

Addis Ababa University
Department of Zoological Sciences
College of Natural and Computational Sciences



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**Abundance of rodent on different land management intervention in Simien
Mountains National Park, North Ethiopia**

By

Derbe Deksios

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fulfilment of the requirements for the Degree of Masters of Science in
Biology (M.Sc.)**

Advisor: Habte Jebessa Debella (Associate Professor)

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DEDICATION

This work is dedicated to Professor Derek Yalden who identified the skeleton of Ethiopian Rodents and passed away in 2013. It is also dedicated to my beloved son Engdashet Derbe who passed away in 2004 E.C after he had scored 8 As` in Ethiopian High School Leaving Examination in age of 15.

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Abstract

This study deals with the abundance rodents in different land management intervention. Overgrazing is one of the conservation challenges of the Simien Mountains National Park . Overgrazing has been devastating the fragile afro-alpine Ecosystem. The objective of this study was to identify habitat quality and abundance of rodent by recording the new rodent hole and the common mole rat hill between May, 2017 (wet season) and January and February 2018 (dry season), assessed thirteen transect lines in average 2-4 km each. In more rodents captured were investigated in six major sites (within twelve) sub sites and the grids were established within representative vegetation covers. During dry season, five species of rodents *Lophuromys flavopunctatus*, *Arvicanthis abyssinicus*, *Stenocephalemys grisicauda*, *Otomys typus*, *Mus mahomet* and one species of insectivores, *Crocidura baileyi*, were recorded. There was significance variation in habitat quality among different land management intervention fresh rodent holes and common mole rat hills ($p < 0.002$ and $P < 0.003$), respectively. ANOVA analytical test result also indicated that rodents' distribution were significantly different with different land management such as moderate, slightly grazed and overgrazed habitats across afro-alpine ecosystem of Simen Mountains National Park. There was also variation in species abundance in grazed, unglazed and completely grazed land management system. The highest abundance was *Arvicanthus abyssinicus* 56% six major sites; in twelve subsets no rodent was recorded in overgrazed Wezahla one low abundance *C.baileyi* 0.6%. Density of rodents highest in *Alchemilla* plant species 8/km² and 0 in overgrazed *Hypericum revolutum* plant species. There was significant different in rodent abundance ($P < 0.04$) in different land management intervention. In general, grazing pressure were negatively affected the habitat quality of rodent and common mole rats' abundances. . Therefore, to reduce overgrazing, it is recommended to strength habitat conservation to gain habitat quality. To follow participatory conservation reduce overgrazing allowing rotational cut and carry system with limited time bound exclude core area and it should be applied in local bases.

Key words: Abundance, density grazing habitat management rodents and Simien Mountains.

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1. INTRODUCTION

1.1 Background and Justification

The Ethiopian highlands represent the Northern end of the Great East-African Rift Valley, formed through intense tectonic activity over the last 200 million years. Over the past 25 million years, several phases of uplift of igneous lava deposits led to brittle basaltic domes of crust that bulged upwards, the largest of which approximately estimated 400 km wide resulted in what is known today as the Ethiopian highlands (Hurni, 1986).

The Ethiopian wolf is hypothesized to be a descendant of a grey wolf-like Eurasian ancestor that colonized the Ethiopian highlands relatively recently and occupied the wider Afro-alpine range available at the end of the Pleistocene (Gottelli *et al.*, 2004).

The process of population fragmentation started with the onset of the current interglacial period (approximately 18,000 years ago), when Afro-alpine habitats were pushed upwards because of warmer climate (Gottelli *et al.*, 2004). One of these highlands, the Simien Mountains National Park (SMNP), represents the most outstanding natural area. It is of paramount specimen importance of world's natural heritages because of its rich biodiversity, high number of endemic species and bio-physical features. The SMNP is also an international significance which has been declared as the world "World Heritage Site" by UNESCO World Heritage Committee in 1978 (Falch and Keiner, 2000).

Due to the civil wars in SMNP in 1980s, human have impact contributed to further reduction the Afro-alpine habitat to less than 10% of its former size (Marino 2003). Subsequent erosion has resulted in dramatic landscape that today forms the Simien Mountains highland plateaus, splitted by deep valleys and gorges; steep escarpments; jugged mountain peaks and sharp precipices (Kingdon, 1997).

Ethiopian wolf and its Prey rodents with their habitat is in critical level in SMNP due to agricultural encroachment, loss of alpine biodiversity, the impacts of overgrazing and heavy human pressure on the natural resources and biodiversity richness. Other factors responsible for the Ethiopian wolf and alpine rodent threat are fuel wood collection, Soil erosion, loss of plant vegetation regeneration potential and the afro-alpine habitat *for* the life of Ethiopian

wolf .Besides, land management problems were not well addressed in different land types on the abundance of prey of the Ethiopian Wolf in SMNP. There were no studies conducted to identify the effect of different land management intervention on the Rodents species abundance and distribution, which in turn affected Ethiopian wolves' population in the SMNP and its soundings. Accordingly, there is a gap on the management options on the appropriate abundance of preys in different land management intervention Therefore, this study is aimed at fill the above-mentioned research gap.

The Ethiopian wildlife conservation Authority (EWCA) who manages Ethiopia wildlife protected areas, and in addressing the tough benchmarks set by UNESCO in SMNP. However; the grazing pressure and 31,000 people live in vicinity of the park which is unsolved problem (EWCA, 2017).

2. LITERATURE REVIEW

Rodents are the most diverse group of mammals (Vagan *et al.*, 2000; Mesele Yihune and Afework Bekele, 2012). They show great diversity in their ecology, morphology, physiology, behaviour and life history (Nedbaet *et al.*, 1996). They are well adapted to a wide range of environments (Nowak, 1999). Rodents are also the most diverse and abundant among mammals in Africa (Afework Bekele, 1996). There are 84 species of rodents in Ethiopia (Afework Bekele and Leirs, 1997). Of the total rodent species of the country, 21% are endemic. The unique topography and wide range of climatic conditions are believed to be the reasons for the diverse rodent biological resources in Ethiopia (Hillman, 1993).

Rodents are better adaptable to the afro-alpine environment than large mammals due to their ability to avoid temperature fluctuations by hiding themselves in their burrows (Marino, 2003). The presence of large body size is another adaptation for the afro-alpine rodents than low land rodent species. Most (60%) of the rodent fauna of the country is confined to the highlands and there are at least 14 endemic species of rodents, all from the north western, central and south eastern highland plateaux (Yalden and Largen, 1992; Mesele Yihune and Afework Bekele, 2012).

Six endemic species belong to the afro-alpine moorland above 3000 masl such as (*Dendromus lovati*, *Arvicanthis blicki*, *Stenocephalemys grisiecauda*, *Stenocephalemys albipes*, *Praomys ruppi* and *Mus mahomet*), four endemic species occurring mountain grassland (*Tachyoryctes macrocephalus*, *Stenocephalemys albocaudata*, *Lophuromys melanonyx* and *Megadendromus nikolausi*) and the other four endemics occur in mountain forest areas. Furthermore, 16 species of rodents found in the high land are common species. However, only some species like *Tachyoryctes splendens*, *Otomys typus*, *Lophuromys flavopunctatus* and *Arvicanthis abyssinicus* survive above 3000 msl. (Yalden and Largen, 1992).

Usually night frosts, diurnal temperature fluctuations and strong radiation are common in the afro-alpine areas. Afro-alpine rodents can avoid extreme cold by staying underground so that they are inherently well adapted as the dominant herbivores of the afro-alpine ecosystem (Marino, 2003; Busby *et al.*, 2006).

Rodents show habitat preferences and this is mainly depending upon on the vegetation type and life history (Fitzherbert *et al.*, 2007). Rodents can be classified as a narrow altitudinal range and generalist altitudinal range based on their survive (Mukinzi *et al.*, 2005). 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 determine the number of individual rodents in a certain area. The loss of ground vegetation leads to loss of cover and food supply for small mammals thereby decreasing rodent diversity and but increasing predation risk which leads to less population size (Hoffmann and Zeller, 2005).

On the other hand, habitat structures and predation risks affect species composition (Massawe *et al.*, 2007). Bushy vegetation provides safe sites for germination and growth of herbaceous vegetation. Hence, enhances the diversity of rodent food resources (Kerley *et al.*, 2004). The density of rodents enhances in habitats such as bush land, grassland and forest in the presence of ample food (Lentic and Dickman, 2005). The diversity of species can be resulted from habitat variability due to the supply of different resources (Cramer and Willig 2002).

In evolution rodents are quite young where the populations keep unexploited source of gene differentiation (Vaughan *et al.*, 2000). The number of rodents and their change of occurrence usually possess extensive vegetation cover (Hansson, 1999). Rodents form major and important components of ecosystems (Avenantand Cavallini, 2007). They interact extensively with their environments and their activities have beneficial effects on other organisms in different ecosystems. They are important dietary components for many carnivorous small mammal, raptors and reptiles (Davies, 2002).

Rodents are vital food for the survival of the Ethiopian wolf (*Canis simensis*) (Sillero-Zubiriet *al.*, 1995). On the other hand, they are host of disease causing parasites such *Schistosomamansonii* (El-Naggaret *al.*, 2011). Ecological studies of the rodent communities in Ethiopia are important due to their high levels of endemism. In addition, the Ethiopian wolves heavily depend on rodents for their survival (Malcolm and Sillero-Zubiri, 1997). Therefore, studies of the rodent community are important to assess habitat quality for wolves and as a predictor wolf density. Hence, the present study covers species composition and abundance in different land management system. Comparatively, better studies of rodents biology have been conducted in the south-eastern highlands of the Bale Mountains in

Ethiopia (Lavrenchenko *et al.*, 1995) and where as studies continued to be carried including species Abundance and diversity (MeseleYihune and Afework Bekele .,2012).

According to Nievergelt (1996), who has mapped roughly 900 hectare in the afro-alpine grassland, 60 % are heavily grazed, 25 % are seriously overgrazed respectively devastated and only 15% show still a more or less natural status. In the areas close to the Gich village, the meadows were heavily grazed and the soil quality was decreasing. Only in the very East, towards Imet-Gogo and (South of Jinbarwenz) near Shayno Sefer and Inatye, there were some areas of untouched grassland left. Long-grass vegetation has more or less disappeared, grassless patches covered with very short herbs and completely bare sports are frequent (Nievergelt *et al.*, 1998: Guttinger *et al.*, 1998).

Global warming during the last 10,000 years progressively confined the Afro alpine Eco system to the highest mountains, and 60% of all Ethiopian land above 3,000m has been converted to farmland. Ethiopian wolf populations face threats that arise from their isolation, small size, and the increasing contact with humans and their domestic dogs. Wolf killings seem to have decreased recently (Sillerio-Zubiri,Gotelli., 1995; Marino., 2003).

). In the Simien SMNP, small mammals are of special interest for different reasons. Several species are endemic only in the highland areas of Ethiopia (Yalden and Largen, 1992: MeseleYihune and Afework Bekele, 2012).

In general the rare rodents are the major food item the Ethiopian wolf *Canis simensis* which is the rarest canid in the world, with a worldwide population size estimated to more than 500individuals and listed as IUCN endangered. This specialist hunter is endemic to the Afro-alpine ecosystem (>3,000msl) of the Ethiopian highlands, where it preys, almost exclusively, on the endemic Afro-alpine rodent fauna (MeseleYihune and Afework Bekele, 2015).

In the case of the rare and endangered Ethiopian wolf *Canis simensis*), even low levels of retaliation could send populations into an extinction vortex, given their small size and additional threats from viral diseases, habitat loss and degradation (Girma Eshete *et al.*, 2017).

3. OBJECTIVE

3.1. General objective

The general objective of this study was to assess habitat quality of rodents in different management status in the SMNP.

3.2 Specific objectives of the study

- to estimate and compare rodent population abundance in different land management system of the SMNP;
- To identify appropriate land management system and vegetation cover preferred for rodents.
- To identify seasonal variation on habitat quality of rodents in different land management's in SMNP.
- To investigate management problems and to show possible solution for conservation and management of rodent habitats and conservation in SMNP.

3.3. Hypothesis of the Study

There are two hypotheses to be tested was:

Ho: there is no significant difference in prey (rodent) abundance within different land management intervention.

Ha: there is a significant difference would be found in the abundance of prey among major land management types within the same habitat type(un controlled grazing zones(overgrazed), Controlled grazing or moderate grazing ,grazing exclusion zones closed)or un grazed areas .

4. MATERIALS AND METHODS

4.1. Study area description

The study area is the SMNP represents one of the most outstanding natural landscapes and is of paramount specimen of world's natural heritage. Because of its rich biodiversity and high number of endemic species and its spectacular bio-physical features, the SMNP(Fig.1) is of international significance and has been declared as one of the world "World Heritage Site" by the UNESCO World Heritage Committee in 1978 and in 1996 registered as National park in danger world heritage site due to human settlement, overgrazing deforestation and reduction of number of *Walia ibex*, Ethiopian wolf and other wildlife(Falch and Keiner,2000).

The original settlers of the Simien Mountains are the Ethiopian Jews (Felasha). The Jews (Felasha) settlements were extended until 1960. Before the 1960s, SMNP was used as subsistence hunting area of the local community especially on *Capra walie* In 1960s, the Ethiopian Wildlife Conservation Organization (EWCO) established SMNP was nationally gazetted in 1969. According to the local community and park office information, 1979, villages located in the lowland areas like Truwata, Tiya, Dirni, Antola and Muchila were destroyed moreover, between 1983 and 1991, it was seriously disturbed by the conflict between the military government and those opponent groups, which is the present government (Ethiopian people Revolutionary Democratic Front, EPRDF). In 1999, development efforts were began to rehabilitate the damaged infrastructure inside the park (Falch and Keiner, 2000).

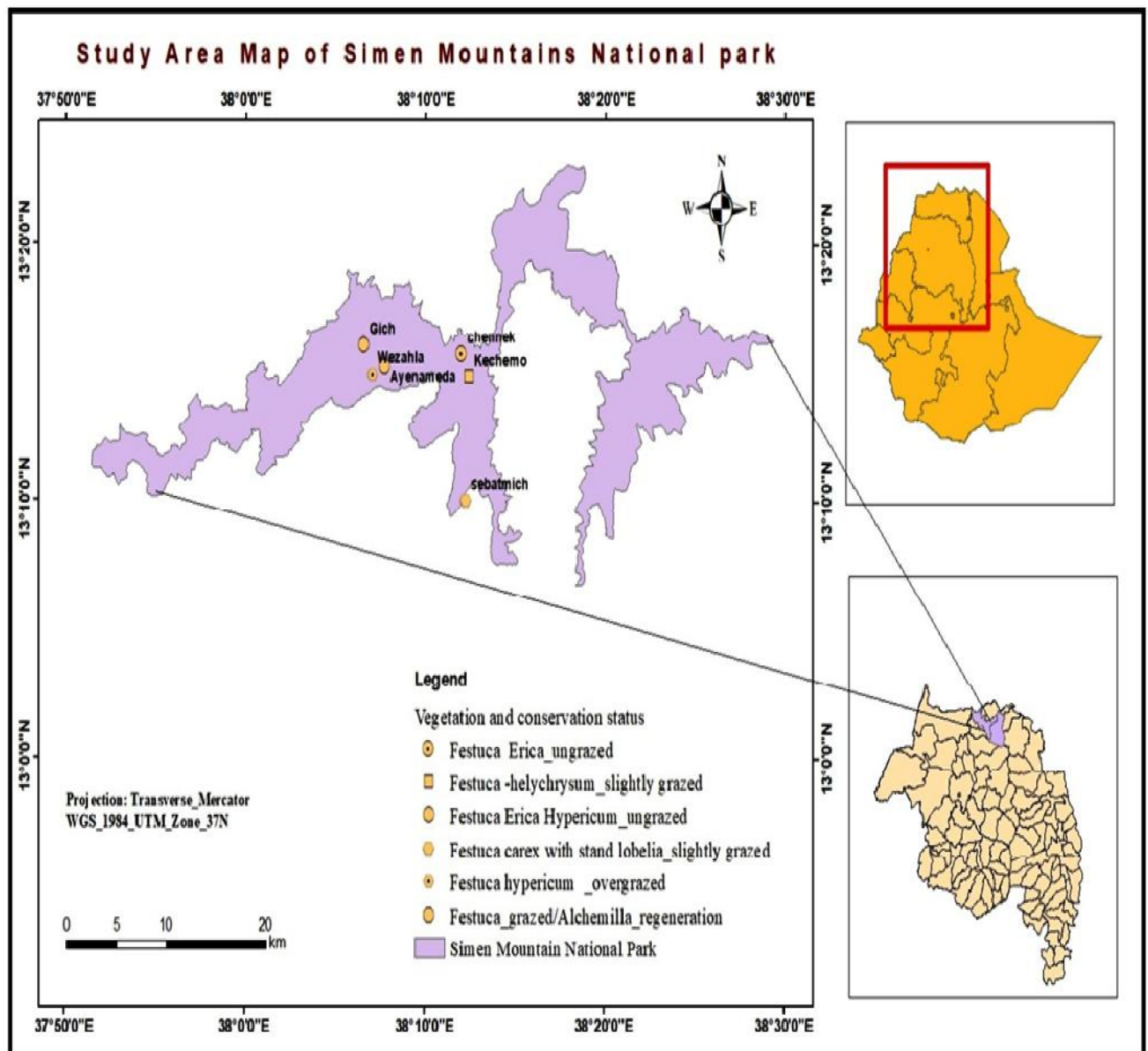


Figure 1. Map of SMNP and sample areas.

4.2. Topography

The topographic feature of Simien Mountains National Park is characterized by marvellous landscapes composed of broad undulating plateaux. It is also known by its precipitous cliffs, deep gorges, canyon-style escarpments and peaks. The topography of SMNP is divided into four main groups (Hurni, 1986). The altitudinal range can be classified as the following:

1. The lowland valleys below 2000 masl.
2. The lowland terrace steps formed by geologic processes. It comprises the main cultivation and settlement area.
3. The steep escarpment between 2000 to 4000 masl which consists of the main habitat of wildlife.
4. The highland plains and valleys of the escarpment which is a densely cultivated and settlement area.

4.3. Geology

The volcanic activities resulted in spectacular scenery to the SMNP. The 3000-3500 m thick sequence of basaltic volcano was deposited on Mesozoic sandstones and limestone that form a 500 m thick cover of the Precambrian crystalline basements. The main part of the Simen Mountains is built up by plateau basalts that are called the Trap series. They are composed of numerous 40 to 50 m thick lava-flows (Falch and Keiner, 2000).

The major part of the Simien Mountains consists of remnants of a Hawaiian-type shield volcano. The KidusYared Mountain is situated near to the centre of the shield volcano. RasDejen (4543 masl), the Bwahit (4430 masl) and Silki are formed from the outer core of this ancient volcano (Falch and Keiner, 2000). The shield volcano is mainly built by several meters thick augite-basalt-flows. The extreme escarpments in Simen appear to be a precondition for the formation of the extended-up lift of the whole massif. Harder rocks on the foot of the escarpment was responsible for the development of large-scale terrace like steps (Hurni, 1986).

4.4. Soil types

There are different soil associations in SMNP. The Humic Andosols are the dominant soil type at the altitude of 3000 masl and above where cultivation is less spread. The other types of soil are shallow lithosols that are mainly common in the area between 2500 and 3500 msl. Below 3000 masl, the typical soils are Haplic Phaeozems associated with cambisols and lithosols (Falch and Keiner, 2000).

4.5. Climate of the study area

The climate in Ethiopia is influenced by the Southwest-Northeast Indian Ocean monsoon system, the Atlantic wind streams from the west, and the mass of the Ethiopian highland blocks. Therefore, most of the Ethiopian highlands receive rain from March to October. More amount of rainfall is received from June to September (Falch and Keiner, 2000).

The climate of SMNP varies from area to area. Generally, the highlands have a relatively low temperature. They are cold in the early mornings of the dry season and receive rain 1500 mm on average in a single rainy season (from May to October) (Hurni, 1986). The climatic difference between the escarpment and the gorge is the cause for the difference in vegetation type. The difference in microclimate between the gorges and the escarpments is reflected by the extent to which the trees are covered with lichens. This is very prominent on the escarpment and rare on the gorges (Dunbar, 1978; Mesele Yihune *et al.*, 2008).

4.6 Temperature

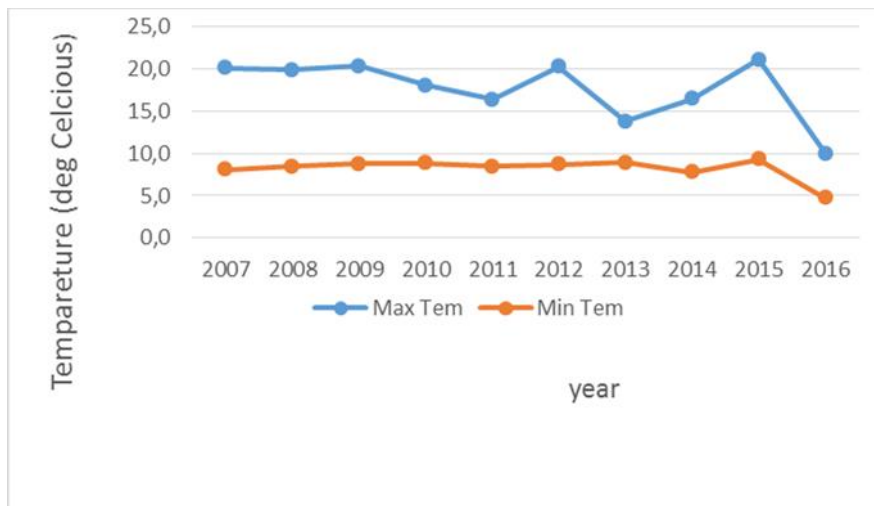


Figure 2 .Annual average minimum and maximum temperature of SMNP

The temperature of SMNP shows high annual variability. The minimum temperature ranges from 5⁰C to 10⁰C in 2016-2015 and maximum temperature from 10⁰C to 22⁰C in 2015-2016. Occasionally, snow occurs at altitude above 3800-4000 masl. However, it does not form a permanent snow cover on the mountain tops. This is because snow line is estimated at 5000 masl, about 4500 m above the peak of RasDejen (MeseleYihune *et al.*,2008).

4.7. Rainfall: The data boughtfrom National metrological Agency

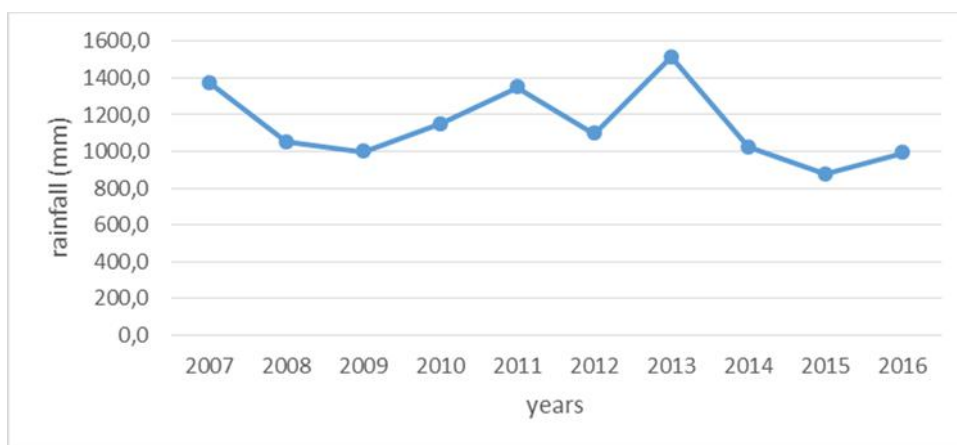


Figure 3 .Average Annual Rain fall of SMNP

In the SMNP, the annual rainfall ranges from 1000-1600 mm. The wettest parts lie to the lowland and along the Northern escarpment. The Eastern escarpment which is located along the Tekeze River receives rainfall later than the Northwest. The total amount of rainfall received by the Eastern escarpment is lower than that of the Northern escarpment. There is

only one wet season beginning usually from late May or early June and continuing till mid-October. Although, rain is expected in most months of the year, the bulk of the annual precipitation falls from May to October (Dunbar, 1978).

4.8. Vegetation

The rich natural vegetation of SMNP only exists due to the steep gorges. It mainly consists of a mixture of Afro-alpine woods, heath forest, high mountain vegetation, montane savannah and montane moorland (Hurni and Ludi, 2000). The common vegetation includes *Erica arborea*, *Lobelia rhynchopetalum*, *Solanum* spp., *Rosa abyssinica*, *Helichrysum* spp., *Hagenia abyssinica*, *Rapanea mesanophloeos*, *Pittosporum viridiflorum*, *Festuca gilbertiana*, *Rosularia simiensis* and mosses. In addition to this, herbs like *Tymus* spp., *Trifolium* spp., *Geranium arabicum*, *Rumex nervosus*, *Otostegia minucci*, *Clematis simiensis* and *Galium spurium* grow on the top of ridges and sides of gorge (Hurni and Ludi, 2000; Puff and Sileshi Nemomesa, 2000).

There are over 20 endemic plant species within and in the buffer zone of the SMNP. Of these, three are exclusively endemic to the Simien Mountains these include *Festuca gilbertiana*, *Rosularia simiensis* and *Dianthus longiglumi* (Falch and Keiner, 2000).

There are three main groups of vegetation cover in the SMNP (Falch and Keiner 2000; Endalkachew Teshome, 1999; 2007). They are explained in the following sections.

4.8.1. Afro-alpine steppe belt

Between 3800 and 4200 masl, there are scattered grass and large number of giant lobellia, *Lobelia rhynchopetalum*. Other species like *Danthonia*, *Festuca* (up to 3800), *Pentastichis*, *Agrostis* (above 3800 m) and *Poa simiensis* also grow in this area. Moreover, the Red hot pocker (*Kniphofia foliosa* and *K. comosa*) provide the red and yellow flowers, and silver straw flowers (*Helichrysum* spp.) and make the area highly attractive.

4.8.2. Sub-alpine highland belt

Such type of belt is only found on the escarpment areas. The most prominent vegetation in the sub-alpine forest belt includes *Erica arborea*, *Erica trimera*, Giant St. John's wort (*Hypericum revolutum*), and Giant lobelia (*Lobelia rhynchopetalum*). Other remarkable plants to the Simien Mountains are the Abyssinian wild rose (*Rosa abyssinica*) and Giant sphere

thistle (*Echinops giganteum*). There are also mosses Grimmiaceae and lichen *Usnea spp.* that cover the high-altitude forest trees. Finally, plants like *Tymus spp.*, *Trifolium spp.*, *Geranium arabicum*, *Rumex nervosus* and *Clematis simiensis* occur at the top of the ridges and sides of gorges.

4.8.3. Afro-montane forest belt

The Afro-montane forest belt is characterized by the presence of more than 20 tree species. *Juniperous procera*, *Hagenia abyssinica*, *Olea chrysophylla*, *Cordia*, *Ficus* and *Szygium guineense* are common trees in the area. Moreover, *Solanum spp.*, *Rosa abyssinica*, *Primula verticillata*, *Alchemilla*, *Tymus*, and *Urtica* are the other types of plant growing in the Afro-montane forest belt. The biodiversity of Afro-montane forest belt is much greater than that of the biodiversity growing on the highland plateau. Based on the location and the type of the vegetation present, the Afro-montane forest belt is classified into two. These are the wet afro-montane forest and the dry Afro-montane forest. The wet afro-montane forest patches are located on the north or northwest facing slopes and in steep and shady gullies. For instance, *Albizia schimperiana* dominated forest is considered to be wet afro-montane forest patches. The dry afro-montane forest patches are found on slopes facing south or southeast. They are typically characterized by the presence of extremely few species.

4.9 Fauna

The Simien Mountains National Park harbours various animals due to its topography. The numerous species of mammals and birds existing in SMNP indicate its unique ecosystem (Hurni, 1986). In the Simen Mountains National Park, 22 large mammals, 13 small mammals and 180 bird species have been recorded. There are some species of mammals, birds, rodents and shrews which are either endemic to Simien Mountains National Park or to Ethiopia. These include Walia ibex (*Capra walie*), which studied its feeding preference, Ethiopian wolf (*Canis simiensis*), Gelada baboon (*Theropithecus gelada*), the grass rat (*Arvicanthis abyssinicus*), wattled ibis (*Isostrychia carunculata*) and Thick-billed raven (*Corvus crassirostris*) (BerihunGebremedhin, 1998; DesalegnEgijuet *al.*, 2015).

4.10 Sampling design

According to the reconnaissance survey made in November 2016, the following sites were selected as possible research areas: Sebatminch, Kechemo, Bwuahit, Chennek, Ayenameda, Wezhla, and Gich, where the research was conducted. Most land management history of each study site was used by the people in Simen since 17th century. The sites according to the park office information: Chennek and some spots of Kechemo conserved and protected since 2000 to the time of writing 2018 G.C. and all Gich area after resettlement completely protected from the time onwards since June 2015. Erica forest and some ecotone with carex are still in good status and with the time of security instability the whole country the first area started to be grazed. Ayenameda plateau and Sebatminch near to the swamp area in good status. However, Wezhla area exposed to overgrazing from outsiders Ambaras and Abergina even if Gich villagers did partial voluntary resettlement programme.

4.10.1 Rodent trapping technique: Sherman's live-traps

Rodents were trapped using the Capture-Mark-Recapture (CMR) technique by Sherman live traps during the dry season between January and February 2018 (Afework Bekele, 1996a,b; Linzey and Kesner, 1997). A representative of six habitat types and four types of management areas were selected. These are vegetation complexes of different species including (Figure 1):

Festuca-Erica (ungrazed);

Festuca-Helychrysum (Slightly grazed);

Festuca-Erica-Hypericum (Ungrazed);

Festuca-Carex-Lobelia (slightly grazed);

Festuca-Hypericum (Overgrazed);

Festuca (grazed) but Alchemilla (on regeneration)

The six major habitat types and four management systems, randomly selected, were identified to represent SMNP. A total of 12 grids (two grids in each habitat type and management type) were used in a randomly selected site. At each habitat type and management area, two permanent live trapping grids, 2500 m² (50 m x 50 m) each, were established. In each trapping site, a standard square (five rows by five columns) trapping grid was established during dry seasons (Linzey and Kesner, 1997).

A total of 50 Sherman live traps were set in two grids at 10 m intervals between points. The grids were surveyed twice during the day. Traps were baited with peanut butter for two days in each site inverted traps to habituate the rodents before actual trapping period.

To provide protection against the strong heat (sun exposure), traps were covered with *Festuca* grass. They were checked three times a day morning at 6:00 before noon 11:30 13:30 hours and late afternoon between 17:00 and 19:00 hours) for three days (in six major sites) or twelve sub sites as recommended by Afework Bekele (1996b). Each captured animal was identified, fur and colour marked by toe clipping but in this study fur clipping in their chest, and released at the site where it was trapped. In addition, weight, sex, approximate age (juvenile, adult), was recorded (Afework Bekele, 1996b). Reproductive conditions (for females closed or perforated vagina and for males scrotal or abdominal testes) were also recorded (Afework Bekele, 1996b) and their weight was also considered to 35-55 gram Juvenile, 55-75 Subadult and above 75 gram full Adult and categorize to different age groups. For .e. g., scrotal males/adults/ and abdominal testes are sub-adults) (Afework Bekele 1996a,b). The rodent trapping were recorded in 18 days and 12 bait days.

4.10.2. Habitat quality Assessment

Line transect method was used to carry out habitat quality assessment (Table 2; Table 4; Table 5) transects were laid down using GPS and ropes. The line transect were taken the same bearing (direction) from the beginning to the end in the same contour. Each line was 500 m apart straight line. During the wet and the dry seasons, habitat quality assessment and new rodent holes and common mole rats' hills of soil were counted.

Dominant vegetation were recorded and each samples were located every 200m except two transects which have a barrier of cliff and agricultural land. In all other sites Chennek, Sebat Minch, Gich Ayenameda and wezhla standard methodology was utilised (Busby *et al.*, 2006). Each line transect was about 2– 4 km in length on each set bearing. Ground cover was assessed as the percentage of soil, vegetation and rock cover within the quadrat according to Braun-Blanquet: scale; 1 = <5 %, 2 = 5-25 %, 3 = 25-50 %, 4 = 50-75 %, 5 = 75-100%. Vegetation type and structure was assessed by measurements at four levels height; <5cm: ground level, 5-25 cm: herbaceous level and 25-50 cm: shrub level. Above 50 the height of shrub level and above were also included and gradient was as follows: flat slope=1; gentle=2; steep=3, were listed. Dominant vegetation were recorded and each samples were located every 200m with 5m radius.

4.11. Data collection

During data collection after the grids established, the coordinates were taken at grid "C₃" which is the centre of the block. Both grids were established apart at 200-metre distance. The same representation for all sites was indicated in Table 1.

Table 1. Representation of live trap grids

A1	A2	A3	A4	A5
B1	B2	B3	B4	B5
C1	C2	C3	C4	C5
D1	D2	D3	D4	D5
E1	E2	E3	E4	E5

The impact of the variables was identified as the dependent variables (population of rodents, common mole rat hole and Number of rodent hole counted: how ever as independent variable management intervention and vegetation type.

4.12 Data analysis

Data were analyzed using Spss statistical software package version 20 and 23. Analysed with test significant variation of the number of individuals caught across vegetation and in different land management Rodent species which vegetation type predetermined location and along the GPS bearing given for habitat quality assessment once the bearing given done with many up and down. Explore Anova was also used to know the variation in which management zone is appropriate for rodent assessed and distribution of new Rodent hole and common mole rat hill in different land management intervention.

5. RESULTS

5.1 Rodent Trapping

Rodent trapped variation in population in different land management four major management units completely overgrazed, grazed, moderately grazed (nature) and ungrazed areas area of Simien legend part (Figure. 1). The highest rodent population found in the moderate grazed or moderate by nature and on species level *Arvicanthis abyssinicus* the most caught species (Fig .4).

A total of 165 individual rodents were captured in six major sites during only dry seasons were identified and recorded were: *Lophuromys flavopunctatus* (Lf), *Arvicanthis abyssinicus* (Aa), *Stenocephalemys grisecauda* (Sg), *Otomys typus* (Ot) and *Crocidura baileyi* (Cb) were recorded. The relative abundance of caught rodent include: *A. abyssinicus* (56%), *L. flavopunctatus* (9%) *S. grisiecauda* (35 %), *O. typus* (1.8%), *C. baileyi* (o.6%) and *Mus. Mahomet* (1.8%) observed.

5.2 Habitat Quality Assessment

The Categorized data in table .2 and 3 which shows that was significance variation in number of rodents fresh hole and common mole rat analysed in habitat quality land management intervention on represented sites),wet and dry seasons respectively. There was variation ($p<0.01$) ($p<0.02$) in the number of rodents hole and common mole rat hole between management intervention .Therefore, the null hypothesis is $H_0=$ is rejected $H_a=$ is accepted. There is a different of rodent abundance, number of rodent hole and mole rat holes with management intervention and vegetation type with season. ($p<0.002$ and $P<0.003$ (Fig.9 and 10).

Table 2. Rodent Captured (recaptured indicated in brackets).

Species	Habitat type	Male	Female	Juvenile	Total	Density (N/Km ²)
<i>Arvicanthus abyssinicus</i>	Festuca grazed Alchemill(regeneration	13	5	2	20(3)	8
<i>Arvicanthus abyssinicus</i>	Festuca grazed Alchemill(regeneration	8	9	3	20(4)	8
<i>Stenocephalus grisiecauda</i>	Festuca grazed Alchemill(regeneration	1	4	0	5(1)	2
<i>Stenocephalomys grisiecauda</i>	Festuca grazed Alchemill(regeneration)	0	1	0	1	1
<i>Lophuromys flavopuncactus</i>	Festuca Erica(ungrazed)	2	3	0	5(2)	1
<i>Stenocephalomys grisiecauda</i>	Festuca Erica(ungrazed)	1	3	0	4(1)	1
<i>Otomys typus</i>	Festuca Erica(ungrazed)	0	0	1	1	0.4
<i>Mus Mahomet</i>	Festuca Erica(ungrazed)	0	1	-	1	0.4
<i>Lophuromys flavopunctatus</i>	Festuca Erica(ungrazed)	2	3		5(2)	1.6
<i>Stenocephalomys grisiecauda</i>	Festuca Erica(ungrazed)	0	0	1	1	0.4
<i>Mus Mahomet</i>	Festuca Erica(ungrazed)		1	0	(1)	0.4
<i>Stenocephalemys grisiecauda</i>	Festuca Erica hypericum(ungrazed	1	0	0	1	0.4
<i>Otomys typus</i>	Festuca Erica hypericum(ungrazed)	0	1	0	1	0.4
<i>Stenocephalemys grisiecauda</i>	Festuca Erica hypericum(ungrazed)	4	3	0	7(2)	2.8
<i>Lophuromys flavopunctatus</i>	Festuca Erica hypericum(ungrazed)	1	0	0	1	0.4
<i>Otomys typus</i>	Festuca Erica	0	2	0	2	0.8

Species	Habitat type	Male	Female	Juvenile	Total	Density (N/Km ²)
	hypericum(ungrazed					
<i>Crocidiura bailyi</i>	Festuca Erica hypericum(ungrazed)			1	1	0.4
<i>Stenocephalemys grisiecauda</i>	Festucahelchrysum Slightly grazed	5	8	4	17(5)	6.8
<i>Stenocephalemys grisiecauda</i>	Festuca helchrysum Slightly grazed	3	3	2	9(5)	3.6
<i>Lophuromys flavopunctatus</i>	Festuca helchrysum Slightly grazed	0	4	0	4	1.6
<i>Arvicanthus abyssinicus</i>	Festucahelchrysum Slightly grazed	3	0	0	3	1.2
No trapping	Festuca hypericum overgrazed	0		0	0	0
<i>Arvicanthus abyssinicus</i>	Festuca hypericum overgrazed	3	6	0	9	3.6
<i>Arvicanthus abyssinicus</i>	Festucacarex lobelia Slightly grazed	5	8	0	13	5.2
<i>Arvicanthus abyssinicus</i>	Festuca carex lobelia Slightly grazed	5	7	2	14	5.6

Table 3.Data collected on habitat quality Assessment wet season

Vegetation type	Rodent	Mole	Livestock droppings
<i>Festuca erica lobelia</i>	16	5	6
<i>Festuca Erica</i>	54	25	3
<i>Festuca</i>	40	20	12
<i>Festuca</i>	10	10	6
<i>Fest Erica helychrysum</i>	15	8	7
<i>Festuca lobelia</i>	10	10	8
<i>Festuca lobelia</i>	15	18	18
<i>Festuca</i>	40	12	24
<i>Festuca helychrysum</i>	45	10	16
<i>Festuca alchemilla Carex</i>	58	30	14
<i>Festuca lobelia</i>	11	5	141
<i>Festuca Alchemilla</i>	61	15	11
<i>Festuca lobelia thyme</i>	45	21	28
<i>Festuca erica</i>	18	32	72
<i>Festuca Kniphophia Erica</i>	42	5	20
<i>Festuca lobelia</i>	45	4	30
<i>Festuca</i>	25	10	80
<i>Festuca lobelia Erica</i>	45	21	16
<i>Kniphophia foilosa</i>	15	3	8
<i>Alchemilla helychrysum</i>	10	2	11
<i>Erica thyme festuca</i>	12	25	89
<i>Helchrysum citrispinum</i>	8	3	150
<i>Hypericum revolutum</i>	41	18	70

Table 4. Rodent and mole rat Assessed in different Management during dry season

Vegetation type	Rodent	Mole	Livestock droppings
<i>Festuca Erica lobelia</i>	10	0	10
<i>Festuca Erica</i>	40	25	19
<i>Festuca</i>	40	9	21
<i>Festuca</i>	17	21	3
<i>Fest Erica helychrysum</i>	12	2	8
<i>Festuca lobelia</i>	5	0	10
<i>Festuca lobelia</i>	45	13	18
<i>Festuca</i>	42	0	47
<i>Festuca helychrysum</i>	41	2	15
<i>Festuca alchemilla Carex</i>	25	2	13
<i>Festuca lobelia</i>	9	4	152
<i>Festuca Alchemilla</i>	50	12	19
<i>Festuca lobelia thyme</i>	41	14	43
<i>Festuca Erica</i>	31	6	12
<i>Festuca Kniphophia Erica</i>	39	30	17
<i>Festuca lobelia</i>	41	0	28
<i>Festuca</i>	20	32	71
<i>Festuca lobelia Erica</i>	37	0	23
<i>Kniphophia foilosa</i>	10	2	11
<i>Alchemilla helychrysum</i>	7	0	18
<i>Erica thyme festuca</i>	3	10	145
<i>Helchrysum citrispinum</i>	0	0	156
<i>Hypericum revolutum</i>	34	4	60

Number of individual *Arvicanthus abyssinicus* has highest distribution in *Festuca alchemilla* vegetation secondly distributed *Festuca helchryu sum* in kechemo Bwahit while Aa has Equivalent distribution with Sg in kechemo Bwahit (Fig.4)

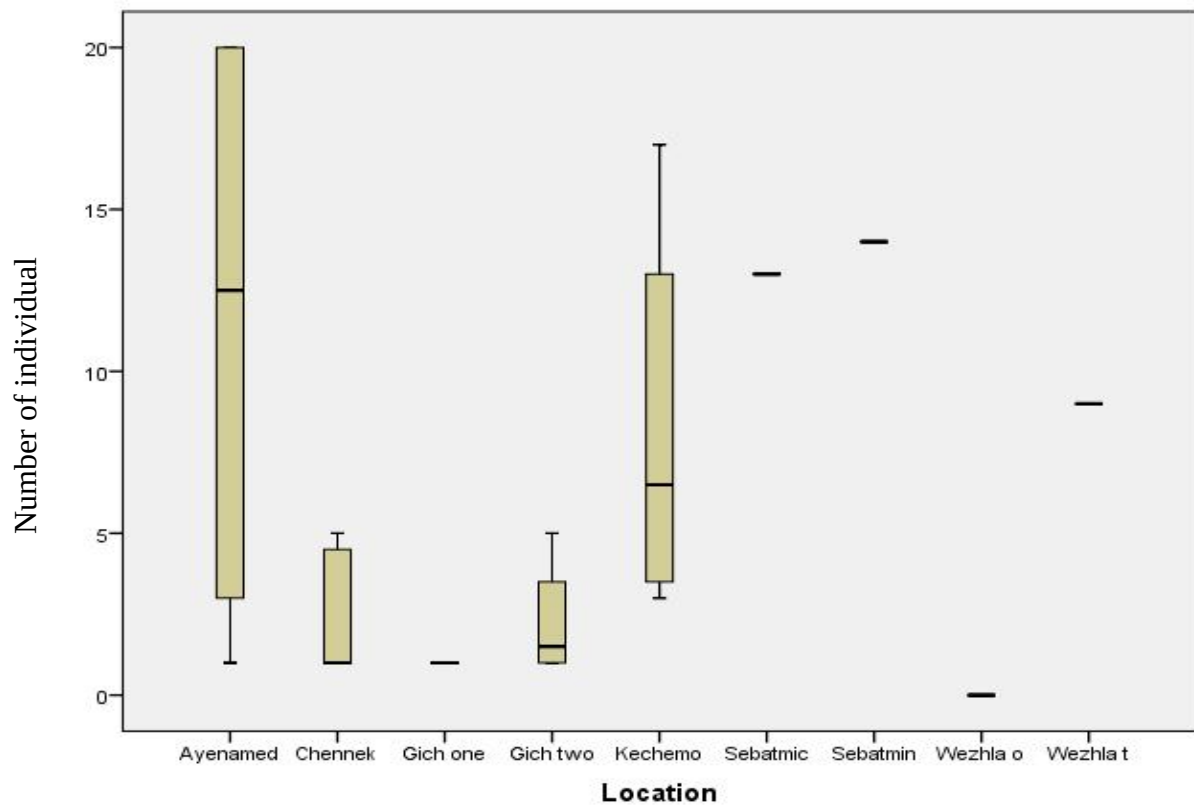


Figure 4. Number of individual of rodent distribution in different land management intervention and habitat

The Number of individual of rodents in different land management intervention.

The highest Population recorded in slightly grazed area and the lowest Population in overgrazed area (Fig.5)

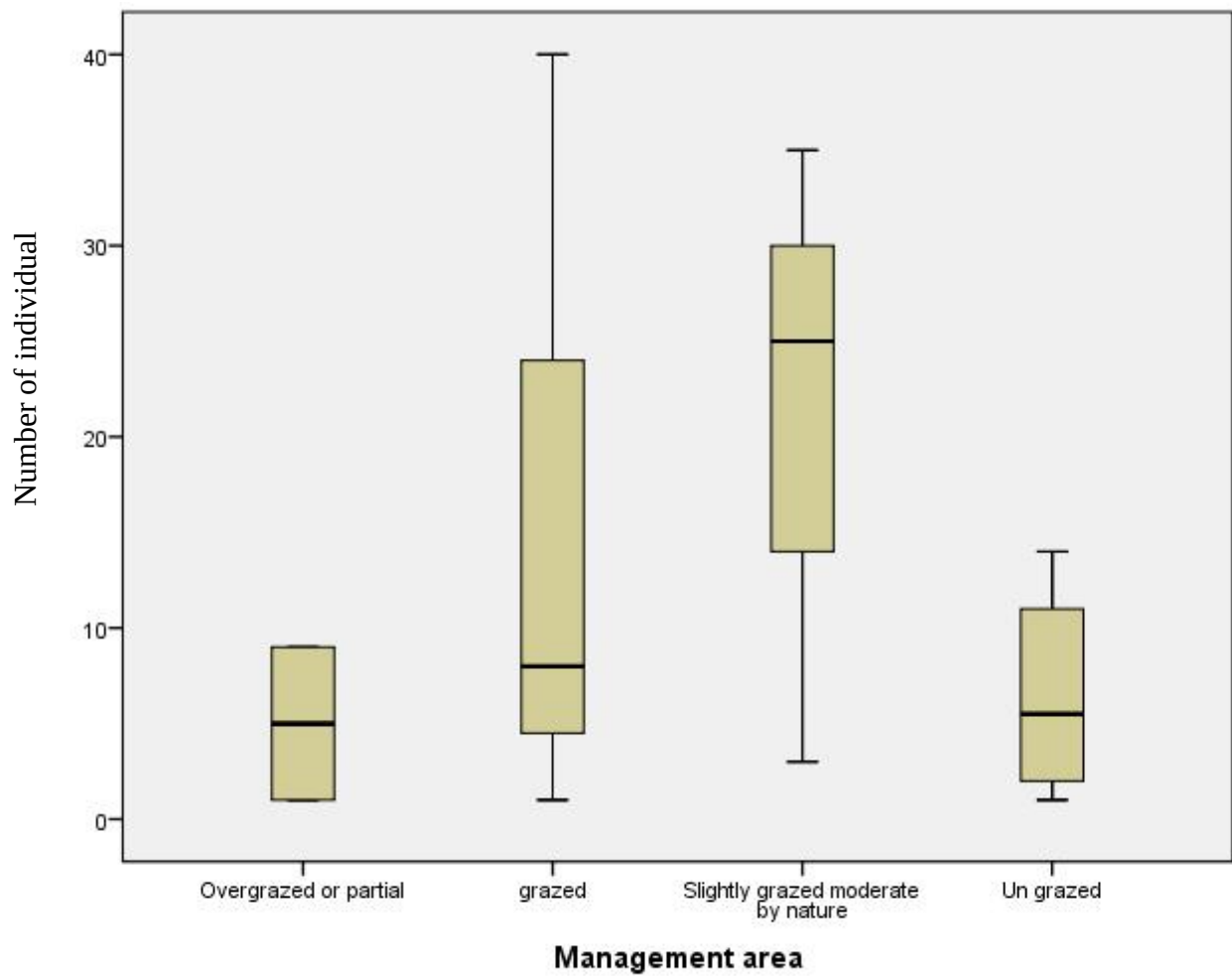


Figure 5. The Number of individual rodents in different land management intervention.

In the whole comparison the highest species of population is *Arvicanthus abyssinicus* the second *Stenocephalomys grisiecauda* with lowest *Crocidiura baileyi* (Fig.6).

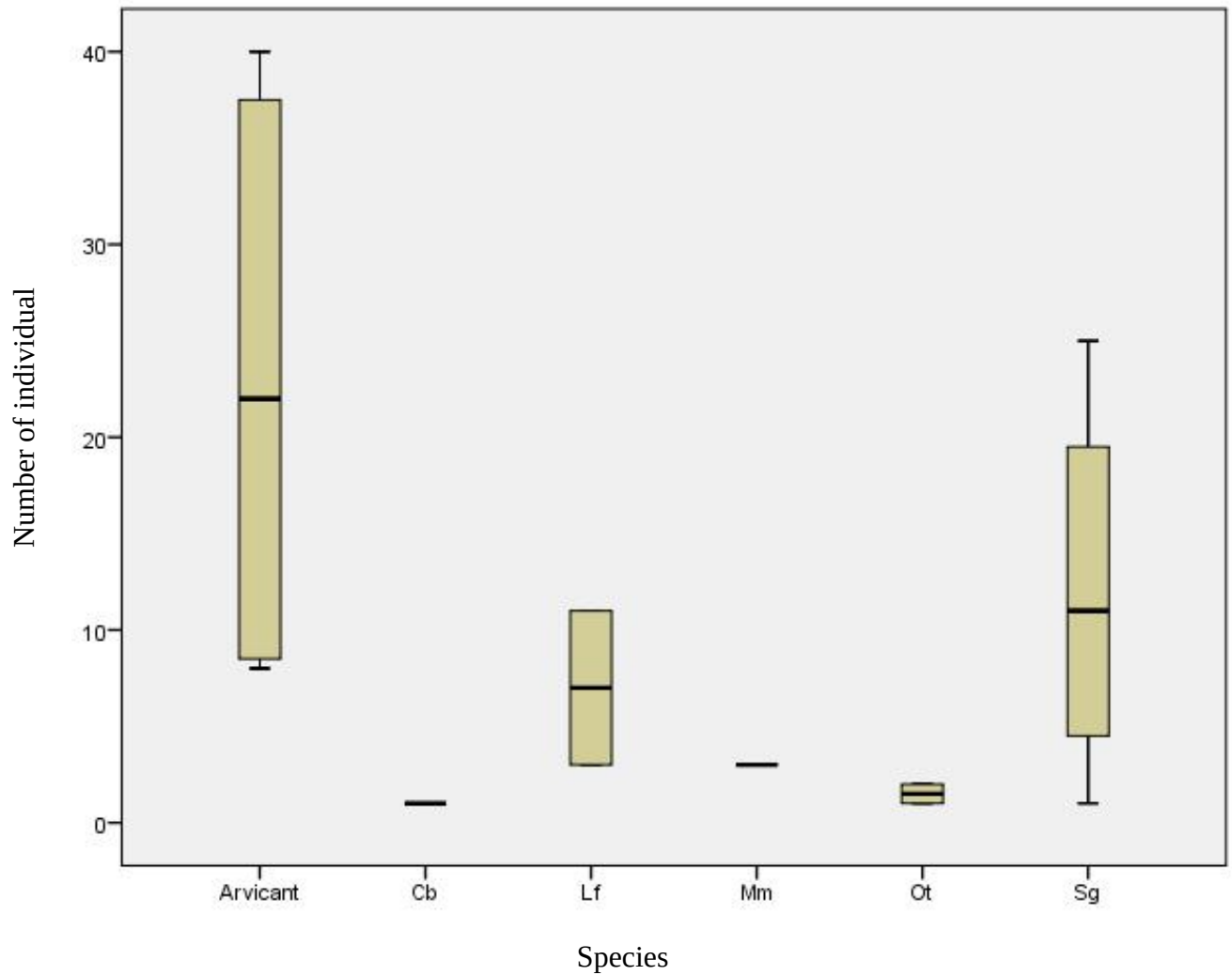


Figure 6. Number of individual recorded with species in study sites

Abundance of rodents with vegetation type the highest fresh rodent hole other than mole rat were found in *Festuca alchemilla* vegetation. The lowest *Alchemilla helchrysum* *Erica* overgrazed vegetation type (Fig.7)

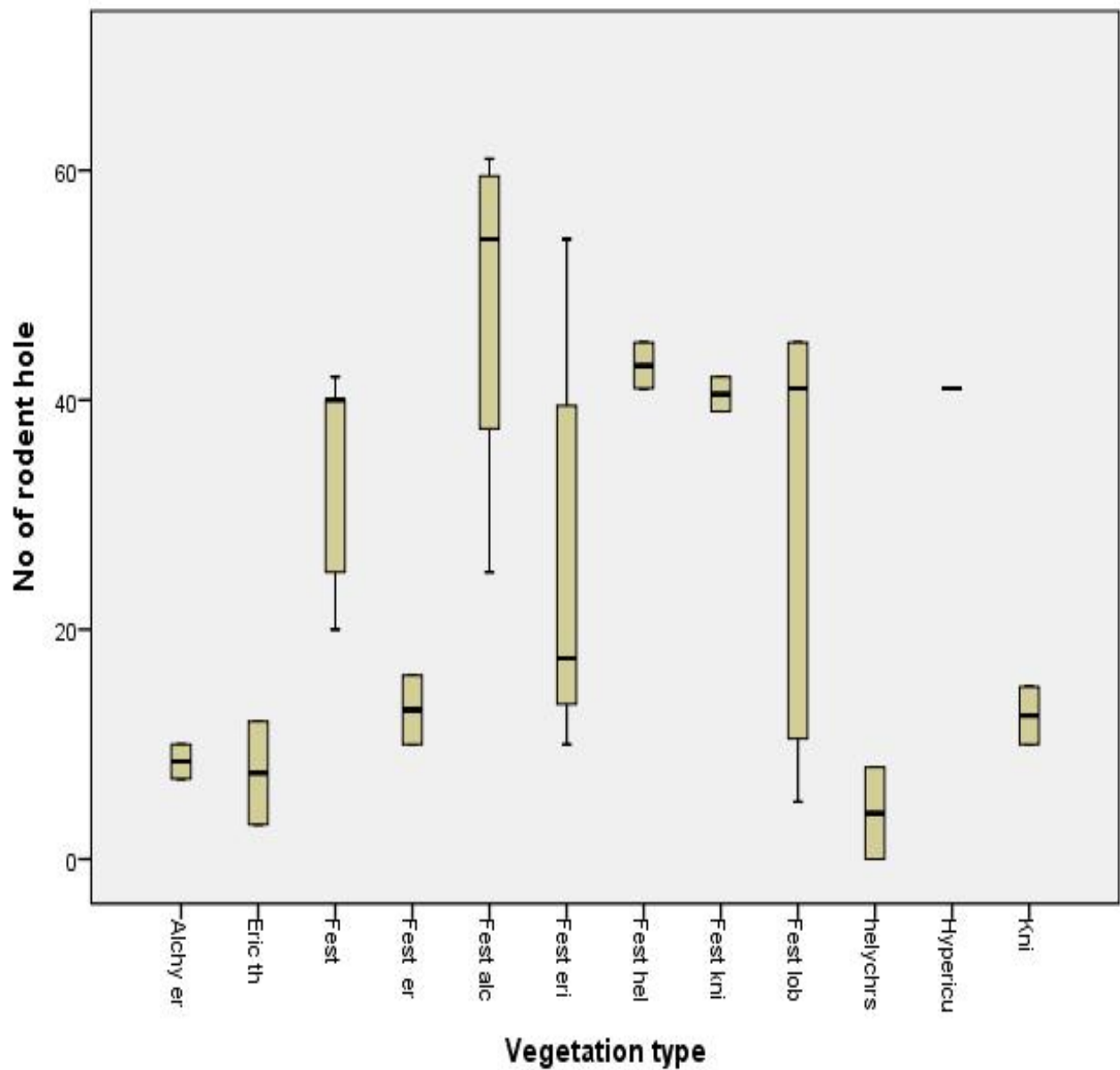


Figure.7 The distribution of rodent hole versus vegetation type

The highest fresh common mole rat hole observed in *Festuca kniphophia foliosa* vegetation. *Festuca* (fest) has lowest variation from the average with lowest overgrazed *Erica* stands (Fig.8)

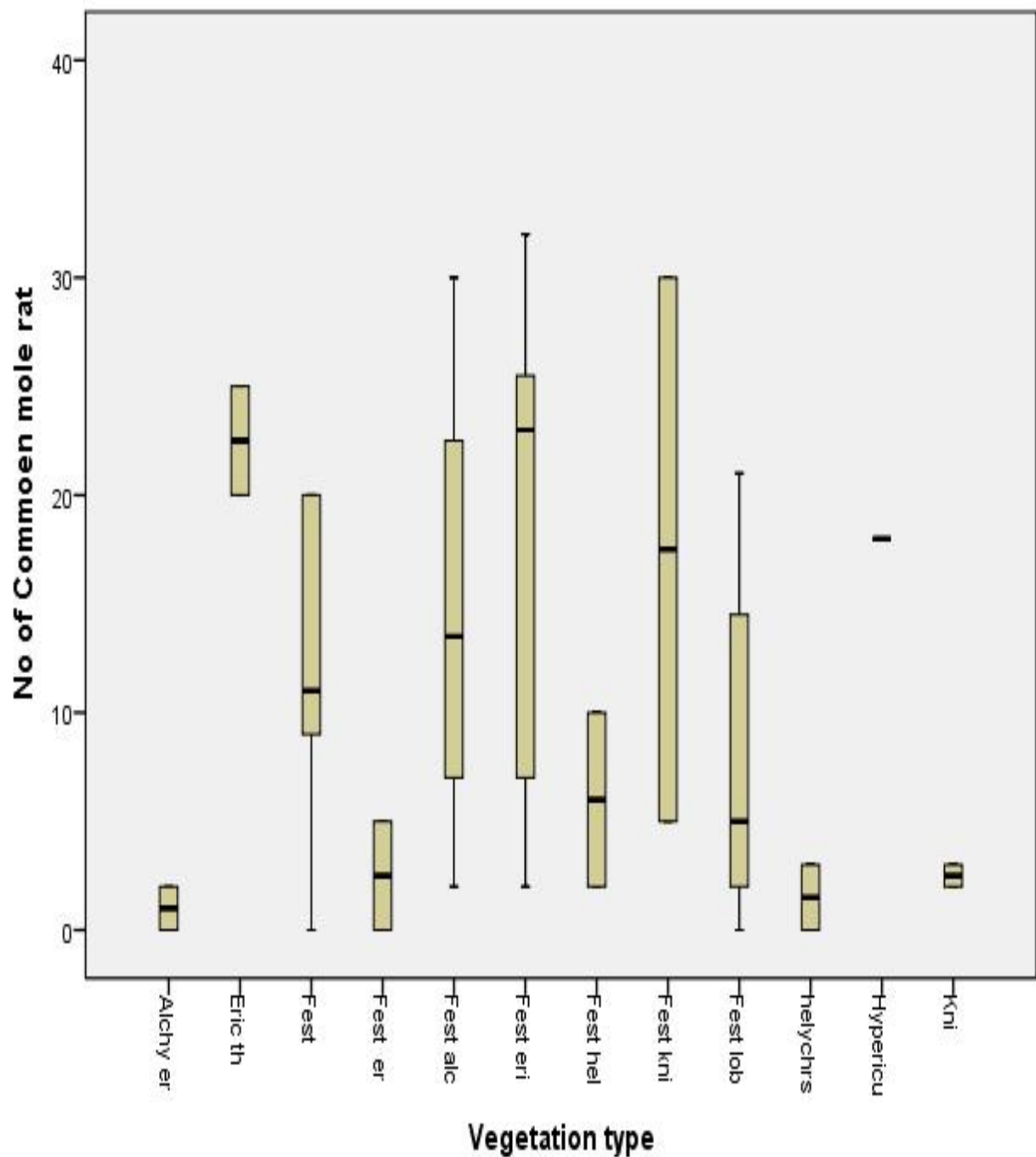


Figure 8. The distribution of common mole rat hill versus vegetation type

The highest no of rodent hole shown during the dry season in slightly grazed habitat the lowest overgrazed wet season .(Fig,9)

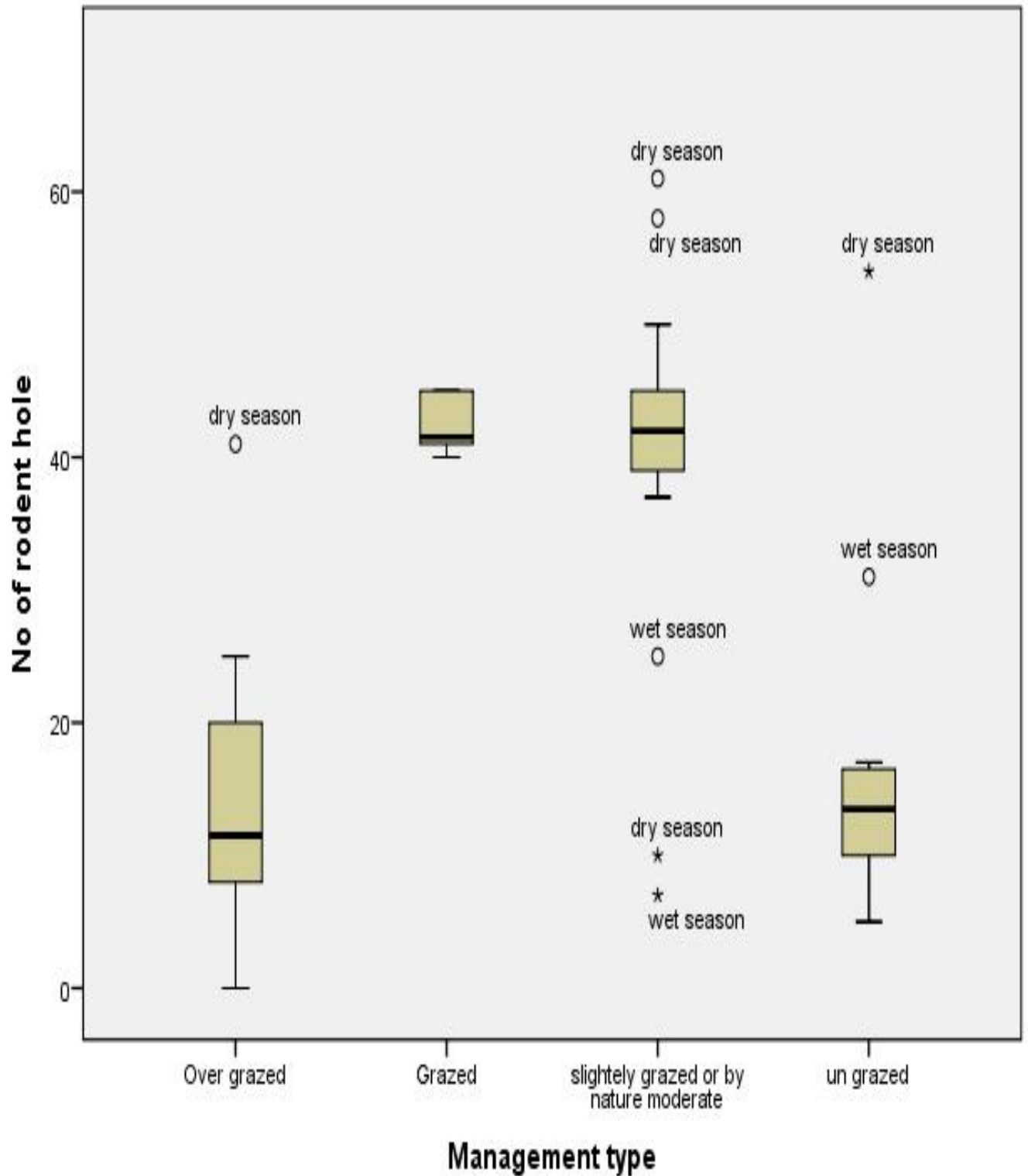


Figure 9. Rodent hole variation assessed habitat quality wet verse dry season.

All in all overgrazed area shown highest common rat hole as fossorial rodent of course it is not recommended to have overgrazing All in all overgrazed area shown highest common rat hole as fossorial rodent of course it is not recommended to have overgrazing (Fig.10)

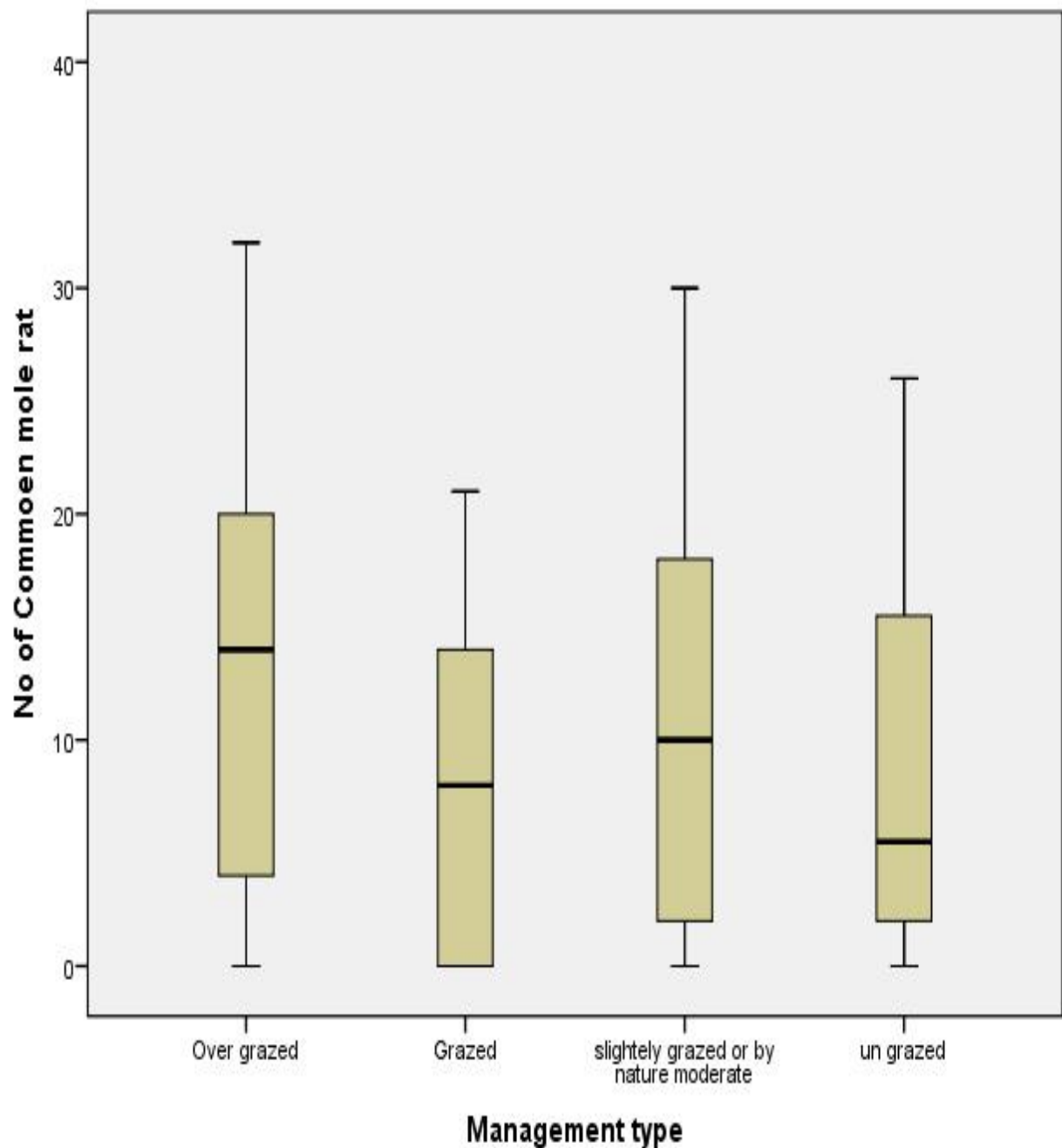


Figure 10. The number of common mole rat versus management type

6. DISCUSSION

The SMNP is largely affected by human population pressure and livestock impact. This determines the rodent population in the study area. In addition, rodent populations are also affected by climatic factors according to this and other studies. Rodents have ecological importance in the study area.

The comparison on the state of vegetation with rodent population in many areas of Simien; particularly, around Wezhla, Ayenamada South of Sebatminch a growing impact of overgrazing the vegetation structure over large area is either disturbed or destroyed the original diversity reduced and Prioritize conservation has an important consequences for wildlife including rodents without human disturbance the potential of natural grassland ecosystem sustain large population could be very high.

The most caught species is *Arvicanthis abyssinicus* (unstriped grass rat) is well adapted to short grass species(*Alchemilla species*).*Alchemilla* Spp is also endangered there is negative correlation between grass rat abundance and overgrazing. In three days observation to capture and two days bait days no trapping occurred in Wezhla over grazed area.

The rodent trapped was significantly different between different management area (grazing) intensity and species of vegetation type the lower captured on long ungrazed *festuca* with *Erica* and the zero captured in overgrazed *Festuca Hypericum* species. Figure.1) It was the highest trapped occurred *Alchemilla spp*s on regeneration with *Festuca* which is highly required to conserve for future conservation of the SMNP(Figure 4).

During Habitat quality assessment, the highest rodent hole was found *Alchemilla festuca* vegetation indicated that showed the quality of its habitat.(Figure 7). The common mole rat was assessed vs vegetation type and the result indicated that the highest population was found in red hot poker (*Kniphophia foloisa*) with *Festuca* species.(Figure.8) In both these studies the rodent trapping and habitat quality assessment showed that the best habitat was moderately or slightly grazed with better conservation status.(Figure 5).

It is obvious overgrazing affects the small mammals more exposed to the predation by carnivores mammal and birds of prey. In gich plateau amazing competition by several cat was taken rodents before entering to the trap by when they approach the smell of peanut butter catch early morning and late afternoon observed every day.

In this Simien, it was observed that *Arvicanthis abyssinicus* was the main prey endangered Ethiopian wolf . Because of patchy distribution in *Arvicanthis abyssinicus* a true short and moderate grass feeder adapted to live stand on hind legs which prefer to feed *Alchemilla* species recorded highest number of captured in Ayenameda(Fig 1 and 4) .On the other hand which is recorded required by Walia ibex (Desalegn Ejigu *et al.*, 2015).

In this study *Lophuromys flavopunctatus*, *Arvicanthis abyssinicus*, *Stenocephalemys grisiecauda*, *Otomys typus* and *Crocidura baileyi* were captured.

The relative abundance of caught rodent include: *A. abyssinicus* (56%), *L. flavopunctatus* (9%) *S. grisiecauda* (35%), *O. typus* (1.8%), *C. baileyi* (0.6%) and *Mus Mahomet* (1.8%) observed moderate and few Long Festuca with Erica which is ungrazed land mostly at this time captured and this idea is supported by Busby *et al.*, (2006) . Different rodent species are confined in the highlands of Ethiopia (Yalden and Largen, 1992). The six species of rodents were (*A. abyssinicus*-unstriped grass rat, *L. flavopunctatus*-harsh-furred rat, *S. grisiecauda*-narrow headed rat, *O. typus*-swamp rat, *T. splendens*-common mole rat and *Mus mahomet*) and one species of insectivores (*C. baileyi*-white toothed shrews) have been recorded in the SMNP and are supported by Guttinger *et al.*, (1998) . moderate and few Long Festuca with Erica which is ungrazed land mostly at this time captured and this idea is supported by (Busby *et al.*, 2006: which has reduced Mesele Yihune and Afework Bekele, 2012) . The Catagorized data ordered in Spss software the significance difference between management sites in trapped rodent was 0.04.

Pelomys harringtoni was observed in the field but not captured in our study. On the other hand, (Busby *et al.*, 2006) recorded three species of rodents (*A. abyssinicus*, *L. flavopunctatus* and *O. typus*) and one insectivore species (*C. thalia*). *A. abyssinicus* is the most abundant rodent species in this study Simien area supported by Gutter *et al.*, (1998) and second abundance *S. grisiecauda* in this time of study More over the most abundance species in

SMNP (Mesele Yihune *et al.*, 2012) .In other hand in Guassa area of Menz indicated that *S. grisiecauda* was the most abundant species in alpine habitat types (Zelalem Tefera, 2001).

Habitat association is important to determine how various species respond to environmental heterogeneity (Martin, 1998). Habitat selection may have evolved as a result of past competitive effects but, only weak inter-specific 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 (Schoener, 1983).

The abundance of rodents varied across all conservation status (management type) and vegetation type in the present study. There was higher number of rodents captured as well rodent hole in *Festuca Alchemilla* followed by *Festuca helchysum* habitats. Mesele Yihune *et al.*, (2012). This is probably because such habitats are good in providing shelter due to their dense cover. The least number of rodents was captured in *hypericum* overgrazed.

This may be related to the poor cover of the habitat exposing rodents to predators and other factors that decrease their population indicated that habitat selection of different species of small mammals mainly relies on the vegetation of the given habitat. Taylor and Green (1976),

7. CONCLUSION AND RECOMMENDATION

7.1. Conclusion

This investigation provide on six species small mammal (rodents with shrew) the distribution in different land management system (grazed, un-grazed, slightly grazed, moderate grazed and over grazed areas) effect on the rodent distribution and abundance which affects Ethiopian wolf population in the Afro-alpine ecosystem in the SMNP.

.The most caught species is *Arvicanthis abyssinicus*(the unstriped grass rat) is well adapted to short grass species(*Alchemilla species*) is negative correlated between grass rat abundance and overgrazing. One of their ecological importance is that they are used as the main prey source for the Ethiopian wolf. This is highly supportedby (Messele Yihune *et al.*, 2012). Thus, affecting the population of rodents can determine the fate of Ethiopian wolf population in the area.

7.2. Recommendation

SMNP has a great potential with scenic beauty for ecotourism development and a home for the conservation endemic, endangered wild life including Ethiopian wolf, and endemic rodent *Arvicanthis abyssinica* should be given high priority for its Conservation by widening the afro-alpine bottle neck grass land areas.

Ecologically based grazing strategy should be entered to the practical conservation of the park by giving priority to the Afro-alpine areas. The moderate natural area around Kechemo Bwauhit strictly prohibited from grazing and any other interference.

. It is highly necessary to implement long term planning conservation measure and create opportunity incentive for scouts and local community.

Through participating the local community, SMNP and EWCA has to design a strategy to allow rotation cut and carry system of *Festuca* in selected habitat the subalpine and afro-alpine part of the park exclude the core area. To assess the wildlife potential of Simien including Ethiopian wolf and Walia Ibex is highly required to assign a budget monitoring and evaluation for last three years there is no census carried out in the park with the park staff.

The continuous monitoring and evaluation become stagnant it needs to be strengthened all stakeholders should involve for future survival of SMNP. The former farmland and *Festuca* grassland of Wezhla is completely overgrazed. Therefore, it should be Prohibited grazing and other activities from outsiders come from Abergina and Ambaras expand the wolf habitat. It raised two major questions why resettled Gich Villagers considering as core and the ideal

habitat for Ethiopian wolf and for its prey rodents and highly required to stop grazing and border expand cultivation.

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9. APPENDIX I

1. Habitat quality assessment line transect

Date----- Location-----observers-----

Start time-----start GPs location-----UTMe-----UTMn-----

Finish Time-----Finish GPs Location-----UTMe-----UTMn-----

Land scape				Cover			Vegetation Levels Cover						Rodents		Droppings				Com
V	H	S	Alt	Cv	Cs	Cr	Gl	Glsp	HI	HIsp	SI	Slpp	Rat	Cmr	TP	Ct	St	O	

2. Rodent Trapping Data Sheet Location of the area.

Date Day Time Observer Slope Rockness

Trapping Grid Cloud Rain Wind

Trap code	Species	Fc/Rc	Weight	Age	Sex	Clip- mark	Male			Female		Juvenile	Notes
							A	S		V			
										I			

10. APPENDIX II

Habitat quality Assessment transect coordinate with the observed site taken.

X	Y	Beginning	End.
413752	1466800	Tsebelu	To tilkamba
413752	1464800	End	
415048	1465900	Amarashema to high kechemomesarirya	
415048	1461900	End	
413810	1456500		Sebatminchrasgodguaditbitikua
413810	1459900		End
413089	1456800	>>	Sebaminchgirge to bitikua
413089	1460600		End
413570	1461700	>>	Kechemo lower tilkamba
413570	1464300		End
411834	1464700	>>	Tinshamba to amdu
411834	1465863		End
405699	1465500	>>	Ayenameda to imetgogo
405699	1468700		End
403029	1467600	>>	Gich to wezahila
403029	1464000		End
404900	1464328	>>	Ayenameda to talk wenz
407700	1464328		End
408500	1464518	>>	Talakwenz north inatye

X	Y	Beginning	End.
408100	1464518		End
408600	1466118	>>	Kuasmekerkbiyagededur
406200	1466118		End
404877	1464000	>>	Ayenameida mid ginbar
404877	1466200		End
409502	1464800	>>	Sewmeselewdingay to enatye
ie409502	1466200		End

PLATES.1



Aa



Sg,



Ot,



Plate 1. Captured rodents species (Aa,Sg,Lf.Cband Ot.)



Helchrysum citripinum



Aa (Juv)



Plate 2. Rodent site Chennek, Sherman's trap and Ayenameda area with Alchemilla Spps.



Plate 3. During wet season habitat quality assessment six pictures (Kechemo)



Plate 4.Dry season habitat quality assessment count