromia region. This area is known to have higher diversity of small mammals. In Ene Proposed National Park, no research is carried out to investigate the distribution, diversity and habitat association of rodents. Thus, this study aimed to gather essential information on the distribution and diversity of small mammals.

1.2. Objectives of the study

1.2.1. General objective

The general objective of this study is to assess the distribution, diversity and habitat association of small mammals in Ene Proposed National Park, Western Oromia.

1.2.2. Specific objectives

- To document rodent species diversity in Ene Proposed National Park.
- To determine the distribution of rodent species in various habitats of Ene Proposed National Park.
- To investigate the habitat association of small mammals in Ene Proposed National Park.

2. LITERATURE REVIEW

2.1. Overview of small mammals

Rodents are known to have economic, ecological, social and cultural values. Some rodent species(less than 5%) are pests and cause significant losses to agricultural crops in many regions of the world (Singleton *et al*., 2003). According to the World Food and Agricultural Organization (FAO) average annual estimate, rodent pests worldwide consume 42.5 million tons of food worth 30 billion US$ (Stoddart, 1984). Rodents cause 5-10% pre harvest and up to 20% post harvest rice loss in Asia (Singlten, 2001). Singlton*et al*. (2003) reported that in Asia alone, the amount of rice eaten by rodents in rice fields each year would provide enough to feed 200million Asians for a year. In 1999-2000-harvest season, rats in Australian can fields destroyed approximately 825,000 tons of sugarcane valued at US $ 50 million (Smith *et al*., 2003).Seventy-seven species of rodents in Africa and 35 species in Eastern Africa are known to damage field or stored crops (Fiedler, 1994). Eleven species of rodents consume or destroy up to 20% cereal crops in some years in Ethiopia (Afework Bekele & Leirs, 1997). Afework Bekele *et al*. (2003) have also estimated yield loss at harvesting stage of maize as 26.4% in Ziway farm, Ethiopia. Similarly, during the serious outbreaks of rodents, some areas in Kenya experience up to 90% maize harvest loss (Odhiambo & Oguge, 2003). Rodents are also involved in the transmission of more than 20 types of pathogens including plague, *leptospirosis, boutonneus* fever, marine typhus, brucellosis, Rift Valley fever, etc (Delany, 1972; Stoddart, 1984; Nowak,1991; Fiedler, 1994).Rodent outbreak is induced by extensive drought period, which was accompanied by a protracted rain to be responsible for most crop damages and spread of disease worldwide (Taylor, 1972;Fiedler, 1994; Leirs, 1995).

Some larger species of rodents have been and still are, sought for food in many parts of the world (Stoddart, 1984). Some are considered very tasty and delicacy when available (e.g. Porcupines *Hystrix spp. &Arvicanthis* spp. in Gimuz natives, Ethiopia). Different species of rats and mice play an important role in different laboratories of the world for biological and medical research (Kingdon, 1974; Stoddart, 1984).Ecologically; rodents serve as a prey base supporting a diversity of carnivores, raptors and snakes. Because of their rapid response to environmental changes, they serve as good indicators of environmental quality (Linzey &

Kesner, 1997). Desert rodents viewed as model organisms for the study of ecological processes (Dickman, 2003). Monitoring of small mammals is a relatively quick and cheap method of indicating healthy or unhealthy ecosystem functioning (Avenant & Watson, 2002). In many instances, rodents provide a major benefit to the environment as bio-indicators (Singlton *et al*., 2003). They are also of intrinsic interest being composed of a high proportion of little known members (Sillero- Zubiri*et al.,* 1995). Despite these contributions, due to the bad public image of the few pest species, rodents hold the dubious distinction of being one of the small numbers of vertebrate groups where the effort put into eradication and control vastly outweighs the conservation (Amori and Gippoliti, 2000). This situation is made less palatable by the fact that 384 species of rodents are currently classified as 'vulnerable', or 'critically endangered (IUCN, 2000).

Over 1150 species of mammals are currently listed for Africa but more mammalian species, specially rodents, insectivores and bats await discovery (Kingdon, 1997). Rodents of East Africa account for about 28% of the total mammal fauna (Kingdon, 1974; Delany, 1986; Kingdon,1989). Similarly, the African insectivore fauna is the most diverse in the world, and this is particularly true for the shrews (Soricidae) that have nearly 140 species (Hutterer & Yalden,1990).Delany (1986) reviewed attempts in Africa over the past decades to survey the ecological distribution and geographical range of small mammals, most of which cover the western part of the continent. In the eastern part, there has been less study for example in Uganda, Kenya and Malawi (BekeleTsgaye, 1999). The continued discoveries of several new species of small mammals from Africa (Delany, 1986), however, indicates the need for further emphasis of continued efforts for similar ecological surveys particularly in remote areas.

Ethiopia's past geological history, unique topography and wide ranging climate have made the country home of diverse biological resources (Shibiru Tedla, 1995; Leykun Abune, 2000) with284 species of mammals of which rodents and shrews account for 39.4% (Yalden& Largen,992; Hillman, 1993; Laverenchenko *et al*., 1997). However, only little more than 17% of the total area, approximately 1,221, 900km^2 (Yalden & Largen, 1992) of the country is ecologically extensively surveyed for small mammals. There is need for further survey as more and more of the habitats are affected as a result of human interference in the ecosystem. Few of the ecological studies of small mammals of Ethiopia are those of Muller (1997), Rupp

(1980), Shimelis Beyene(1986), Yalden (1988a, 1988b) Sillero-Zubiri *et al*. (1995), Afework Bekele (1996a, 1996b), BekeleTsegaye (1999), TilayeWube (1999) and Alemu Fetene (2003) focusing on population ecology, habitat selection, habitat use, population dynamics of single species or on rodent community in an area, concentrating on the southwestern forest, south and south-eastern highlands, the Rift Valley areas, the Simen Mountains and few Central Ethiopian highlands and forest areas..

2.2. Factors Affecting Small Mammal Distribution and Diversity

Vegetation provides food, shelter and cover to small mammals. The structure and composition of vegetation, therefore, in general determines the distribution, abundance and diversity of the small mammals are reflections of habitat variables. In general the more diverse the habitat the more diverse is the small mammalian fauna, and the better the habitat, the better is immigration, survival abundance, recruitment, length of breeding season and body weight of the small mammals (Rogers and Gorman, 1995).

Altitude wise distribution of animals including small mammals is reported to following different patterns high altitude communities are believed to have decreased species number by virtue of their occupation of smaller areas than low lands at equivalent latitudes and their isolation from similar communities than low land sites which will often from part of a continuum(Begon et al.,1996).

A reciprocal relationship is also reported to exist between small mammal's community type and plant structure dynamics. Rodents have been shown to influence the abundance structure and dynamics of plant communities as seed consumers and dispersers (Brown et al., 1986). Their distribution and abundance are influenced by environmental factors such as the nature and density of vegetation, climatic conditions, disease, predation and habitat exploitation by humans (Johnson and Horn 2008). Absence of sufficient food and ground cover largely determined the number of individuals rodents in certain area. The loss of ground vegetation leads to loss of cover and food supply for small mammals thereby decrease the distribution of rodents (Parasad and Kashyap, 1995). Rodents occurs in every habitats from the high arctic tundra where they live and breed under the snow to the hottest and driest climatic zone.

3. STUDY AREA

3.1. Study Area Description

Ene proposed National Park, which was recognized in 2015, is located around Haro Sabu town in western lowlands of Oromia National Region about 610 km from Addis Ababa, the capital city of Ethiopia.The area is located between 8° 42’ 25”Nand 9° 7.’ 00” N latitude and between 35°5. 45” E and 35°. .18’,28” E longitude. Covering an area of about1, 600 ha .Ene proposed National Park and the surrounding area is the unexplored potential conservation site in Western Ethiopia, the National Regional State of Oromia, The park located midway between two Zones; Kelem Wolega zone to north-east, and Illuabador zone from South-west. It is bordered by three woredas namely Laloqile ,Chanka, and Dale Sadiin Kelem Wolega. Most of the area located between altitudinal ranges of 1090 - 1300masl.

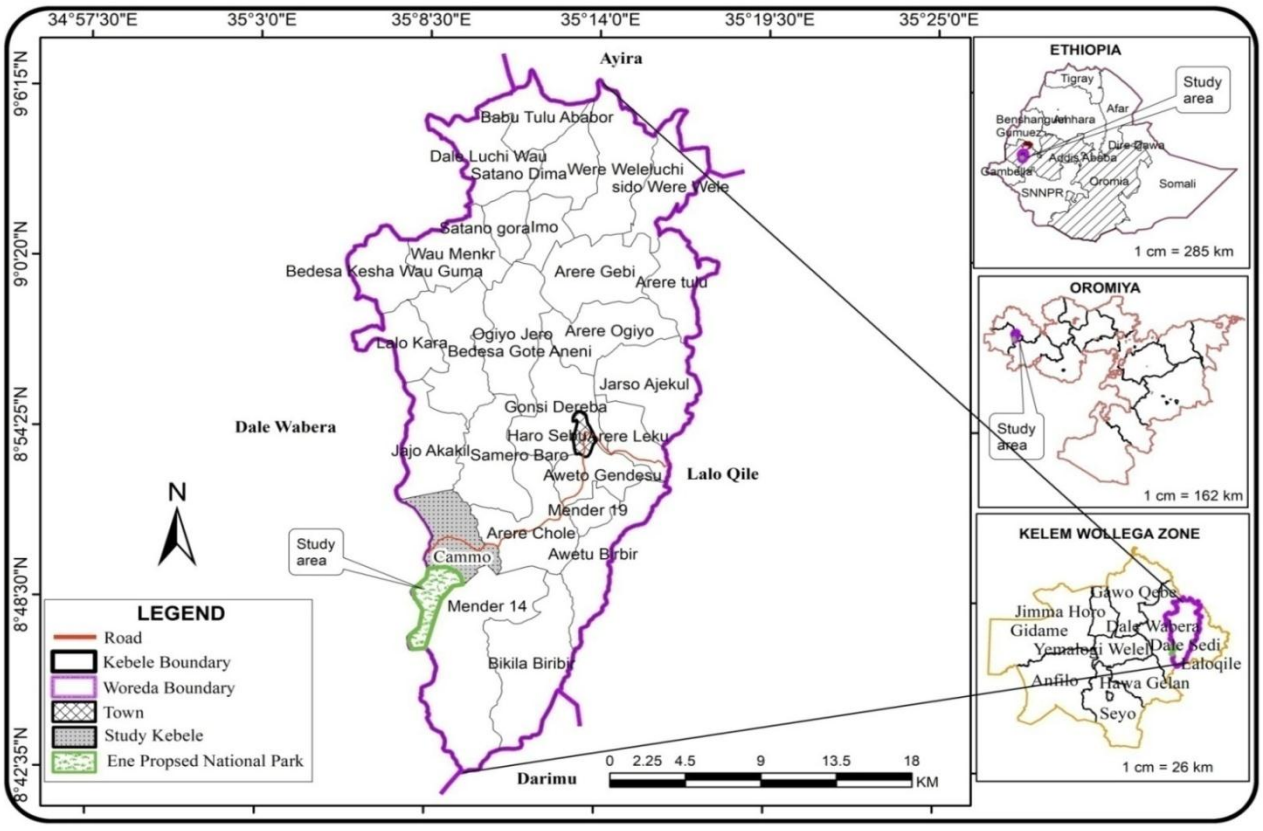

Figure 1 Map of the study area, Dale Sadi wereda, Oromiya,Ethiopia(Etho-GIS,2015)

3.2. Habitat type of the Study Area

The park consists of four different habitat types; mixedwoodland, woodland, riverine forest and grassland habitat types. Each of the different habitat have their own contribution for the existence of small mammals.

3.2.1. Woodland

Woodland covers the largest portion 50% of the Ene proposed national park. It consists small to moderate sized trees covered with well-developed grasses (fig 2).

Figure 2.Woodland (photo by Solomon Asefa, February 2018)

3.2.2 Riverine forest

Riverine forests are found around the narrow strip of the riverbanks in the study area such as Birbir and Kuni. Riverine forest covers 15% portion of the study area. The forest consists different types of mixed vegetation types from smaller trees to the largest *Podocarpusfalcatus* trees (fig 3).

Figure 3. Riverine forest (photo bySolomon Asefa, February, 2018)

3.2.3.Grassland

Grassland covers 15% portion of the study area. Elephant grass *(*P*ennisetum spp*.) which is usually tall up to 3m is the dominant grass species of this area (fig 4). The scattered trees that occur in this habitat are resistant to fire. They have thick bark and the dominant tree species in this study site are broad-leaved *Combretum* species in association with *Terminaliaalbiza*. Local people in search of grazing land clear site deliberately by setting fire (fig 4)

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Figure 4. Grassland (photo by Solomon Asefa , February, 2018

3.2.4 Mixed Woodland

Mixed Woodland is the second largest habitat covering an area of 20% next to woodland (OFWE, 2012).Based on the types of dominant species the mixed woodland area can be characterized as mixed and *Combretum* woodlands. The *Combretum* woodland, which is found at the border of the park, is characterized by dominant species of *Combretum* and *Terminalia* species (OFWE, 2012). This habitat is typically covered with a well-developed grass, which is commonly burnt every year.

Figure 5. Mixed Woodland (Photo :Solomon Asefa,February,2018)

3.3. Climate

3.3.1. Temperature

According to the temperature data obtained from the Dale Sadi AgriculturalOffice the mean monthly maximum temperature of the area ranged betweenApril29^{0}C andMarch34^{0}C and the mean minimum temperature of the area ranged betweenJuly21^{0}C and August 25^{0}C.

3.3.2 Rainfall

The rainfall distribution of the study area ranged between 1200mm and 1500mm as the data from Dale Sadi Agricultural Office The area receives the highest rainfall 1500mm during the wet season, June to September and the lowest rainfall1200mm during the dry season, November to February (DSAO, 2015).

4. MATERIALS AND METHODS

4.1.Materials

Materials that are used during the study period include digital camera) geographic positioning system (GPS) books, live traps , pesola spring balance and measuring tape.

4.2. Methods

4.2.1. Preliminary survey

Preliminary survey was conducted in the study area from the first week of November 2017 to December 2017 to collect information about the study area (climatic condition, topography, and approximate size of the area). The actual fieldwork was carried out between September 2018 to October 2018. Approximate size of the study area was gathered from relevant governmental authorities (Oromia Forest and Wild life Enterprise, Dale Sadi Agricultural office) and the local people living around study area. Different habitat types and representative habitat sites were observed. The vegetation type was identified as grassland (GL), mixed woodland (MWL), woodland (WL) and riverine forest (RF). Representative grids were randomly selected among the vegetation types. Each randomly selected grid site was numbered. Accordingly, the six grids were randomly selected, that are proportional to the size of the vegetation types (i.e. two grids for woodland, two for mixed woodland, one grid each for grassland and riverine forest were surveyed).

4.2.2. Data Collection

Data on the diversity, temporal distribution, and habitat associations of rodents and insectivore species of Ene Proposed National Park were collected for both October and September 2018 using the standard trapping techniques. Up on detection of rodents; habitat types, month of the year, species name and number of individuals observed were recorded. Most of the trapped small mammalian fauna of the Ene Proposed National Park are identified and their exact taxonomic positions are given. For identification of rodent species, Misonne (1971),Yalden et al. (1976), Bates (1988, 1994), Nowak (1991), Afework Bekele (1996a),

were used. Small mammal diversity of the total study area was given from direct encounters and the signs of animals observe. However, there are still few species (16%) not identified with the available facilities.

4. 2.2.1. Trapping

Trapping was conducted monthly for two days starting from September 2018 to October 2018. A permanent 4900 m^2 live trapping grid was established at four randomly selected habitat types, grassland, mixed woodland, woodland and riverine forest habitats for two consecutive days and nights. In each trapping site, a standard square (seven rows by seven columns) trapping grid was established during September and October seasons as was suggested by (Linzey and Kesner, 1997).

A total of 12 live traps were placed 10meters intervals at different trap sites on each randomly selected grid. Each grid was sampled at least for two days, the first day to set traps, and the other to collect and record information.

At each selected grid, suitable trap sites were surveyed a day before rodent signs (burrows, runways)to increase the trap success (Delany, 1978; George, 1984).Traps were baited with peanut butter rolled with corn or barley flour. When a unique habitat, rather than the characteristic one was observed, few additional traps were set in at random to sample the fauna. These include the two trials to sample communal rodents from few villages. The padded clothes provide protection for trapped animal against the strong heat and to conceal traps. Traps were usually set in the morning between 07:00and 08:00. On the first day, and checked the same day in the afternoon between 17:00 and18:00 for diurnal catches. All traps were checked for nocturnal catch and collected the next morning between 07:00 and 08:00 a.m.

In areas where the diurnal catch were high, the occupied traps were all collected and the same number of traps were re-set to increase the chance of nocturnal catch. Repeated checks were not possible because of the shortage of time. During both months traps were tied to suitable

branches of trees as used by George (1984).Additional information on the general habitat type, the dominant vegetation and the special features of the area for each grid were recorded. All the necessary information of the trapped rodents were noted down. Body measurements of each captured specimens; weight using various sized Pesola spring balance, head body length, tail length, hind foot and ear length were recorded. Sex of each individual was identified. Age structure (adult, young or juvenile) was recorded based on their weight and pelage color (Afework Bekele, 1996).

4.3. Data Analysis

The diversity and distribution of small mammalian fauna was assessed as the percentage trap success between months and different habitat types. Shannon-Weaver Index was used to compute small mammal species diversity of the habitats. Bites (1988, 1994), Nowak (1991), Afework Bekele (1996a), were used for species identification.

Species Diversity Index Analysis

The species diversity of each habitat of each seasons of the area was analyzed using Shannon- Wiener diversity Index (Shannon and Wiener, 1949). Shannon-Wiener diversity Index is calculated as:

H' = - Σ [($\frac{ni}{N}$) xln ($\frac{ni}{N}$))] where:s

H' = Shannon-Wiener diversity Index

ni = number of individuals of each species (the i^{th} species) and and N = total number of individuals for the site, and ln = the natural log of number

ln = the natural log of number.

Species Evenness Analysis

Species evenness, which measures the pattern of distribution of the small mammal's populations that present in the area, will be evaluated using Shannon-Wiener evenness Index (E) as follows:

$E = \frac{H'}{Hmax}$ Where:

E = Shannon-Wiener Evenness Index

H' = Shannon-Wiener diversity Index

H_{max} = ln S= natural logarithm of the total number of species (S) in each site

(Southwood and Henderson, 2000).

Species Similarity Analysis

Diversity indices measure the degree of uncertainty (if the diversity is high in a given habitat, the sureness of finding a particular species is low). In reference to the composition of species, Simpson's similarity index (SI) was used to assess the similarity of species between two different habitats, and season by using the formula:

$SI = \frac{2C}{A+B}$ where,

SI = Simpson's similarity index

A = Number of species that occur in site A

B = Number of species that occur in site B C = Number of species shared by A and B

5 . RESULT

5.1.Small Mammals Diversity

During the present study, a total of 107 individual rodents (Order *Rodentia* and Insectivora; Family *Murida*e and Sorcidae) were captured in four habitat types during October and September. The highest number of rodent species were recorded from the family Muridae that contained six species, followed by Sorcidae that contained one species. The least number of species was recorded for the family of Sorcidae that contained only eight species (Table 1). Out of the small mammals trapped, 99 individuals represented 6 species of rodents while the remaining eight represented the insectivore specie. Larger rodents such as the porcupines, *Hystrix cristata* and the unstrapped ground squirrel, *Xerus rutilus* were observed throughout the Ene area. Trapping of these species, however, was not possible.

Table 1. Diversity of the rodents and insectivores in Ene proposed National Park.

Family	Species	Total capure
Muridae		
	Desmomys harringtoni	23
	Arvicanthis niloticus	20
	Myomys albipes	17
	Mus musculus	13
	Lemniscomys.barbarus	21
	Acomys cineraceus	5
Soricidae	*Crocidura sp*	8
	7	107

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5.2. Species Diversity and Similarity

Among the habitat types woodland had the highest diversity index with Shannon Weiner Index (H'=1.66) and evenness (E=0.798) and the second diversified habitat was riverine forest (H'= 0.74) and (E=0.485).The third diversified habitat was mixed woodland (H'=0.743) and (E=0.462) and the least diversity was recorded in grassland (H'=0.83) and (E=0.399) during October , Woodland had highest diversity index with Shannon Weiner

index (H'=1.31) and. evenness (E =0.632),The second diversified habitat was riverine forest (H'=1.015& E=0.63),followed by the mixed woodland (H'=0.732 and E=0.528) and the least diversity in grassland(H'=0.65) and E=(.0.316) during September (Table2).

Among the four habitat types, the highest mammalian species similarity was observed between woodland and riverine forest both during October (SI =0.67) and September (SI =0.66) followed by the species between mixed woodland and grassland habitats (with SI values of 0.64 and 0.65) during September and October, respectively. However, with the SI value of 0.48 (during September) and 0.31 (during October), rodent species were least similar between grassland and riverine habitats**.**

Table. 2 .Diversity evenness indices (E) and diversity index (H'), for rodent species in the four habitats.

Habitat type	Months	Species richness(S)	diversity index (H')	Evenness (E)
Mixed woodland	September	4	0.743	0.528
	October	5	0.732	0.462
	Common	4	0.779	0.562
Woodland	September	7	1.31	0.632
	October	8	1.66	0.798
	Common	8	1.45	0.7
Riverine forest	September	5	1.015	0.63
	October	6	0.87	0.485
	Common	5	0.776	0.482
Grassland	September	4	0.65	0.316
	October	5	0.83	0.399
	Common	4	0.725	0.35

5.3.Distribution by Habitat Type and months

Most of the small mammal species were trapped from the woodland (48 individuals out of the 107 rodent species captured).The riverine forest (33) habitat had the second highest number of species during October and September. Woodland habitat has highest overall trap success, in terms of the number of species caught (7species) followed by riverine forest (7species) (Table3).

Table. 3. Distribution of different species of rodents and insectivores in four natural habitat type (GL=Grassland,WL=woodland,RF=Riverine forest, MWL=Mixed woodland)

Rodent species	Habitats				Total
	GL	WL	RF	MWL	
Lemniscomys barbarous	1	11	6	3	21
Crocidura sp	1	4	3	-	8
Desmomys harringtoni	2	10	6	5	23
Acomys cineraceuss		2	2	1	5
Myomys albipes	2	6	5	4	17
Arvicanthis niloticus	4	4	6	6	20
Mus musculus	1	4	5	3	13
Total numberof speciess	10	48	33	16	107

In term of monthly distribution, 7 species of small mammals were recorded during October and 7 species were recorded during September. (Table 4).During October, 62 individuals were trapped whereas during September 45 individuals were caught (Table 4).

Table. 4.Monthly distribution of rodents and insectivores in EPNP (Dash indicates absence of the species).

Species	Months	
	September	October
Crocidura sp	3	5
Desmomys harringtoni	12	11
Acomys cineraceuss	3	2
Mastomys albipess	8	9
Arvicanthis niloticus	7	13
Lemniscomys barbrusss	7	14
Mus musculus	5	8
Total number of individuals	45	62
Number of species	6	6

5.4. Habitat Association

The distribution rodents and insectivores significantly differed ($p<0.001$) across studied habitats throughout the study period. Variation in species composition and distribution was observed across all habitats. *M.abipes*, *D.harringtoni* and *A.nicloticus* were widely distributed in all habitats. *D.harringtoni* is the largest recorded rodent species from all habitat types followed by *A.niloticu*s. Most (48.4%) of the species were trapped from woodland habitat followed by riverine forest habitat (28.1%). Furthermore, 18.2% and 5.3% of the species were trapped from mixed woodland and grass land habitats, respectively.

The number of different species of rodents and insectivores caught across all four habitat types had been further sub-divided in to those caught during the day and night. A total of 58 individuals were captured during the night time and 49 during day time. However, there was no statistically significant difference ($p>0.05$) between the overall number of species recorded during the day and night time.

6. DISCUSSION

Six small mammal species were recorded from EPNP. This may not represent all the species present in the study area, but it gives update accounts of some of the small mammal species

present in the study sites. If exhaustive survey is made by increasing the study period and the sampling area, the number of small mammal species identified in this study area may be more. The distribution of small mammals depends upon food preference and habitat covers. Some species were restricted to a single habitat while others occupy two or more habitats Variation in the number of small mammal species was observed among the four habitats during September and October. During September and October the highest number of species was recorded from woodland (48) followed by riverine forest (33) and mixed woodland (16) and grassland (10).

Two of the rodent species (*M. albipes* and *D. harringtoni*) were caught out of their former recorded altitudinal limits and geographic ranges, while others are well within their range from which they have been previously recorded in Ethiopia or elsewhere in East Africa. *A.niloticus* represents the genus over large area of its range. Its distribution extends up to the Nile valley and the Horn of Africa to Senegal across the sub-Saharan belt (Capula et al, 1997). It favors savanna at lower altitude, in which case Ene proposed National park is the most favorable habitat.

M. albipes, the forest dweller of eastern and western plateaux (Yalden& Largen, 1992) is also widely distributed common rodent in EPNP both in the wild and in human habitations. Yalden recorded this same species from southwestern Ethiopia at 820 m a.s.l. suggesting that the range of this species is limited by low rainfall rather than other factors such as high temperature. Afework Bekele (1996a) trapped the species from Menagesha State Forest between 2000 and 3300 m a.s.l. Yalden et al.(1976) also reported the occurrence of this species along the Ethiopian border with Kenya(Moyale) suggesting the probable range extension of the species into the neighboring countries. The species has been recorded from various parts of Ethiopia including DebreMarkos, Bahir-Dar, Dembecha, KibreMengist, Lekemte, Mendi, Lake Zeway, Nijabara,Goba, Muger River, Bako, Bedele and Alemaya (Yalden et al. 1976). All the above evidences suggest the tendency of the species to extend its range and occupy open niche. Besides, the northwestern lowland ecosystem is quite different from the extensively used and degraded ecosystem of the south western counterpart. Therefore, there is a high possibility for M. albipes to expand its range from its former range (the northern highlands) to the stable ecosystem with diverse niches of the southwestern lowland particularly to the Ene area.

D. harringatoni is the fairly abundant rodent in EPNP next to *Arvicanthis nialoticus*. It is also an endemic species whose range was thought to be restricted to the highlands of Ethiopia. The yellowish agout dorsal pelage and greyish white underside and the grooved upper incisors are the main features that distinguish it from *A. nicloticus*. *Desmomys harringatoni* used to occur largely with *M. albipes* showing a range overlap. Although further records and detailed published information about these species are lacking, there is a high possibility for the species to be pushed from highlands of Ethiopia to the nearby western lowlands of the region. *D.harringatoni and M.albipes* were also captured from human habitations surrounding the EPNP.

The Nile-rat, *Arvicanthis niloticus*, is the most common rat of EPNP in all habitats including human habitations. Yalden et al. (1976) did not list records and distribution of this species in Ethiopia due to the then unsettled taxonomic problem of the whole genus. *A. niloticus* represents the Genus over large area of its range. Its distribution extends up to the Nile Valley and the Horn of Africa to Senegal across the sub-Saharan belt (Capula et al., 1997). It favors' savanna at lower altitude, in which case, EPNP is the most favorable habitat. It has very few records from forest habitat (Fiedler, 1994). EPNP provides conducive habitat for several species of this genus.

The distribution of rodents varied across habitats throughout the study area. Although, *D.harringtoni was* distributed in all habitat types, it was highly abundant in woodland habitat. Habitat association is important to determine how various species respond to environmental heterogeneity (Martin1998). Habitat selection may have evolved as a result of past competitive effects but, only weak interspecific competition perhaps necessary to maintain habitat selection. Hence, the coexistence of species can be determined by resource availability and by means of which species utilizes which habitat and interact with others.(Schoner 1983).There was high number of species in woodland followed by riverine forest habitats in the present study. This is probably because such habitats are good in providing shelter due to their dense cover. The least number of rodents was captured in grassland habitat. This may be related to the poor cover of the habitat exposing rodents to predators and other factors that decrease their population (Iyawe, 1988) indicated that habitat selection of different species of small mammals mainly relies on the vegetation of the given

habitat. This idea is also supported by (Taylor and Green1976) where cover removal reduced most species of rodent population. Whenever there is enough cover and adequate food, the abundance of rodent population is high.

The absence of the widespread commensal rodent, *R. Rattus* and R. *norvegicus*from EPNP and the surrounding area was unexpected. Their absence is also confirmed by the abundance of other species, like *Mastomys* sp. and *M. albipes* in human habitations, that otherwise were competitively excluded. *R.rattus* might not have been introduced into these areas. Since they are easily transferred from one village to the other, the absence from this area may indicate their absence from the whole EPNP. This strategic geographic location and its inhospitality to human interference made it to have unique and undisturbed habitats. It is particularly suitable for all grass loving species. This is confirmed from the trapped species composition. This is particularly true for the genus *Arvicanthis,* which is shown by their occurrence all over the habitats of EPNP in higher proportion.

The flat nature of Ene area, with no natural or artificial barrier for free movement, allows the animals to change their position following changes associated with seasons. For the survival of *Arvicanthis,* cover is the most important component of their microhabitat (Fiedler, 1974; Delany, 1986;Afework Bekele et al., 1993). However, the complete absence of cover from over the larger area of Ene during the dry season was not a problem for them. The cracks made by the black cottony soil during the dry season are the best area to escape from the danger of predation. The tunnels of the cracks extend over several meters allowing free movement and safe forage. This observation is well in line with the findings of Delany (1986) and Afework Bekele et al. (1993), which showed the attainment of maximum number during the mid-dry season. In EPNP, they comprised the bulk of the dry season capture after the burn and habitat degradation. *Mastomys* was reported to be a pioneer to invade such habitats (Oguge, 1995). . As human activities change habitats a lot, a disturbed habitat affects diversity of small mammal and makes the area to have fewer rodents. In the present study area, the highest numbers of species were recorded in riverine forest and woodland habitat. The presence of more number of small mammal in woodland habitat of the study area might be due to the availability of food and other resources to meet their requirement. The occurrence of more species of rodents in Woodland habitat is probably due to the movement

of these species from the peripheral part of the study area towards the inner in search of food and cover.

L.barbarus, the only specimen of the zebra mice (one male and female) were sampled from the riverine habitat during October. Data gathered on this species did not allow discussion of their other ecological aspects.*M .albipes* is the fairly common genus all over the lower half of the EPNP. All the three species of the genus occurring in Ene have one observable common character. All plug their burrows with loose soil or sand. Their abundance in the area is simply judged by observing these characteristic burrows. Inhabitants of closed burrow system are exposed to very different environmental conditions. Light, temperature, and humidity are relatively constant in their burrow system (Schmidt-Nielsen et al., 1970; Arieli et al., 1977).

High diversity of small mammals species were recorded in the riverine forests and woodland during October. Small mammals in the present study area show no uniform distribution among the four habitats. Hence, their abundance significantly varies among habitats between months More small mammals shift from grassland to the riverine and woodland habitats during October Such seasonal movement in search of resources condition is common in mammals (Yaba,et,al,2011:Girma,et,al.2012).Generally, the distribution of rodent species in the study area was presumably related to vegetation structure, availability of food and human and livestock impact in the study area. The grazing by livestock had a significant impact in the rodent community. Grazing has a number of detrimental effects which directly impact on rodent communities including food competition, trampling of rodent holes, reduced vegetation height and associated reductions in predation cove (Guttinger, et al.,1998).

Regarding species similarity among the four habitat types of the study area, the highest species similarity was obtained from woodland and riverine forest both during October and September. followed by grassland and mixed woodland. The reason for the observed similarity may be because the resource and cover conditions of these two habitats are relatively similar to each other than either to the grassland habitats. The species similarity was relatively less between the riverine and grassland than woodland habitats. This record contradicts with the finding by Girma Mengesha and Afework Bekele (2008) and Gonfa et, al,(2011)that report high mammalian species similarity between woodland and grassland habitats.

7. CONCLUSION AND RECOMMENDATIONS

7.1. Conclusion

An ecological study was carried out for two months in EPNP dealing with the diversity, distribution and habitat associations of small mammals. Seven species of small mammals were recorded for the first time in the area.

The diversity of small mammals showed marked difference among habitats. This could be related to the difference in habitat preference of rodent depending on the availability of cover, food and vegetation.

During October, woodland habitat appeared to be a choice for most of rodent species encountered in the study period**.** The two months field work in EPNP revealed the richness of the area in terms of ecological and biological resources.

7.2. Recommendation

Gazeting EPNP and protecting it as a National Park, in addition to the above purposes could further facilitate the development of tourist industry. It will play a great role in attracting valuable foreign exchange into the country both nationally and locally. The protected area will also serve as a recreation centre for both foreign and domestic visitors.

Additional detailed study of long duration on the diversity and other ecological aspects of the area should be conducted to get detailed information of the area. Concerning the small mammalian fauna of EPNP, in the lowland ecosystem is also a prey base for various carnivores of special conservation interest. Further detailed studies focusing on individual species and community ecology must be undertaken.

Stopping habitat alteration that is the primary cause extinction of wildlife. That means enforcing conservation laws, controlling tree felling, and collection of other forest products.

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APPENDICES

Appendix .1 Average body measurements of small mammals trapped during the September. (HB = Head body length, T = Tail lenght, HF = Hind foot length, Er = Ear length, Wt = weight. Length is measured in mm and weight in g).

Species	Sex	No.of Individuals	Body measurement				
			HB	T	HF	ER	Wt
Crocidura Sp	M	1	140	71	14	5	44
	F	1	140	49	22	8	57
Acomys cineraceus	M	2	102	122	32	9	51
Desmomys harringtonis	M	2	125	125	25	16	70
	F	3	149.2	132	31.6	13.3	119
Mastomys albipes	M	1	107.6	122	22.3	14.6	46
	F	2	105	105	21	15	38
Lemniscomys barbarous	M	2	90	120	25	12	28
	F	1	90	130	26	10	39
Mus musculus	M	4	75	36	10	7	7
Arvicanthis niloticus	F	3	75	48	11	6	8

Appendix.2..Average body measurements of small mammals trapped during the October.(HB = Head body length, T = Tail lenght, HF = Hind foot length, Er = Ear length, Wt = weight. Length is measured in mm and weight in g).

Species	Sex	No.of individuals	Body measurement				
			HB	T	HF	ER	Wt
Crocidura Sp	M	1	153	136.5	33	14.5	132
	F	2	149	134	31	14.3	127
Acomys cineraceus	m	2	103	98	29	120	96
Arvicanthis niloticus	m	2	130.2	123.5	31.2	12.7	96.6
Desmomys harringtoni	M	3	153	136.5	33	14.5	132
	F	2	149	134	31	14.3	127
Myomys albipes	M	4	114	126	22.7	47.6	14.6
	F	6	85	108	19	12	20
Lemniscomys barbarouss	M	1	90	120	25	12	28
Mus musculus	M	2	75	36	10	7	7

Appendix 3. List of the major vegetation species in Ene Proposed National Park.

A.Treepecies

Combretum spp.

1. *Combretum mole*

2..*Ficus sicomorus*

3. *Entada africana*

4. *Acacia seyal*

5. *Lonchocarpus laxiflora.*

6. Lannea fruiticosa

7. *Balanites aegyptiaca*

8. *Allophylus macrobutrys*

9. *Oxytenanthera abyssinca*

10. *Combretum hartmmanianum*

11. *Acacia polycantha*

12. .*Ptero carpulucens*

13. *Entada africana.*

14. *Piliosstigma thonningii*

15. *Terminalia laxiflora*

16. *Ficus mochstteri*

17. *Ficus pamata*

18. *Ficus gnpalocarpa*

19. *Combretum collinu*

20. *Acacia seiberana*

Source: Flora of Ethopia and Eriteria volume4 and 5(2006)Addis Ababa

Appendix 4. List of large mammals in Ene Proposed National Park.

Scientific name	Common name
Papio anubis	Anubis baboon
Conis adustus	Side striped Jakal
Orycterpus afer	Aardvark
Syncerus caffer	Buffalo
Tragelaphus scriptus	Bushbuck
Tragelaphus strepsiceros	Greater kudu
Sylvicapa girmmia	common duicker
Chlorocebus aethiops	Greavet monkey
Panthera pardus	Leopard
Mellivora capensis	Ratel (Honey badger)
Crocuta crocuta	Spotted hyaena
Felis serval	Serval cat
Panthera leo	Lion
Chlorocebus aethiops pygrey	Vervet monkey

Source; Girma Mangasha ,(2011)

Appendix 5. Sample photographs of rodents taken during the field study

(Photo by: Solomon Asefa)