

ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES



Population status, distribution and ecology of Gelada baboon (*Theropithecus gelada*) in Azwa and Arego, South wollo, Dessie, Ethiopia.

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DECLARATIONS

I, Yonatan Ayalew Mekonnen, confirm that this thesis is my original work and has not been presented for any degree in any other University and that all sources of materials used for the thesis have been duly acknowledged.

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Abstract: The population status and distribution of gelada baboon in Cliff Azwa and Arego was investigated and test statistics was applied to age-sex categorical variable. The study area was stratified into five study blocks namely Aba Tasho, Aba Gude, Doro Mezeleya, Azwa and Dikule genet. The study was carried out from August, 2008 to March, 2009. Data on movement, distribution and human gelada interaction were collected in the area based on the questionnaire survey and field observation. Data were analyzed using descriptive statistics, and responses were compared using t-test and one-way ANOVA to compare age-sex categorical variables. The population size and abundance of geladas in the area was determined from total (direct) count. A total of 338 individual geladas were recorded with a density for the entire region of 0.071 geladas/km² and actual density specific for the home ranges was 6.22/km². Of this, males were 74, females 186 and juveniles 78. There was significant difference ($P < 0.05$) between males and females, males and juveniles and females and juveniles. Large number of infants indicates that the population is increasing. Geladas spent more time feeding (57.26 %). Other activities such as vocalization, defecation and looking at the observer were the least (2.33%) in their time budget. They depend on grass during the wet season (82.77%) but during the dry season, they fed on roots (38.71%) and leaves (38.5%) in larger proportion and almost in equivalent amount. There are significant differences ($P < 0.05$) on the type of food taken during the dry and wet seasons.

Key words: abundance, body size, distribution, extinction, Gelada baboon, habitat, human activities, juvenile.

1. INTRODUCTION

The goal of population ecology is to understand, predict, and explain the dynamics of biological populations (Akçakaya *et al.*, 1997). To achieve this goal, application of a population model to demographic data is required (Oli, 2003). The population status of different species of primates ranges from rare and endangered to abundant and relatively secure (Nowak *et al.*, 2008). Local populations are likely to be influenced by different kinds of human activities, such as intensive logging, hunting, tourism, recreation, motor traffic, and development of transportation networks (Nowak *et al.*, 2008). However, the distribution and numbers of most species are not known (Southwick and Siddiqi, 2005). The distribution and abundance of primates are determined by a complex set of historical, human and environmental factors.

Most primate populations today face ongoing habitat disturbance, but not all primate species respond to disturbance in the same way. While many primate species experience declines in population density when their habitats are disturbed, several primate species are not threatened and these species will generally require less conservation attention (Cowlshaw and Dunbar 2000).

It is estimated that only about 50,000-60,000 geladas remained in the wild and their numbers are thought to be declining (Dunbar, 1998). The highest density of geladas, and the only place where they are officially protected, occurs in the Simien Mountains National Park (SMNP) (Beehner *et al.*, 2007).

Accurate population estimates of geladas, as well as all of Ethiopia's endemic species, are important for several reasons. First, population estimates across time will determine whether numbers of a particular species are being maintained, in decline or in recovery. Second, establishing accurate numbers for each species is a first step for conservation and wildlife management policies. Third, as there have been increasingly more reports of human-gelada conflict particularly with respect to crop-raiding, it is important to determine whether or not the gelada population in different areas may be increasing beyond what the habitat can support (Beehner *et al.*, 2007).

Today, geladas occur only in few areas throughout the northern Ethiopian highlands, and one isolated population south of the Rift Valley in Arsi Province (Mori and Gurja Belay, 1990). The present study is to reveal essential ecological information on the population status, distribution and habitat association of Gelada baboons in Wollo, Azwa.

2. LITERATURE REVIEW

2.1 Ethiopia as home of endemism

In biogeography, an area of endemism is defined as the congruent distributional limits of two or more species (Platnick, 1991). Harold and Mooi (1994) define an area of endemism as a geographic region comprising the distributions of two or more monophyletic taxa that exhibit a phylogenetic and distributional congruence and having their respective relatives occurring in other defined regions.

Ethiopia is the land of dramatic natural contrasts. Altitude span the lowest point on the African continent as well as the fourth highest peak, while climatic conditions range from scorching arid barren area of the Somali-Kenyan border region to the wet slopes of the fertile southwest. The vegetation is consistent with the diverse habitat type that varies with topography. Arid desserts, drenched rainforest, Afro-alpine moorland and pretty landscape are the characteristics of the country's topography. The Ethiopian Highlands are distinguished from the rest of Africa by their vast extent of high ground (Yalden, 1983). They cover an area of some 519, 278 km² (Kingdon, 1989).

The Ethiopian highlands first began to lift 75 million years ago, pushed upwards by volcanic forces. The main dome was split into two halves, the northern and southern highlands, by the creation of the Great Rift Valley. Plants and animals from different directions then colonized these separate massifs. During the ice ages, the escarpments along the Red Sea provided a gateway for Palearctic species. The southern highlands were linked to the Horn of Africa by rift wall connections. Both the northern and southern highlands are adjacent to tropical Africa but the dry Kenyan desserts in the south and the Nile River flood plains in the west were significant obstacles for potential plant and animal immigrants. The ecoregion's biota shows both Palearctic and Afrotropical influences. Although, the highlands are biologically poor when compared to other Afromontane habitats, the lack of diversity in the Ethiopian highlands reflects their recent post-volcanic, post-glacial history. Though, a high rate of endemism is found in Ethiopia promoted by geographical isolation and the unique climate (Kingdon, 1989).

Some of the endemic mammals of Ethiopia are: the Ethiopian wolf (*Canis simensis*), Menelik's bushbuck (*Tragelaphus scriptus meneliki*), mountain Nyala (*Tragelaphus buxtoni*), Gelada baboon (*Theropithecus gelada*) and walia ibex (*Capra walie*). The Ethiopian highlands are homes for 31 endemic species of mammals out of 284 (Yalden, *et al.*, 1996).

2.2 Gelada baboon (*Theropithecus gelada*)

The Gelada baboon (*Theropithecus gelada*) is one of the most impressive primates. Although, it has been kept regularly, it has never been as popular or numerous in zoos as, for example, the Hamadryas baboon *Papio hamadryas* or the Mandrill *Mandrillus sphinx* (Blaszkewitz, 1987 as cited by Johann, 1998). Geladas prefer to sleep on rocky cliffs, from which they descend in the morning to go foraging in the nearby grasslands. Most of the gelada populations are found foraging in grasslands between 1500 and 4000 m altitude (Stammach, 1987).

Male gelada baboons weigh an average of 20.25 kg. Their bodies are 69 to 74 cm in length while their tails are 45 to 50 cm long. Female geladas are somewhat smaller than males. They weigh an average of 14.8 kg and 50 to 65 cm in body length and their tails are 30 to 41 cm long (Van Hooff, 1990). Members of both sexes have short rostrums and wide nostrils. They have short brown fur and both males and females have a hairless patch on their chests, usually triangular in shape, which is outlined by white hairs. Both sexes have pale eyelids which are used for expression. Males are marked by the presence of whiskers and a brown hairy mantle. The gelada is endemic to the Ethiopian highlands,

the Blue Nile Gorge and the upper Wabi-Shebeli Valley, which mark respectively the western and southeastern boundaries of their range (Woltheim, 1983).

2.2.1 Survivorship and mortality

Mortality among immature (infants) is highest. Among adults, the mortality rate is higher among males than among females. The life expectancy is about 12.3 years for males and 13.8 years for females. The Infant mortality at Sankaber is correlated with the number of wet season months in which infants undergo climatic severity due to harsh cold stress. Adult mortality was also highly seasonal, being greatest during the wet season months and least during the dry season months (Dunbar, 1980). The main cause of mortality was probably respiratory and other infections contracted during the climatically adverse wet season when the animals were subjected to constant soaking at temperature below 0⁰C. The other main cause of mortality was infestation by tape worm (*Multiceps servalis*) (Ohsawa, 1979).

The importance of climate as a determinant of mortality was confirmed by Ohsawa (1979) and Dunbar (1984b), who found that mortality among both immature and females was higher at higher altitude where the climate was extreme. Male mortality rate, however, correlates with the rate of harem take over, suggesting that the physiology stresses imposed on males by these social change might reduce the life expectancy of the older animals. But there was no evidence to suggest that food shortage was ever a cause of mortality (Dunbar, 1984b).

2.2.2 Fecundity

Geladas have low birth rate compared with other baboons and macaques. Females give birth for the first time at about 4 years of age and continue to produce offspring thereafter at an interval of approximately 2.14 years. Males are considered to be reproductively mature at 6 years of age (though they undergo puberty at the age of 3-4 years). Increasing climate severity with high altitude result in high rate of abortion due to cold stress (Dunbar 1980). Births are more synchronized within reproductive units than they are between units of the same or different band (s). Much higher degree of synchrony within individual harems of female must be attributed to social factors. Takeover of harem by males from all-male groups was identified as the primary cause of this synchrony (Dunbar 1980; Dunbar 1984a).

The birth rates of individual females are also influenced by two other factors, namely females' age and her dominance rank within the unit. The first one is probably a consequence for increasing ovulatory irregularity with age. Graham *et al.*, (1979) found a positive correlation between the number of offspring a female had and her dominance rank. Stress from repeated harassment by higher ranking females caused ovulatory failure in low ranking individuals.

Actual gene flow between bands occur as a result of only two processes: the migration of individual reproductive units from one band to another and the transfer of individual animals (usually males) between bands. Females were observed to migrate between bands as individual (only very rarely observed to move from one reproductive unit to another even within the same band) (Dunbar 1980, Ohsawa 1979). Females have

remained within their natal units together with their female relatives throughout their lives, whereas males first join an all-male group as juveniles or sub-adult and then later move back to a reproductive unit in different band.

2.2.3 Reproduction and mating system

Among monkey species for which sufficient information is available, a distinct birth season or birth peak is very common. Environment and seasons influence the mating systems of most primate species. Dominance hierarchy as a result of mating and food access is common among primates (Denham, 2001). Males compete to control over the reproductive units. This may acquire harems either by direct challenging the hegemony of another harem holder and taking over the entire unit or by entering a unit as a subordinate follower in order to build up an incipient unit with one or two of more peripheral females (Dunbar, 1984b).

Gelada baboons do not have a specific mating season, though it has been noted that the birth rate is higher during the rainy season. When a gelada female comes into estrus, a ring of red beading develops in the naked patch on her chest and her ano-genital region swells visibly. The estrus cycles of females within a group are fairly synchronized, as are births. This may be due to social influence through hormonal regulation (Kawai, 1979).

Gelada reproductive units are highly variable in size and composition. The typical reproductive unit contains a single breeding male and an average four reproductive females (1-10) together with their dependent young. A proportion of the units in each band contains additional adult male (i.e. followers) (Dunbar, 1984b).

Infanticide among primates was first observed in *Presbytis entellus* (Mori *et al.*, 1997). Its function was interpreted as to make mothers of infant victims come into estrus by killing the infants of the former leader. The genes for infanticide are understood to propagate through increasing reproductive success of the perpetrator male, depending on the theory of sexual selection against the cost for the females. Recently infanticide behaviour has been observed in gelada baboon in Arsi region. The birth interval of female gelada can be shortened after takeover of a unit by a new leader male (Mori *et al.*, 1997).

2.3 Reproductive unit and Band

Gelada baboons live in groups of one male with several females and their offspring. These groups are called one male units (OMUs). Traditionally the basic social unit of gelada is considered to be the one-male group (Crook, 1966), and this is the smallest grouping within the social system. These units, together with all male groups of bachelor males associate together into higher level groupings. Associated OMUs may travel in the same area making up a second level of organization called the band. OMUs have been known to travel with several different bands at different times or even alone, so membership within a band is not permanent. Geladas are not territorial and it is common to find congregations of separate bands grazing together wherever conditions are favourable. Outside of these social organizations are groups consisting entirely of males (Stammach, 1987). The two main components of the system are the individual reproductive units and the cluster of units (termed as bands) that share a common home range. The one male unit provides the context in which most social behaviour and all

reproductive activity takes place, whereas the band is the basic ecological unit (being precisely analogous to the *Papio hamandrias* band). The gelada band may also be the fundamental genetic units in that member of a given band and are genetically more homologous than members of different bands (Shotake, 1980; Gurja and Shotake 1998; Gurja and Mori, 2006).

Grooming is exhibited by all members of an OMU. Grooming between the females and males is very important to the social stability of the group. When OMUs grow beyond capacity, the male is unable to give grooming attention to all the females. When this happens, unity within the group is lost, leaving a number of females unattended and able to form new groups with males from roaming associated male units (AMUs) (Dunbar, 1978).

The females within an OMU are generally the true leaders of the group. If an outside male attempts to take over the group by supplanting the male using physical force, the females may choose to support or oppose either male. Regardless of who wins the fight between the two males, the females can chase the unwanted male from the group with their own show of physical force. Males that associate continuously with and have exclusively mating access to those females are termed harem-holders (or just harem males). Other adult males who associate regularly with a reproductive unit (but do not have access to the females) are termed as followers. Followers may be either young adult males or old males well past their prime (Dunbar and Dunbar, 1975) (Smuts, 1987).

Many primates appear to have mechanisms to cope with conflict within social groups. One such mechanism is reconciliation as non-agonistic contact between two opponents

shortly after a conflict. Reconciliation appears to restore relationships after they have been disrupted by a conflict (Swedell, 1997).

2.4 Social organization

The term 'social' indicates to do more than one individual together. But all aggregation of animals is not social. To be social, they must have some form of species specific communication pattern and stay together for individual relation and activity patterns. This keeps them together on the basis of reacting to each other (Tinbergen, 1965). Solitary pattern, believed to be present in most nocturnal prosimians, has generally been considered to be the most primitive of primate social systems. Several factors have been inferred to be responsible for a 'solitary' life style. These include nocturnality, small body size, insectivory and predation pressure. However, none of these explanations are satisfactory and it has been suggested that a combination of several factors may involve in determining social organization in primates (Muller *et al.*, 2007).

The behaviour of primates is adapted to their ecological and social environment (Maestriperi and Kappeler, 2001). Nowadays, the study of primates' social behaviour comes with new results which will give a clue about the evolution of human, based on various disciplines. For instance, scientists found that the beginning of morality in primate behaviour. Wade (2007) explains that after fights between two combatants, others would console the loser. This behaviour of primates has its implication for the evolution of human morality. Four kinds of behaviour; empathy (i.e. understanding of another's feeling), the ability to learn and follow social rules, reciprocity and peace making are the basis of sociality. Empathy quickly led to explore the conditions for

morality which is seen in humans also since social behaviours are the precursors of human morality.

2.4.1 Group management and anti-predator behaviour of gelada

Group management should be guided by the social structure of gelada groups in the wild. Females form the core of a social unit (harem). Numerous harem and bachelor groups can form bands of up to several hundred animals (Kawai, 1979; Dunbar, 1984c).

Anti-predator behaviour of gelada baboons has been observed to consist of simple flight (i.e. they run away to cliffs after becoming alarmed by potential predators). However, active anti-predator behaviour was observed in a recently found gelada population in Arsi. This population showed frequent active counter-attacks and severe mobbing at predators. Males fought domestic dogs on the plain and exhibited a systematic mobbing behaviour towards a leopard on the cliff face to chase it off. These active anti-predator behaviours are the first confirmed reports on gelada baboons and may provide a useful insight for the understanding of the process of evolutionary adaptation to highland habitats. Sleeping on the cliff face at night is also considered as a passive anti-predator behaviour because the site is too steep for predators. Few bands aggregate to form large temporary “multi-band” (i.e. up to several hundreds). This aggregation is also another passive anti-predator behaviour that enables them to detect while they are spreading in the plain for foraging (Iwamoto *et al.*, 1996). Details on predation of gelada baboons are not available in the literature. Possible predators of these animals include large carnivores and raptors (Kawai, 1979. Jablonski, 1993).

2.4.2 Vocal Communication of Gelada

Vocal communication system facilitates for increasing group size and levels of social bonding within primate social groups (Dunbar, 1993). Vocal communication can play a role in the evolution of social behaviour (McComb and Semple, 2005). Dunbar (2003) suggested that language originally evolved to service social relationships when primate groups became too large for grooming. Two-phase bark and rhythmic grunts are the typical examples of vocal communication (Estes and Wilson, 1992).

Generally, there are two vocal patterns: (1) contact calls, when one individual approaches for friendship and (2) aggressive and defensive calls like “wahoo” for inter or intra group aggression and when the predator is in the vicinity. Frequency of calling and the production of different vocalizations were related to social rank and to the age of the sender (Aich *et al.*, 1990).

2.4.3 Visual and tactile Communication of Gelada baboon

Postures and expressions are relatively undeveloped and usually associated with vocal signals (Harcourt, 1992). This includes social presenting, staring, staring with open mouth, head-bobbing, tension yawning and lipsmacking. Tactile communication includes social grooming, nose-to-nose greeting and social mounting (Chapais and Berman, 2004; Harcourt, 1992; Estes and Wilson, 1992).

2.4.4 Agnostic Behaviour

This type of behaviour is observed during dominance and defensive threat displays. During aggression, individuals take a measure to dominate or defend themselves against the intruder (Estes and Wilson, 1992).

2.4.5 All-male Group

Young males leave their natal units as juvenile or sub-adult to join or form all-male groups (Dunbar and Dunbar, 1975). All-male groups are more labile in their attachment to their natal bands and may spend a considerable proportion of their time wandering alone or attached to an adjacent band. Although the process whereby all-male groups are formed is poorly understood, Dunbar and Dunbar (1975) suggested that young males might become members of an all-male group either joining an existing group or by forming a new group through gradual intensification among male juvenile members per group. Coalitions are thought to be of particular importance in primate societies because they allow individuals to buffer themselves against many of the intrinsic costs of living in groups, especially when group size gets large (Dunbar, 1988; Harcourt 1992). These costs include direct competition for access to resources as well as indirect effects that arise from the fact that dominant female harassment seriously affect reproductive endocrinology and can lead to a reduced fertility for the subordinate (Smuts & Nicholson, 1989).

2.5 Distribution and population status

Population ecology deals with the number of animals that can be counted or estimated in natural populations. The scope of population ecology is best defined as the scientific

study of the distribution and abundance of animals and that distribution is merely another aspect of abundance (Andrewartha, 1971).

A majority of gelada baboon populations lives in Gich and Sankaber areas of the Semien Mountains National Park in Ethiopia. Its distribution is closely related to the escarpments and gorge systems of the Provinces of Tigre, Wollo, Shoa and Begemdir and a small population also inhabits the Wabi-Shebeli gorge (Yalden and Largen, 1992). This species prefers montane grasslands and shrublands between 1500 and 4000 m altitude, it also occurs in cultivated land, while it seldom enters forested areas (Crook and Blake, 1968; Dunbar, 1977b; Yalden and Largen, 1992; Iwamoto, 1993). Gelada baboons inhabit highland plain bordered by cliffs. But there are many factors that affect the population of gelada. Among them, habitat alteration including all types of habitat changes which are known or suspected to be influencing population and human predation such as hunting; killing of members of the species for different purposes are the major ones (Woltheim,1983).

Ludwig (1996) reports a population of 4000-7000 Geladas in the Simien National Park, which is lower than previously thought. Although, the species is currently classified as least concern (Gippoliti, 2008), habitat loss as a result of human population growth may affect the distribution of Geladas in the wild (Gippoliti, 2008).

2.6 Feeding habit

Gelada baboon is the only primate which has a specialized graminivorous diet. They feed in the grassland of the plain during the day time and spend nights on the cliff (Iwamoto *et al.*, 1996). Depending on the season, grass comprises more than 90% of the diet. Little is

known about the digestion and usage of crude fibre-rich food in Geladas (Iwamoto, 1993). However, Gelada baboons also have a highly specialized diet, comprising grass hay and fibre-rich vegetables. Gelada baboons prominently feed on grass (*Poaceae*). They also feed upon cultivated crops leading to conflict with the local human communities (Mesele *et al.*, 2008). Only Geladas which had access to grass diet survived over generations probably because these groups had the opportunity to eat the high-fibre foods provided for ungulates (Dunbar, 1977a; Kawai, 1979).

Gelada baboons are exclusively herbivorous, but their choice of food changes depending on seasonal availability. During the wet season (July and August), when green grass blades are abundant, they make up around 90% of the diet. In November, when the grasses have seeded, the seeds make up around 70% of their diet. During the dry season (January and February), around 60% of their food is grass rhizomes and around 25% grass blades (Dunbar, 1977a; Kawai, 1979). Geladas are also known to harvest leaves, roots, tubers, wood, bark or stems, seeds, grains and nuts, fruit, flowers other than grass throughout the year (Kawai, 1979; Jablonski, 1993).

Gelada baboons are highly specialized feeders. The opposability of their first two digits is the highest of all the catarrhine primates and allows them to pick grass blades individually so that they can sort good grass from bad grass during the dry season. It is also notable that their phalanges are short and robust, which allows them to dig efficiently for tubers when desired. These specializations allow gelada baboons to take advantage of grassland environments that other primates could not inhabit as successfully (Dunbar, 1977a).

2.6.1 Morphological specialization for Graminivory

The theropithecine as a group is characterized by small incisors and greatly enlarged molars (Szalay and Delson 1979; Jolly, 2001). Molar teeth are also hypsodont, the enamel layer being both deep and heavily ridged. These are adaptations to prolong the life of the tooth row as is the case with many other grazing mammals. They have the highest “opposability” index of the non-human primates (a measure of the extent to which thumb and index finger can be opposed) (Napier and Napier, 1967). This allows them to select green grass blades very skillfully from even the dried sward (Dunbar 1977a). Their relatively short, stubby fingers make it possible for them to dig for roots and bulbs more efficiently and rapidly than other monkeys. Typically, they feed in sitting position. Gelada often sit on their haunches rather than directly on the ground and use a unique shuffling way of walking when the distance to move to a new feeding site is very small (Warnham, 1980). This tendency to feeding in a sitting position may explain why gelada possesses a sexual skin on the chest as well as on the perineal (Dunbar, 1984c).

The amount of time spent feeding increases with altitude. This is a consequence of metabolic costs of maintaining body temperature increase as the ambient temperature declines with increasing altitude. The problem is compounded when foraging quality declines as altitude increases so that further time has to be devoted to feeding to offset the shortfall in the nutritional intake (Warnham, 1980).

2.7 Threats to primates

The heaviest impact on primates is likely to be human activities. Road construction and the expansion of cities followed by the rapid growth of economy in Asia (e.g. China and

Indonesia) create a difficult situation for the species to continue their its survival. At the same time, primates are also a food source in these areas (Hamada *et al.*, 2007). Clearing of forests for timber and agriculture is increasingly leaving primates in isolated small populations that face edge effects and genetic isolation leads to the risk of extinction (Hill *et al.*, 2001). Expansions of human habitation, destruction of habitat for agriculture and poaching have resulted in a sharp decline in the primate populations (Choudhury, 2001).

The change in the vegetation structure of land closer to protected areas may attract wild herbivores. Different types of food items are targeted by wild animals, from cereals to fruits and from vegetables to trees. (Mesele *et al.*, 2008). Within the Simien Mountains National Park, geladas are completely protected.

Increasingly, geladas come into contact with humans as local farmers expand their cultivation and livestock grazing to steep hillsides once inhabited only by wildlife. Additionally, due to their specialized diet, geladas are severely affected by soil erosion, drought and even global warming (Dunbar, 1998).

2.8 Economic Importance for Humans

The economic importance of gelada baboon has both negative and positive aspects.

Negative: As human populations in Ethiopia grow, city boundaries are expanding and get into the reserve or wild areas. Cultivated areas also increase by destroying the natural habitat. Gelada baboons have been blamed for raids on cultivated lands (Kawai, 1979; Jablonski, 1993).

Positive: Past records show that gelada baboons were hunted for food by farmers during the dry season (Jablonski, 1993).

2.9 Conservation Status

The conservation status of gelada baboons does not appear to be cause for concern at this point yet. It has listed as Least Concern in the Gippoliti (2008) Red Data Book as this species has a large range, remains abundant, and despite increasing threats there is no reason to believe that it has undergone any major range-wide decline that would warrant listing in a threatened category. Within Africa, geladas are permitted to be hunted, killed, or collected only on government authority, but only provided that it is in the national interest or for the purpose of science (Dunbar, 1993). Where geladas have been accused of raiding locally cultivated lands, they are shot by farmers (Kawai, 1979).

3. OBJECTIVES OF THE STUDY

3.1 General objective

The general objective of the study is to provide information on population status and distribution and ecology of gelada in Azwa, Wollo.

3.2 Specific Objectives

- To study the population status of Gelada baboon in the study area.
- To estimate the density of species.
- To determine their distribution.
- To identify factors that influence fecundity and mortality in the study area.
- To identify the problems faced by gelada baboons.

4. METHODS

4. 1 Study area

The study area is located in the Amhara Regional State of South Wollo Zone, 380 km north of Addis Ababa. The mountain of Azwa is an extension of Harego that exists between Dessie and Kombolcha. Azwa Mountain is the mountain to the side of Dessie as shown in Figure 1. The area is characterized by an altitude ranging from 2445 to 2720 m above sea level and dominated by grasses, shrubs and bushes.

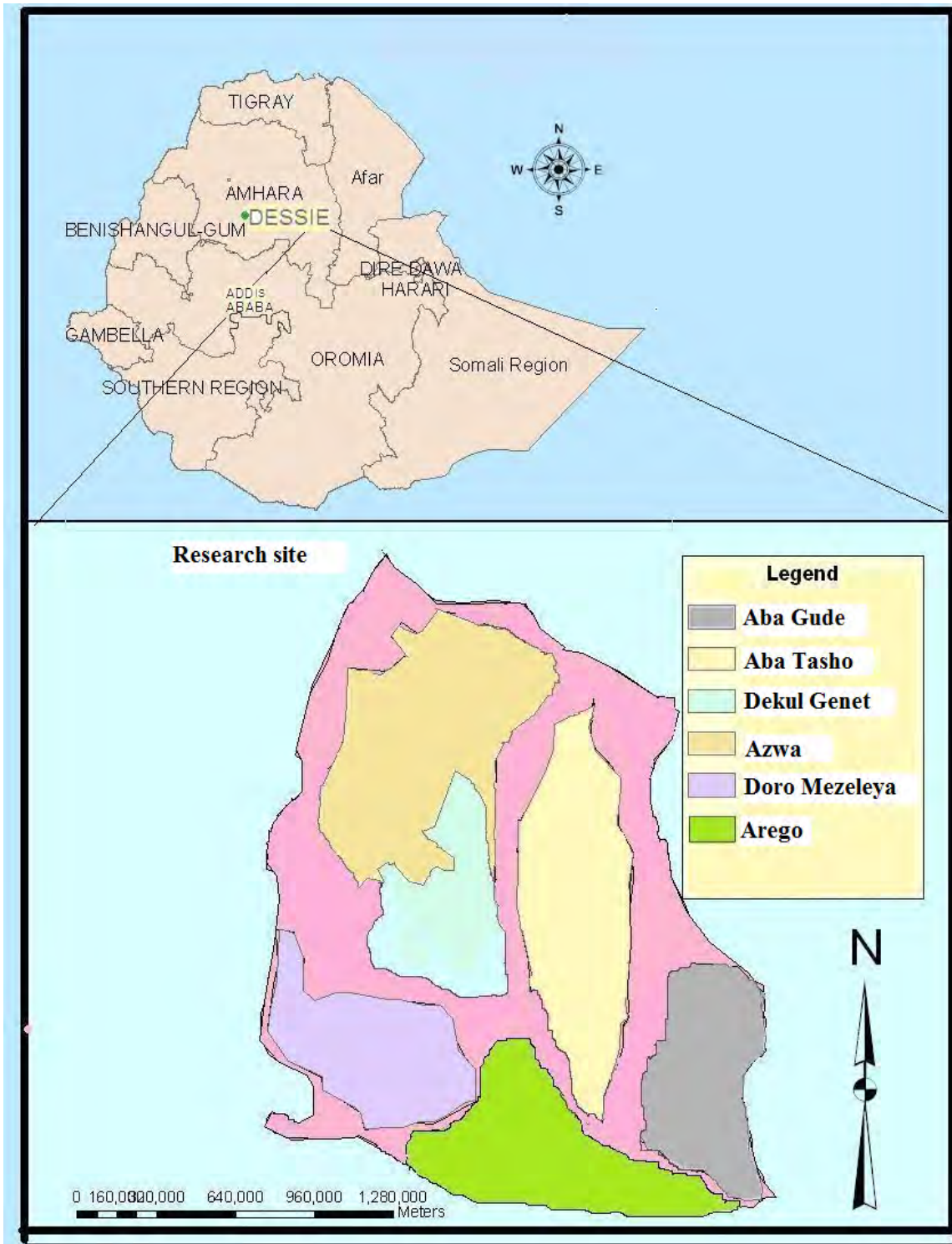


Figure 1. Map of the study areas

4.1.1 Climate

Mean annual rainfall of Dessie region is about 108.72 mm and it is characterized by “Woyina Dega” environmental condition. Data for temperature is not available in the Meteorological station and Agricultural desk.

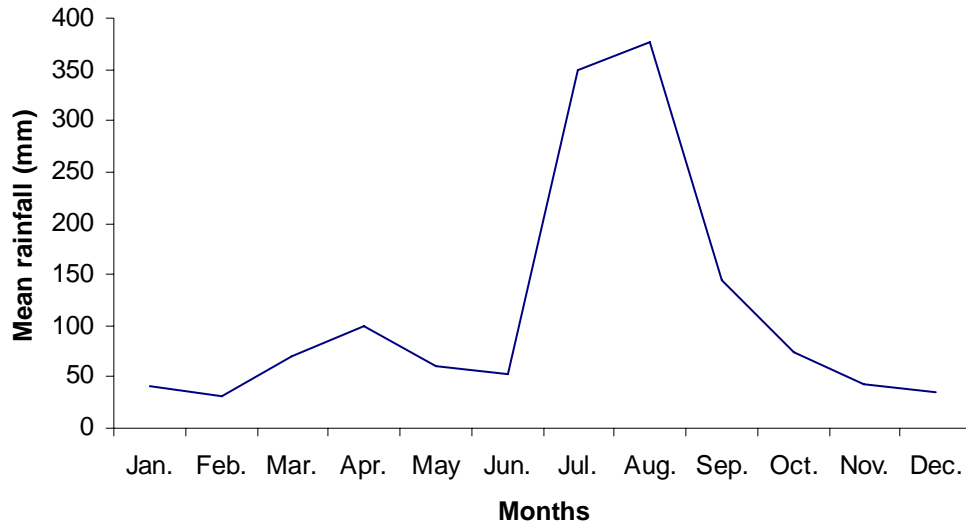


Figure 2. Mean annual seasonal rainfall of Dessie region (from 1996-2006) (Source; The Ethiopian Meteorological station).

4.2 Duration of the study

Primary observation was carried out during the first week of August 2008. During this period, information was gathered on the accessibility, climate, vegetation, fauna, topography, infrastructure and gelada baboon occupancy in the area. After the second week of August, field survey was conducted up to October, 2008 and from November, 2008 to March, 2009 to cover wet and dry seasons respectively.

4.3 Preliminary study and materials

Based on these reconnaissance surveys, the study areas were identified and habitat types were classified based on the elevation and dominant vegetation types. Organization and arrangement of the site and logistic support, hiring, assistances, purchasing field equipment, and layout of blocks were also carried out during this period. Materials used for this study were two pair of 10x42 bushnell binocular, a digital photographic camera, tape measure, compass and map showing the area.

4.4 Study sites

The study area was divided into five study sites (blocks) or census zones using area topography maps (scale 1:50,000). But the population for Dekul Genet and Azwa were recorded together since the two habitats are adjacent to each other and are not totally separated as shown in Figure 1. The boundary of the other study areas was traced based on the cliffy separation. In addition, habitat types were classified based on the dominant vegetation type they contain. These include census zone 1- Azwa and Dekule Genet with scattered trees, grass and bushes. Census zone 2- Aba Tasho characterized by bushes, shrubs and grass. Census zone 3- Aba Gude dominated by grass. Census zone 4- Doro Mezleya dominated by grass and census zone 5- Arego, dominated by bushes, shrubs, and grass. Azwa and Dikul Genet occupy the largest proportion. Aba Tasho, Arego, Aba Gude and Doro Mezeleya comprise from second to fifth in position, respectively as shown in Table 1.

Table 1. Area coverage of the five study zones and the proportion of each study area out of the whole study sites.

Census zone/habitat	Area (m ²)	Proportion	No. of blocks
Azwa and Dekul Genet	22,996 m ²	41.3%	2
Aba Tasho	19,825.37 m ²	19.3%	1
Arego	10,746.84 m ²	19.16%	1
Aba Gude	6,001.63 m ²	10.7%	1
Doro Mezeleya	4,246 m ²	9.57%	1

4.5 Sampling design

Total census was conducted from a suitable vantage point or while moving along the block. Any sign of the species left was recorded to identify their distribution. Any individual observed during the study period were recorded along with its age structure.

4.6 Habitat preference

Habitat preference of Gelada baboon was assessed *via* a combination of the five different habitat types for both dry and wet seasons. Dominant habitats that Gelada encountered were considered as habitat types in which baboons existed in large number (Crook & Blake, 1968).

4.7 Feeding ecology

Diet composition of gelada baboon was analyzed by faecal and direct observations (Dunbar, 1984b).

4.8 Population estimation

Total count was made to determine the population size of gelada baboon in the study area. This was determined by using ground survey techniques (Southwood and Henderson, 2000). Identifying the troop and counting the number of individuals form the basis for estimating the population density. The population density is calculated by the following formula.

$$\text{Density} = \frac{\text{Number of individuals in the area}}{\text{Total area}}$$

4.8.1 Population structure

Based on direct observation, individuals in the study sites were counted with in their social system (i.e. band or troop). The determination of age structure of Gelada baboon was based on physical size and developmental characteristics (Kawai *et al.*, 1983).

4.9 Total count

All gelada counts were conducted on the same day during morning hours (7:00–11:00 a.m.) to avoid double counting. A day training on the methodology of counting geladas was given to the local people that were involved in the direct count (Behner *et al.*, 2007). In each habitat, the population is recognized as a band. There is one band in each habitat type. The band is composed of groups (i.e. one male units and bachelor male units) and census was conducted along with age-sex categorical variables (Stammbach, 1987). Fixed-point count in which the observer remained at one point and records all primate groups was applied (National Research Council, 1981). Binocular was used for counting animals at distance and for identification of age and sex. Time of start and stop

for foraging activities and change of habitat were recorded. Basically census was conducted 10 times each session for each block.

Census was conducted based on the following age-sex categories: adult males, adult females, sub-adult males, sub-adult females and immatures (juveniles). Adult males were defined as males with visible manes and overall size about twice that of adult females. Sub-adult males were defined as males similar in size to adult females with early development of a mane. Adult and sub-adult females were estimated based on body size. All other individuals were considered as juvenile (Beehner *et al.*, 2007).

When gelada baboons were encountered, the observer recorded the time, group size and habitat type where the group was spotted (Fashing and Cords, 2000). Censuses were conducted on foot by the researcher and together with villagers who are familiar with the area (Branch, 1983).

4.10 Day Journey Length and home range

The length of day journey range and home range was calculated by allocating the initial and final foraging areas which the baboons covered in their diurnal activities for both seasons (Sharman and Dunbar, 1982).

4.11 Activity time budget

Scan sampling was used to collect behavioural data as described by Altmann (1974). The method involved observation of multiple group members. Activity types and dietary data were collected from two selected and partially habituated neighbouring study troops of baboons, Group A and Group B, on an average of 14-17 days per month from August

2008 to March 2009. A total of 7079 individual behavioural observations were recorded from 3000 group scan. The focal groups were identified by the natural marking, size, coat colour and facial features of some distinctive members of each of these groups.

The behaviour of gelada is investigated by approaching the individual to about 100-150 m with binocular to observe their activities and food items that they consume. During the study, the activities of individual baboons were recorded based on scan samples taken at 20 minutes interval from 06:30- 12:30 in the morning to 14:00-18:30 in the after noon (Dunbar, 1984c). The first dominant activity that lasted for 5 minutes duration was recorded.

5. RESULTS

5.1 Reconnaissance survey

During the wet season *Guniperus procera* and *G. equiptus* trees predominate on the top of the Azwa Mountain. Different fruiting plants including *cactus* also inhabit the area. Gelada baboons are seen 1km away from the water fall. A lot of people come to the study area to keep their personal hygiene by spring water. Gelada baboon move away from humans up to a minimum distance of 100 m. Dominant plants that exist in the area are shown in Table 2. Geladas are also seen closely in the local waste disposal area. They existed closely in the waste disposal zone, Doro Mezelaya as shown in Figure 3.

Table 2. Dominant plants in the study area.

Local names	Scientific names
Dedeho	<i>Euclea racemosa</i>
Ketketa	<i>Dedonaea viscosa</i>
Embacho	<i>Rumex nervosus vahl.</i>
Kentaf	<i>Entada abyssinica</i>
Kakema	<i>Rhus natalensis</i>
Embes	<i>Allophylus abyssinicus</i>
Agam	<i>Carissa spinarum</i>
Kulkual	<i>Opuntia ficus indica</i>

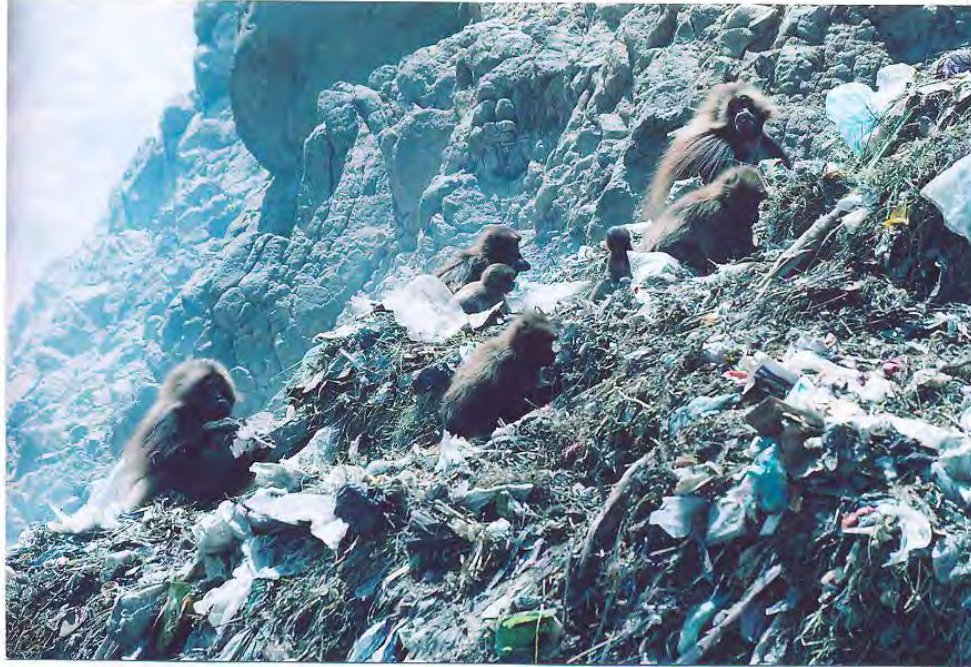


Figure 3. Gelada baboons at the waste disposal site.

At the waste disposal site, they were feeding on debris of vegetable remnants including lettuce, onion, banana, mango, papaya, avocado and meat. The baboons devote their time in search of these food remnants. They live peacefully with domestic animals of the local people in Doro Mezeleya as shown in Figure 4. They peacefully share resources with dogs without showing aggressive behaviour. In the grazing fields, they share resources with goats and sheep. At Azwa, there is deforestation and exploitation of natural resources. Soil erosion, basically gully erosion, threatens the habitat. The area is highly threatened by human settlement in all directions. Human-wild life conflict is the problem of the area. Since the baboon inhabits the cliffy and rocky area, it is not convenient for agricultural activities. But there is a flat plot at the top of the mountain where people began to settle on the top of the mountain by destroying the habitats of the baboons.



Figure 4. Domestic animals (goats and dog) in the study area sharing resources with gelada.

5.2 Group size

Gelada baboons in the study area live in group. The troop consists of 13.5 individuals in the average. In the study area, up to 9 males form male coalition. OMU mostly consists of one male, up to eight adult females and their offspring.

5.3 Activity time budget

The size of Group A was between 6-10 and Group B was between 7-12. Each group contains a single adult male and they exhibit one male multi-female social organization. Their diurnal activities analyzed in terms of activity time budget and evaluated as shown in Table 3.

Table 3. Activity time budget of Gelada baboon in Azwa and Aba Tasho

Activity recorded	Time spent in each activity (%)
Feeding	57.26 ± 0.21
Moving	17.61 ± 0.78
Social	14.27 ± 0.67
Resting	4.31 ± 0.54
Scratching	4.17 ± 0.56
Other	2.33

Other activities include vocalization, defecation and looking at the observer. During the wet season, feeding time is greater than the dry season. But the difference is not statistically significant ($P > 0.05$). During the dry season, geladas spent more time for moving and resting than the wet season. They also spent more time engaged in social activity during the dry season than the wet season as shown in Figure 5 though, the difference for all activities are not statistically significant for both seasons ($P > 0.05$).

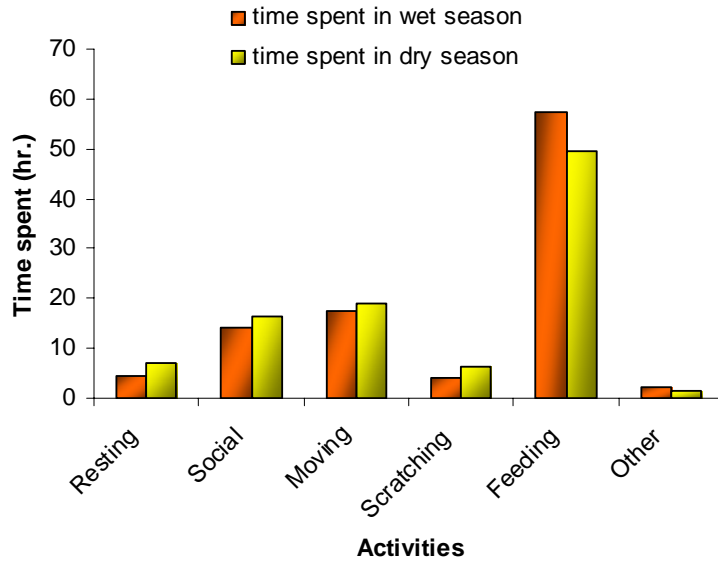


Figure 5. Seasonal activity time budget comparisons for both dry and wet seasons in Azwa and Aba Tasho.

Feeding time of gelada baboon varied across months ranging from 42.15% during February to 65.39% during September. Moving ranged from 14.51% (September) to 19.79% (December) and resting ranged from 3.4 % (September) to 6.34% (January). Social activity ranged from 10.98% (September) to 16.45% (February). Other activities were the highest during September (4.2%) and the lowest during February (0.56%).

5.4 Feeding ecology

Diet composition:

Two combined study groups were analyzed for a total of 7079 feeding behavioural records. Gelada baboons have a variety of food resources that is important for overcoming harsh condition. During the wet season, the feeding habit covered nearly 83% grass, 7.56% leaves, 4.62% fruits, 3.78 % roots and 1.26% flowers (Fig. 6). Faecal

analysis showed that gelada baboon is dependent on grasses and fruits during the wet season.

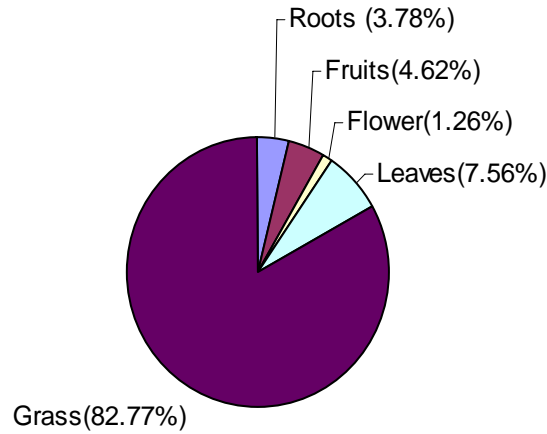


Figure 6. Proportion of food intake during the wet season.

Unlike the wet season, roots and leaves are taken in larger and equal proportion during the dry season. Since there is no sufficient grass, baboons fed on the roots of dried grass and leaves of perennial plants in larger proportion which is statistically significant ($P < 0.05$) (Fig. 7).

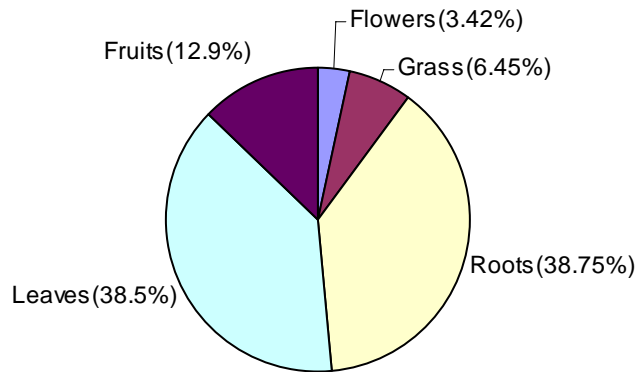


Figure 7. Proportion food intake during dry season

In Azwa, grasses, bushes and shrubs are dominant. Some of these shrubs and bushes are fruiting plants which are additional food resources other than grasses. During dry season, they feed on leaves and roots 38.5 and 38.71%, respectively. Fruits (12.9%) and flowers (3.42%) constitute the fourth and fifth proportions to the overall diet composition respectively. Figure 8 shows diet proportion in the wet and dry seasons.

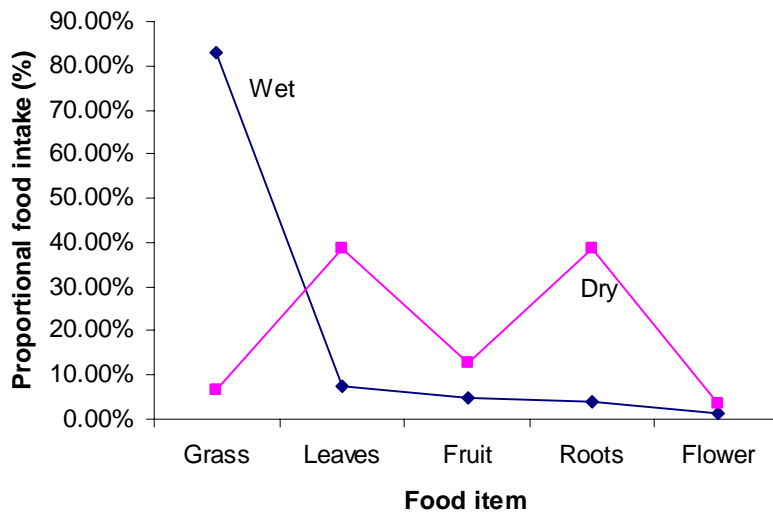


Figure 8. Seasonal feeding behaviour of Gelada baboon at Azwa and Arego regions.

Even though their preferred food is grass, during the dry season they are forced to feed on young leaves and roots of dried grasses. They also feed on fruits and flowers more than the wet season. The seasonal difference in consumption of fruit Feeding is statistically significant ($P < 0.05$) but feeding flowers ($P > 0.05$) is not significant but not for flowers.

5.5 Population size and structure

There were significant differences ($P < 0.05$) on the number of individuals across the study areas (Table 4). Sub-adult males were the least abundant. Generally, sex ratio was significantly different in favour of females.

Table 4. Group and band Size of gelada baboons at the five study sites.

No. of observation site	Study site	Band size	Unit
1	Aba Gude	47	Group 1= 14 Group 2= 10 Group 3= 12 Group 4= 11
2	Azwa and Dikul Genet	62	Group 1= 9 Group 2= 9 Group 3= 12 Group 4= 12 Group 5= 9 Group 6= 11
3	Aba Tasho	72	Group 1= 14 Group 2= 17 Group 3= 11 Group 4= 15 Group 5= 15
4	Doro Mezeleya	78	Group 1= 13 Group 2= 16 Group 3= 20 Group 4= 18 Group 5= 11
5	Aregu	79	Group 1= 15 Group 2= 21 Group 3= 16 Group 4= 14 Group 5= 13

Based on the eight months period of study, the population size of Gelada baboon was 338. The population density for the entire 4910.77 km² area of the region was 0.068/km² while the actual density of the baboon based on their area of home range was 6.14/ha. The population size of gelada baboon across age and sex categories is as shown in Table 5. Figure 9 shows the comparison for the five study areas during the eight months period.

Table 5. Population size of the five study sites across age and sex categories during the eight months of study period.

Age structure	Aba Gude	Azwa and Dikul Genet	Aba Tasho	Doro Mezeleya	Arego
Group 1					
Adult male	1	1	1	1	1
Adult female	4	5	6	4	6
Sub-adult male	2	-	-	1	2
Sub-adult female	3	1	3	3	3
Juvenile	4	2	4	4	3
Group 2					
Adult male	2	1	3	3	1
Adult female	4	3	6	5	7
Sub-adult male	-	-	1	-	4
Sub-adult female	1	2	3	3	5
Juvenile	3	3	4	5	4
Group 3					
Adult male	2	2	2	3	9
Adult female	4	4	4	7	-
Sub-adult male	1	2	-	1	2
Sub-adult female	2	2	3	4	5
Juvenile	3	2	2	5	-
Group 4					
Adult male	1	3	1	2	1
Adult female	6	3	5	7	6
Sub-adult male	-	1	2	2	-
Sub-adult female	-	3	3	3	4
Juvenile	4	2	4	4	3

Table cont...

Group 5					
Adult male	-	1	4	3	1
Adult female	-	4	3	3	8
Sub-adult male	-	-	2	-	-
Sub-adult female	-	2	3	2	2
Juvenile	-	2	3	3	2
Group 6					
Adult male	-	1	-	-	-
Adult female	-	5	-	-	-
Sub-adult male	-	-	-	-	-
Sub-adult female	-	2	-	-	-
Juvenile	-	3	-	-	-

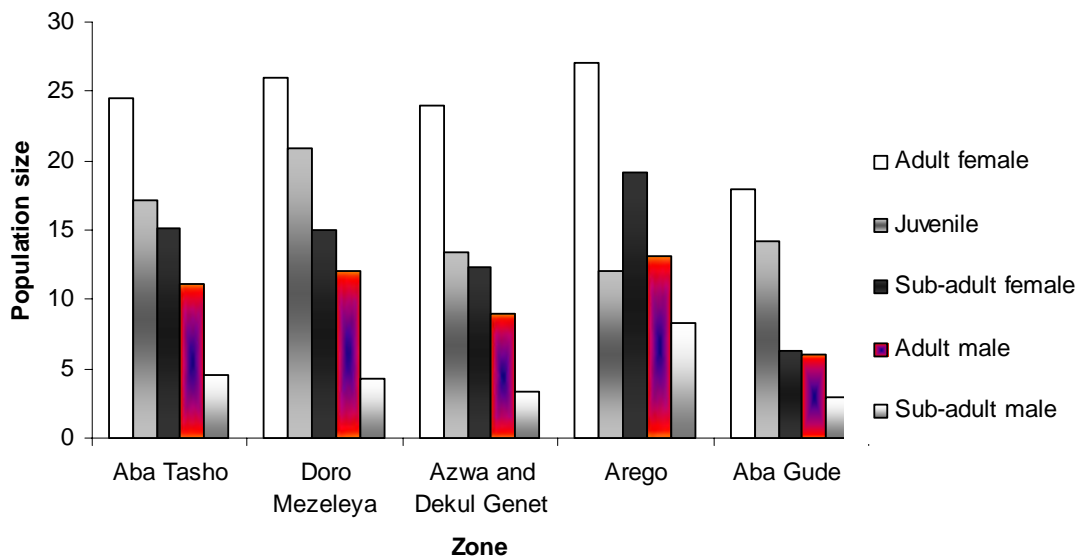


Figure 9. Comparison on the population size of five study sites with the age structure.

Except Aba Tasho-Arego and Doro Mezeleya-Arego habitat pairs, the rest habitat pair comparisons shows that there are significant differences in age and sex ratio. Across all habitats, the proportion of males (i.e. adults and sub adults) was small. Across months there is no significant difference on the population structure of Gelada baboons with respect to age and sex for all study blocks. The population size in each study area is

shown in Figure 10. For both seasons, the baboons were resident in their habitats. Though, some bands migrate from one habitat to another, the majority of the population remains in their habitats.

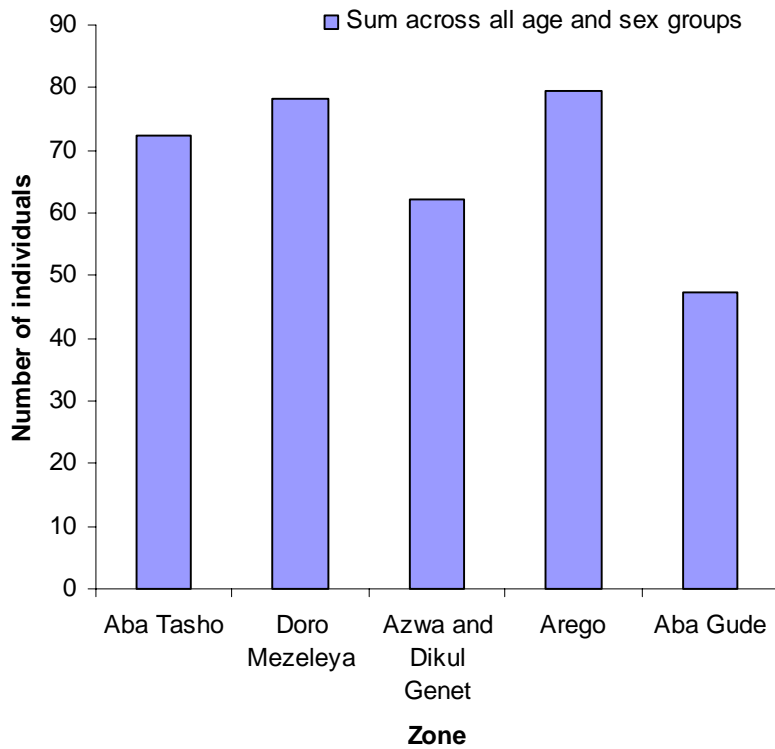


Figure 10. Comparison of Gelada population in different zones.

Except Aba Gude, the other study zones did not show significant differences ($P > 0.05$) in population size during the eight months of study periods. The population size for both seasons in the study zones are shown in Figure 11.

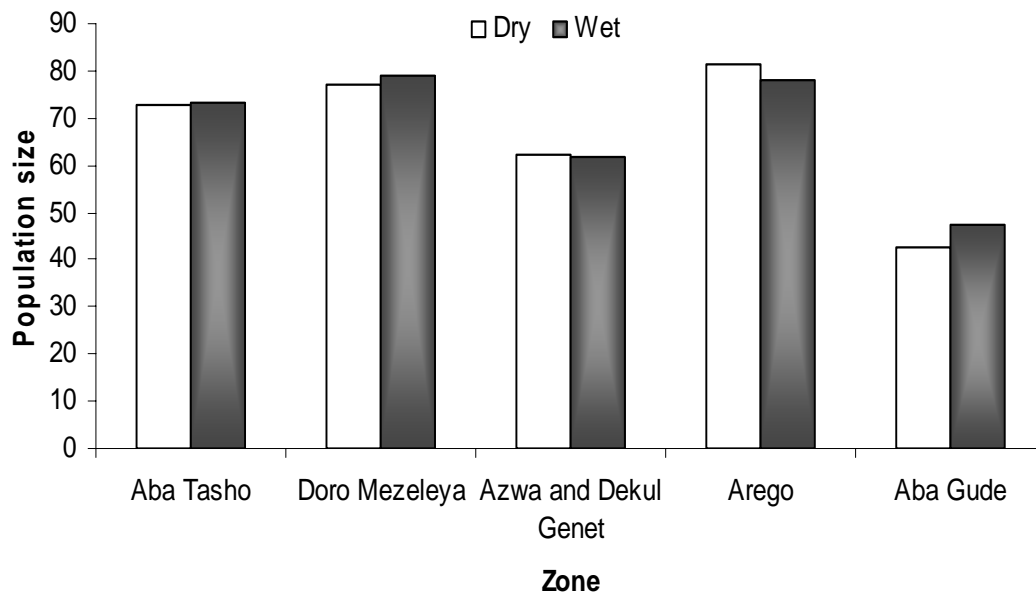


Figure 11. Population size of wet and dry season for the five zones.

The age-sex category for both seasons is shown in Figure 12.

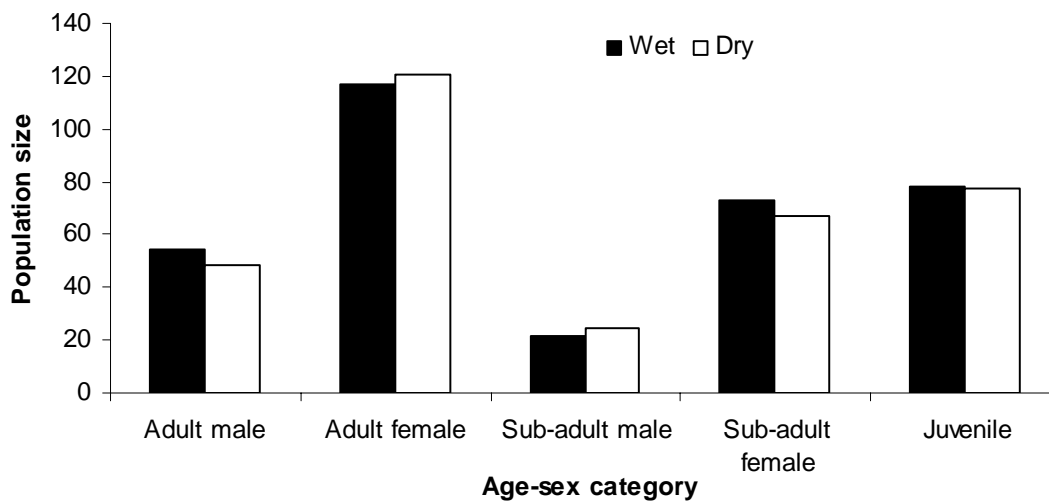


Figure 12. Comparison of age-sex category for dry and wet season.

During the dry season, adult female and sub-adult male were in larger proportion. During the wet season, adult male, sub-adult female and juveniles increased in number. But

between dry and wet seasons, there was no significant difference ($P>0.05$) across age-sex categories. Male-female, male-juvenile and female-juvenile pair wise comparisons show significant difference ($P<0.05$) as shown in Table 6.

Table 6. Test statistics for age and sex, male and female, male and Juvenile, and female and Juvenile categories for the over all population size.

Type	t	df.	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Male and female	6.154	9	0.000	26.193	16.56	35.82
Male and juvenile	12.24	9	0.000	15.22	12.41	18.03
Female and juvenile	6.44	9	0.000	26.51	17.21	35.81

In Aba tasho and Azwa, sub adult female and Juvenile had no significant difference. But the rest pair wise comparisons have significant differences. In Doro Mezeleya and Aba Gude, except sub-adult female and adult male, the rest pair wise comparison showed significant difference. Whereas in Arego, adult male and juvenile, sub-adult male and juvenile had no significant differences. The rest pair wise comparisons were statistically significant (i.e. $P<0.05$) as shown in appendix vi.

5.6 Distribution

Geladas are not evenly distributed across habitats. Their distribution is based on the availability of food and the distance from humans. Bushes and shrubs also provide shelter for geladas. Strategically, they are distributed in open cliffy grassland as shown in Figure

13. In the cliff Azwa, the baboons are distantly apart from each other for positioning since trees and bushes will limit their vision.



Figure 13. Gelada baboon at the open cliff grassland during the dry season.

5.7 Daily range length and home range

The average daily range length for the eight months of study periods was 3796 m in the (ranging from 2960 m during wet to 4536 m during dry). There is significant difference ($P < 0.05$) in daily range length and for the wet and dry seasons. The average home range for the wet and dry seasons was $41.3 \text{ km}^2 \pm 0.355$ and $70.88 \text{ km}^2 \pm 0.513$ respectively.

6. HUMAN-GELADA CONFLICT

Questionnaire data were obtained from 50 farmers. Seventy percent of the farmers were victims of Gelada during crop harvesting. Geladas feed on all crops that the farmers planted including teff, maize, sorghum, barely and wheat. Thirty percent of the farmers are threatened by grivet monkey and anubis baboon as shown in Table 7. Grivet monkeys feed on carrot, raddish, lettuce and potato plantations.

Table 7. Percentage comparison of crop damage by gelada baboon, grivet monkey and anubis baboon.

Animal	Type of crop damage (%)					Total No. of farmers	Percentage
	Maize	Sorghum	Barely	Wheat	Teff		
Gelada baboon	40%	27%	13%	11%	9%	35	70%
Grivet monkey	34%	39%	7%	10%	10%	9	18%
Anubis baboon	6%	52%	31%	7%	4%	6	12%

The farmers protect their crops and vegetables by chasing away the baboons. Sometimes they put traps to kill them. The Regional Agricultural desk did not take any action for the conservation or for the well being of farmers. Expansion of agriculture to the hill side of Gelada habitat (Fig. 14) creates difficulty for the continuity of the species in the future.



Figure 14. The expansion of agriculture to the hill side of gelada habitat at Azwa region.

7. DISCUSSION

7.1 Group size

The group sizes considerably vary across and within the habitats. The availability of food and the distance in which the baboons occur away from human settlement areas determine the group size in the study area. When food is abundant as observed in Doro Mezeleya, the group size is relatively larger. When they are far from human settlements as observed in Aba Gude, the group size is smaller compared to other habitats. Dunbar (1992) also found that bands at disturbed habitats are larger than the remote areas.

7.2 Activity budget

Gelada baboons spent much time in feeding. As grazing herbivores, the problem of undigested cellulose is compensated by feeding large amount of grass (Ohsawa, 1979). When they feed, they do not forage in one place for long time rather they move from one place to another. This is an important adaptation for the sustainability and keeping the area to regenerate after some days. Therefore, moving takes the second position in their daily activity patterns. But feeding time was highest during September (wet season) in which resource is abundant and lowest during February (dry season). During the dry season, due to the shortage of food, the baboons cover a greater distance in search of their food. Dunbar (1984c) also obtained similar results on activity time budget. But, scratching their body, grouped as activity time budget indicates that the baboons are living with a considerable amount of ectoparasites. They use both forelimbs and hindlimbs for scratching their body.

7.3 Feeding ecology

Theropithecus gelada feeds on a variety of food resources that is important for overcoming harsh environmental conditions. Faecal analysis during the wet season showed that gelada baboons are dependent on grass and fruits. This indicates that geladas shift their feeding strategies to tolerate the harsh dry season. They predominantly feed grasses if available as reported by Iwamoto (1993).

7.4 Population status and structure

There was a considerably high infant population showing that the population is increasing (Beehner *et al.*, 2007). The population favour females more than males since females are in larger proportion. Ohsawa (1979) in Gich plateau recorded 325 geladas. A total of 338 geladas counted in the Azwa and Arego is comparable with the population at Gich plateau. Ohsawa (1979) and Dunbar 1980 found that at Sankaber, infant and adult mortality was correlated with the number of wet seasons due to harsh cold stress. But adult and infant population at Azwa and Arego regions for both seasons did not show significant difference.

The ratio of age and sex is consistent with the result that is observed by Beehner *et al.* (2007) at Simen Mountain National Park. Adult male and sub adult male, adult male and juvenile, juvenile and sub-adult male are not significantly different in their abundance. The possible reason for such unusual population structure could be a considerable amount of male coalition that have migrated from the rest of four habitats into Arego since the area is not preferred by adult dominant male baboons.

7.5 Distribution

Gelada baboons prefer the open grassland habitats (Dunbar, 1984a). This area is helpful to safeguard themselves since gelada baboons will take a measure to avoid from predators by visual communications. This mean that rather than hearing and smelling, they have well developed vision that informs them the presence of other species (Dunbar, 1984b). In the cliff Azwa, the baboons are distantly apart from each other for positioning since trees and bushes will limit their vision. When one group observes the presence of another species, they communicate with each other by vocal and physical expression. Geladas daily range length is greater during the dry season. Iwamoto (1993) revealed that due to the shortage of food resources, baboons move greater distance in search of their food during the dry season.

The distribution of Gelada baboon for both wet and dry seasons did not show change. The possible reasons are: a) five of the habitats are similar in their vegetation cover except Azwa and Dikul Genet and b) for both seasons, four of the habitats have the same quality in terms of the availability of food and the baboons did not have to go far and waste their energy for the sake of food. During the wet season, food is abundant and there is no need to leave their habitats. But, at the time of difficulty, during the dry season, the baboons were expected to move from habitats to habitats in search of food. But this did not happen, because geladas shift their feeding habit from grass to roots and evergreen plant leaves. Thus, adaptation will help Geladas to cope up with the harsh dry season in their habitats. Although Azwa and Dikul Genet have grass beneath trees and shrubs during the dry season, the habitat is not preferable to stay the whole dry season.

Strategically, scattered trees and bushes are not preferred habitats by gelada baboon because the primary sense of the species is to detect the presence or absence of predator or danger by vision (Dunbar, 1984b). Habitats with trees and bushes create difficult situations to detect or run from predators.

7.6 Daily range length and home range

Day journey length and home range is a linear function of band size in the five study areas, indicating that an animal has to cover with more or less constant area each day to obtain nutritional requirements (Waser 1977, Sharman and Dunbar 1982). As altitude increases, the animals search proportionally less field to find the same quantity of grass to harvest. The metabolic, ecological and demographic factors interact to influence the distance that animals must cover during the day. In general, the bigger the group, the longer the day journey and home range. The longer the day journey, the greater the time that has to be devoted to moving, which will, in turn, place further constraints on the animals time budget. The only way in which the time budget can be adjusted while conserving social time is to reduce the band size in order to reduce the distance that has to be covered each day. There are some evidences that suggest bands at higher altitude are smaller than those at the lower altitude (Dunbar, 1984a). Bands at Azwa and Dikul Genet (i.e. higher altitude) are smaller than the other study areas which are nearly at the same elevation.

8. CONCLUSION AND RECOMMENDATIONS

The Ethiopian highlands are confounded with endemism which is a result of adaptation towards high altitude and isolation from currently mixed population (Kingdon,1989). The landscapes of Wollo typically Azwa and Arego regions are also part of this endowment by being the homes for an endemic primate, *Theropithecus gelada*. Data obtained from wet and dry seasons have inferences about the dynamics of ecological and demographic variables.

Gelada baboons inhabit cliffy open grassland of Azwa regions than closed canopy of Arego. Gelada baboon shows a considerable difference in its group composition. But, they also exist at the border area of both Arego and Azwa. The city council waste disposal site was inside the study area (Doro Mezeleya). Vegetable remnants are food sources for geladas and they stay at disposal site unusually longer time without searching their food in other locations. Hence, Geladas can be exposed to epidemics spread from human through contaminated food. For the other study areas, the baboons behaviour was natural and searching their food by moving from one area to the other. Studies on the population status and distribution of this species will help for further studies on various ecological and evolutionary adaptations.

The area is convenient for investors to generate income by constructing recreation centers with complete facilities for watching wildlife. Through developing the habit of wildlife watching, it is possible to create awareness for successful conservation.

At present, the habitats of gelada are restricted from all directions. Road construction, city and agricultural expansion threaten the habitat.

Therefore the following points are recommended:

- The city council should take an action to prohibit the expansion of human settlements.

- Translocating farmers to other area is among the possible solutions for the current problems of the study area.

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APPENDIX I

Total (direct) count data sheet

Name of data collector _____ Survey site _____

Season _____ Longitude end
(x) _____

Latitude beginning(Y) _____ Longitude beginning (x) _____ Latitude
end(x) _____

No. of observ.	Time	Habitat	Estimated animal distance	Total No.	Age/ sex category					Others Animals	comment
					Sub-adult male	Sub-adult female	Adult male	Adult female	Juvenile		
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											

APPENDIX II

Daily activity pattern record sheet

Social organization		Time (min.)	Movement a) walking b) running	Resting a)standing b)sleeping	Social behaviour/5min a) grooming b)communicating c) fighting d) defending	Reprod. behaviour a)rutting b)sniffing c)mating d)pregnancy	Remark/ association	
Group size	Group Composition							
	age							sex
	a)adult b)sub- adult c)juvenile d) male	d)male e)female f)unknown						
	a) b) c)	d) e) f)	a) b)	a) b)	a) b) c) d)	a) b) c) d)		
	a) b) c)	d) e) f)	a) b)	a) b)	a) b) c) d)	a) b) c) d)		
	a) b) c)	d) e) f)	a) b)	a) b)	a) b) c) d)	a) b) c) d)		
	a) b) c)	d) e) f)	a) b)	a) b)	a) b) c) d)	a) b) c) d)		
	a) b) c)	d) e) f)	a) b)	a) b)	a) b) c) d)	a) b) c) d)		

APPENDIX III

Feeding activity data sheet for both dry and wet seasons

No. of obser.	Dry food items					Wet food items				
	Grass	Leaves	Root	Fruit	Flower	Grass	Leaves	Root	Fruit	Flower
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

APPENDIX IV

Daily travel distance data sheet

Seasons	Group	Daily travel distance	Home range (ha)
Wet	A		
	B		
	A		
	B		
	A		
	B		
Dry	A		
	B		
	A		
	B		
	A		
	B		

APPENDIX V

Farmers' questionnaire

A. Introductory questions

1. Respondent number.....
2. Age.....
3. Sex.....
4. Residence
 - a. Kebele.....
 - b. Village.....
 - c. Woreda.....
 - d. Distance from the study area.....
5. Marital status.....
6. Family size.....
7. Educational level (for family members)
 - a. No formal education.....
 - b. Primary education.....
 - c. Secondary education.....
 - d. Beyond secondary education.....

B. Household Economy and Resource Use

8. What is the size of your farmland?
.....
9. What type of crop did you grow?
 - a.
 - b.
 - c.
 - d.
10. How much did you get last year?.....

11. Do you keep livestock? If yes

- a. Number of cattle.....
- b. Number of sheep and goat.....
- c. Number of pack animals.....

12 Where do they graze?

- a. In the study area.....
- b. Others.....

13. Do you have a private grazing land? Yes/No

- a. If yes, what is the size of your private grazing land?.....
- b. How many months do they graze in your grazing land?.....
- c. How many months do they graze in the study area?.....

14. Do you have private wood plot? Yes/No

- a. If yes, what is the size of your private wood plot?

15. Where do you collect your fire wood?

- a. From the study area
- b. Other area

16. What do you collect as firewood?.....

C. Conflict and Damage

17. The type of wildlife that you know in the area.....

18. Do you think conserving wildlife is important?

.....
19. What kind of problems do you face because of wildlife?

- a. Crop damage.....
- b. Predation.....
- c. Disease transmission.....
- d. Others.....

20. Have you lost any livestock to wildlife? Yes/ No

- a. If yes, How many?
- b. What is the species involved?

21. Which animal are the most problematic in terms of livestock predation

	predator	prey	Extent (Number killed)		
			Last year	In the last 5 years	In the last 10 years
1					
2					
3					

22. Which animals are most problematic in terms of crop damage?

number	Animal type	type of damaged crop	Extent of damage (last year)
1			
2			
3			

23. Is the damage increasing or decreasing?

24. How do you minimize the damage?

25. Do you get help from other sources to solve your problem?

Yes.....

No.....

26. If yes, from where do you get the help?

27. What is the tendency of the crop damage from time to time?

a. Increasing.....

b. Decreasing.....

28. At what time is the problem of crop damage more severe? (Specify the month)

29. At what stage do gelada baboons attack your crops most?

Stages	Crop				
	bean	barely	wheat	pea	others
planting					
seedling					
vegetative					
harvesting					

30. Describe the different techniques you use to control (minimize) the damage caused by gelada baboon.

- i.....
- ii.....
- iii.....

31. Which of these techniques are

- a. Most effective.....
- b. Least effective.....

32. What measure do you think should be taken by the following in order to prevent the damage?

a. By the government

.....
.....
.....

b. By the private sector

.....
.....
.....

c. By the farmers

.....
.....
.....

APPENDEX VI

Multiple Comparisons

Scheffe

Dependent Variable	(I) Age category	(J) Age category	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Aba Tasho	Adt. male	Adt. Female	-12.9438*	.99651	.000	-16.1829	-9.7046
		Sub male	7.0062*	.99651	.000	3.7671	10.2454
		Sub adt. female	-3.5200*	.99651	.027	-6.7592	-.2808
		Juvenile	-5.5400*	.99651	.000	-8.7792	-2.3008
	Adt. female	Adt. Male	12.9438*	.99651	.000	9.7046	16.1829
		Sub male	19.9500*	.99651	.000	16.7108	23.1892
		Sub adt. female	9.4238*	.99651	.000	6.1846	12.6629
		Juvenile	7.4037*	.99651	.000	4.1646	10.6429
	Sub adt. male	Adt. Male	-7.0062*	.99651	.000	-10.2454	-3.7671
		Adt. Female	-19.9500*	.99651	.000	-23.1892	-16.7108
		Sub adt. female	-10.5262*	.99651	.000	-13.7654	-7.2871
		Juvenile	-12.5463*	.99651	.000	-15.7854	-9.3071
	Sub adt. female	Adt. Male	3.5200*	.99651	.027	.2808	6.7592
		Adt. Female	-9.4238*	.99651	.000	-12.6629	-6.1846
		Sub male	10.5262*	.99651	.000	7.2871	13.7654
		Juvenile	-2.0200	.99651	.407	-5.2592	1.2192
	Juvenile	Adt. Male	5.5400*	.99651	.000	2.3008	8.7792
		Adt. Female	-7.4037*	.99651	.000	-10.6429	-4.1646
		Sub male	12.5463*	.99651	.000	9.3071	15.7854
		Sub adt. female	2.0200	.99651	.407	-1.2192	5.2592
Doro Mezeleya	Adt. male	Adt. Female	-12.3150*	1.01977	.000	-15.6298	-9.0002
		Sub male	9.3263*	1.01977	.000	6.0115	12.6410
		Sub adt. female	-1.3825	1.01977	.765	-4.6973	1.9323
		Juvenile	-7.3200*	1.01977	.000	-10.6348	-4.0052
	Adt. female	Adt. Male	12.3150*	1.01977	.000	9.0002	15.6298
		Sub male	21.6413*	1.01977	.000	18.3265	24.9560
		Sub adt. female	10.9325*	1.01977	.000	7.6177	14.2473
		Juvenile	4.9950*	1.01977	.001	1.6802	8.3098
	Sub adt. male	Adt. Male	-9.3263*	1.01977	.000	-12.6410	-6.0115
		Adt. Female	-21.6413*	1.01977	.000	-24.9560	-18.3265
		Sub adt. female	-10.7088*	1.01977	.000	-14.0235	-7.3940
		Juvenile	-16.6462*	1.01977	.000	-19.9610	-13.3315
	Sub adt. female	Adt. Male	1.3825	1.01977	.765	-1.9323	4.6973
		Adt. Female	-10.9325*	1.01977	.000	-14.2473	-7.6177
		Sub male	10.7088*	1.01977	.000	7.3940	14.0235
		Juvenile	-5.9375*	1.01977	.000	-9.2523	-2.6227
	Juvenile	Adt. Male	7.3200*	1.01977	.000	4.0052	10.6348
		Adt. Female	-4.9950*	1.01977	.001	-8.3098	-1.6802
		Sub male	16.6462*	1.01977	.000	13.3315	19.9610
		Sub adt. female	5.9375*	1.01977	.000	2.6227	9.2523

Scheffe

Dependent Variable	(I) Age category	(J) Age category	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Azwa	Adt. male	Adt. female	-15.7637*	.89976	.000	-18.6884	-12.8391
		Sub adt. male	5.3188*	.89976	.000	2.3941	8.2434
		Sub adt. female	-3.6175*	.89976	.008	-6.5422	-.6928
		Juvenile	-4.7237*	.89976	.000	-7.6484	-1.7991
	Adt. female	Adt. Male	15.7637*	.89976	.000	12.8391	18.6884
		Sub adt. male	21.0825*	.89976	.000	18.1578	24.0072
		Sub adt. female	12.1462*	.89976	.000	9.2216	15.0709
		Juvenile	11.0400*	.89976	.000	8.1153	13.9647
	Sub adt. male	Adt. Male	-5.3188*	.89976	.000	-8.2434	-2.3941
		Adt. female	-21.0825*	.89976	.000	-24.0072	-18.1578
		Sub adt. female	-8.9363*	.89976	.000	-11.8609	-6.0116
		Juvenile	-10.0425*	.89976	.000	-12.9672	-7.1178
	Sub adt. female	Adt. Male	3.6175*	.89976	.008	.6928	6.5422
		Adt. female	-12.1462*	.89976	.000	-15.0709	-9.2216
		Sub adt. male	8.9363*	.89976	.000	6.0116	11.8609
		Juvenile	-1.1062	.89976	.823	-4.0309	1.8184
	Juvenile	Adt. Male	4.7237*	.89976	.000	1.7991	7.6484
		Adt. female	-11.0400*	.89976	.000	-13.9647	-8.1153
		Sub adt. male	10.0425*	.89976	.000	7.1178	12.9672
		Sub adt. female	1.1062	.89976	.823	-1.8184	4.0309
Arego	Adt. male	Adt. female	-13.9438*	1.39308	.000	-18.4720	-9.4155
		Sub adt. male	4.8125*	1.39308	.032	.2843	9.3407
		Sub adt. female	-6.0713*	1.39308	.004	-10.5995	-1.5430
		Juvenile	1.0913	1.39308	.960	-3.4370	5.6195
	Adt. female	Adt. Male	13.9438*	1.39308	.000	9.4155	18.4720
		Sub adt. male	18.7563*	1.39308	.000	14.2280	23.2845
		Sub adt. female	7.8725*	1.39308	.000	3.3443	12.4007
		Juvenile	15.0350*	1.39308	.000	10.5068	19.5632
	Sub adt. male	Adt. Male	-4.8125*	1.39308	.032	-9.3407	-.2843
		Adt. female	-18.7563*	1.39308	.000	-23.2845	-14.2280
		Sub adt. female	-10.8838*	1.39308	.000	-15.4120	-6.3555
		Juvenile	-3.7212	1.39308	.154	-8.2495	.8070
	Sub adt. female	Adt. Male	6.0713*	1.39308	.004	1.5430	10.5995
		Adt. female	-7.8725*	1.39308	.000	-12.4007	-3.3443
		Sub adt. male	10.8838*	1.39308	.000	6.3555	15.4120
		Juvenile	7.1625*	1.39308	.000	2.6343	11.6907
	Juvenile	Adt. Male	-1.0913	1.39308	.960	-5.6195	3.4370
		Adt. female	-15.0350*	1.39308	.000	-19.5632	-10.5068
		Sub adt. male	3.7212	1.39308	.154	-.8070	8.2495
		Sub adt. female	-7.1625*	1.39308	.000	-11.6907	-2.6343
Aba Gude	Adt. male	Adt. female	-11.9363*	.28066	.000	-12.8485	-11.0240

	Sub adt. male	3.1263*	.28066	.000	2.2140	4.0385
	Sub adt. female	-.3513	.28066	.813	-1.2635	.5610
	Juvenile	-8.2012*	.28066	.000	-9.1135	-7.2890
Adt. female	Adt. Male	11.9363*	.28066	.000	11.0240	12.8485
	Sub adt. male	15.0625*	.28066	.000	14.1502	15.9748
	Sub adt. female	11.5850*	.28066	.000	10.6727	12.4973
	Juvenile	3.7350*	.28066	.000	2.8227	4.6473
Sub adt. male	Adt. Male	-3.1263*	.28066	.000	-4.0385	-2.2140
	Adt. female	-15.0625*	.28066	.000	-15.9748	-14.1502
	Sub adt. female	-3.4775*	.28066	.000	-4.3898	-2.5652
	Juvenile	-11.3275*	.28066	.000	-12.2398	-10.4152
Sub adt. female	Adt. Male	.3513	.28066	.813	-.5610	1.2635
	Adt. female	-11.5850*	.28066	.000	-12.4973	-10.6727
	Sub adt. male	3.4775*	.28066	.000	2.5652	4.3898
	Juvenile	-7.8500*	.28066	.000	-8.7623	-6.9377
Juvenile	Adt. Male	8.2012*	.28066	.000	7.2890	9.1135
	Adt. female	-3.7350*	.28066	.000	-4.6473	-2.8227
	Sub adt. male	11.3275*	.28066	.000	10.4152	12.2398
	Sub adt. female	7.8500*	.28066	.000	6.9377	8.7623

Based on observed means.

*. The mean difference is significant at the .05 level.