ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

DEPARTMENT OF ZOOLOGICAL SCIENCES

Diurnal Activity Patterns and Foraging Habit of Abyssinian Blue-Winged Goose (*Cyanochen cyanoptera*) in Menz-Guassa Community Conservation Area, Ethiopia

A Thesis Submitted to the Department of Zoological Sciences in Partial Fulfillments for the Requirements for the degree of Master of Science in Zoology (Ecological and Systematic Zoology)

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Addis Ababa, Ethiopia

October, 2021

Acknowledgement

First and foremost, praises and thanks to God, the Almighty, for his showers of blessings throughout my research work to complete the research successfully.

I would like to express my heartiest and sincere gratitude to my supervisor Dr. Bezawork Afework for her invaluable advice, continuous support, and patience throughout this study. Her immense knowledge and plentiful experience have encouraged me in all the time of my academic research and daily life. She has taught me the methodology to carry out the research and to present the research as clearly as possible. I would also like to thank her for her empathy and great sense of humour.

I would also like to acknowledge with much appreciation, Professor Afework Bekele, who gave me the permission to use personal data collection equipment.

I am overwhelmed in all humbleness and gratefulness to acknowledge Ato Getabalew Assefa , Ato Abebe Gosem and Ato Antenehe Tesefay who helped me a lot while conducting field research, in gathering necessary information, collecting data, collecting specimens as well as recording observations out in the field. I am also grateful to the local people for the cooperation and help they have rendered during the period of field work.

I am also extremely grateful to Ato Melaku Wondafrash for the plant identification process and W/t Sosina Bayu for sharing her knowledge in the analysis of the data and its statistical computation.

My gratitude extends to the Department of Zoological Sciences and also Addis Ababa University thematic research fund, for providing financial support. I am also very grateful for the Menz-Guassa Community Conservation Area administrators for providing excellent working area.

Last but not the least; I am very much thankful to my family who helped me in every aspect. My appreciation also goes out to my friends who directly and indirectly provide me inspirations and valuable suggestion during the course of this study.

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Acronyms

AAU	Addis Ababa University
ANOVA	Analysis of Variance
BLI	BirdLife International
EWNHS	Ethiopian Wildlife Natural History Society
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
MGCCA	Menz-Guassa Community Conservation Area
NGS	Next-Generation Sequencing
SPSS	Statistical Package for the Social Sciences

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Abstract

The Abyssinian blue-winged goose (Cyanochen cyanoptera), a waterfowl species is one of the endemic birds found in Ethiopia. Diurnal activity patterns and foraging habit of the Abyssinan blue-winged goose was studied in the Menz-Guassa Community Conservation Area. Data were collected during the wet season (August, 2020) and dry season (January, 2021). Scan sampling methods were used to collect data of the activity patterns and foraging habit of Abyssinian blue-winged goose. Data were presented using descriptive statistics and tables. Results were compared with ANOVA test. Abyssinian blue-winged gooses were observed in daily activities of foraging, scanning, flying, preening, resting, and showing other activities. Foraging activity comprised highest (50.5%) followed by other activities (18.6%), scanning (17.4%), resting (8.9%), preening (4.1 %) and flying (0.4 %) during the wet season. During the dry season, foraging activity (55%) was the highest again followed by resting (18.5%), preening (11.9%), scanning (9.1%), others (4.8%) and flying (0.5 %). There was a statistically significant variation in the diurnal activities of foraging, scanning and others between the wet and dry seasons. During both seasons activities such as preening, resting and others have showed statistically significant variation with seasons between different hours of the day, while the rest of the activities such as foraging, scanning and flying showed insignificant variation. The mean proportion of time spent to different activities by the Abyssinian blue-winged goose also varied insignificantly within the three time slots (morning, midday and late afternoon) of the day between the wet and dry seasons. Abyssinian blue-winged gooses were seen as grazers during both seasons. Plant species mostly from the families Asteraceae, Cyperaceae, Fabaceae, Lythraceae, Ranunculaceae, Rosaceae, Poaceae and Polygonaceae were recorded from the foraging area of the Abyssinian blue-winged goose. The species largely consumes grasses and feed by picking. The average picking rate of the Abyssinian blue-winged goose was 44.57 pick/minute and has shown insignificant variation between the two seasons. The study provided knowledge about the poorly known diurnal activities of the Abyssinian blue-winged goose between seasons and between different hours of the day, as well as their foraging habit. Lots of attention should be given for the conservation and maintenance of this endemic species.

Key words/Phrases: *Abyssinian blue-winged goose, Diurnal activity patterns, Foraging, Menz-Guassa Community Conservation area, Picking rate.*

1. INTRODUCTION

1.1 Background of the study

Ethiopia is one of the few countries in the world that possesses a unique and characteristic fauna with a high level of endemism (Alemneh Amare, 2015). The country has ecological diversity ranging from humid forest and extensive wetlands to the desert of the Afar depression (Agena Anjulo *et al*., 2016). This is because its geographic position, range of altitude, rainfall pattern and soil variability. It is also one of the richest and incredible ornithological destinations in Africa. Of the fauna resource residing in the country, there are more than 821 bird species identified with 17 endemics and 36 globally threatened in the country. From the recorded bird species, 275 are seasonal migrants, 176 Pale arctic and 31 species are global conservation concerns (BirdLife International, 2021).

The Abyssinian blue-winged goose (*Cyanochen cyanoptera*), a waterfowl species is one of the endemic birds of Ethiopia MGCCA (BirdLife International, 2021). These birds are called waterfowl birds as they tend to live near freshwater ponds or water-resource areas. They are not typical geese like that of the true geese found in North America, Europe and Asia. They use the term 'goose' as part of their name since many species of waterfowl in the southern hemisphere, mainly related to the shelducks, are usually called geese. This species belongs to the order Anseriformes. They belong to separate ancient lineages that may ally either to the Tadorninae, the Anserinae, or closer to the Anatinae (dabbling ducks). The most goose like species of the subfamily Anatinae are the sheldgeese, which together with the closely related shelducks constitute the tribe Tadornini. It is the only member of the genus *Cyanochen* spp and there is no subspecies recognized (Johnsgard, 2010).

Activity budget studies quantify the time animals allocate to different activities. It is an important tool for understanding habitat use and niche separation (Upadhyaya and Saikia, 2010). This suggests that it has an invaluable aid for managing waterfowl communities and habitats (Hepworth, 2001). Time-activity patterns are especially suitable for comparative studies, such as those among seasons of the year, sexes and habitats (Holmes *et al*., 1979). Biotic variables such as competition predation, food availability, habitat type and phylogenetic constraints and abiotic variables such as climatic conditions have significant impacts on bird activity patterns, both at the

spatial level such as habitat and landscape scales and the temporal level, such as daily, seasonal and annual scales (Hooper *et al*., 2005). Moreover, different environmental conditions like temperature, precipitation, food availability and the number of daylight hours (day length) change regularly and strongly influence the activity of life on Earth (Rave and Baldassarre, 1989).

Patterns of daily activity and behaviour can vary widely between species and these activity budgets helps us studying the life history and ecological adaptations of birds (Asokan and Ali, 2010). Furthermore, foraging behaviour has played an important role in empirical studies of avian foraging ecology and studies on foraging behaviour in relation to the proportion of time allocated to activities can hence provide details to time budget for birds (Blendinger, 2005; Mwangi, 2017). Since the portioning of food resource is important for the survival of avian species, it is important to focus on foraging behaviour studies that explore how birds utilize different food niches to adapt to the habitat.

Studies of captive Abyssinian blue-winged goose suggest that they are largely active at night (Soothill and Whitehead, 1988), which perhaps explain why there is no detailed knowledge of the ecology and population status of this species. The only available information on the species is limited to reconnaissance surveys and short-term observation records. Therefore, this study contributes to knowledge about the poorly known behaviour of the Abyssinian blue-winged goose with the different diurnal daily activities between seasons and the foraging habit in MGCCA, Ethiopia.

1.2. Objective of the study

1.2.1 General Objective

- To study the activity patterns and foraging habit of Abyssinian blue-winged goose in Menz-Guassa Community Conservation Area, Ethiopia

1.2.2. Specific Objectives

The specific objectives of this study area were:

- To explore the activity patterns of Abyssinian blue-winged goose with respect to the time of the day and seasons
- To explore the foraging habit of Abyssinian blue-winged goose
- To identify the food items consumed by Abyssinian blue-winged goose

1.3. Research questions

1. Do the diurnal activity patterns of Abyssinian blue-winged goose vary depending on seasons?
2. Do the diurnal activity patterns of Abyssinian blue-winged goose vary depending on the time of the day?
3. What does Abyssinian blue-wing goose feed during wet and dry season?
4. Does the picking rate of Abyssinian blue-winged goose vary depending on seasons?

1.4. Significance of the study

This research helped to provide knowledge and understanding of the activity patterns and foraging habit of Abyssinian blue-winged goose. In addition it showed the effect of season and time on the activity patterns and habit of the bird. Furthermore, it created awareness and appreciation of the benefit of the area for the bird.

1.5. Delimitation of the study

While doing this thesis, the researcher has faced various problems like that of anthropogenic disturbance, when the human presence was high in the study site of the birds were hiding themselves in adjacent grasslands, making it difficult to conduct the research.

2. LITERATURE REVIEW

2.1. Taxonomy of the Abyssinian blue-winged goose

The Abyssinian blue-winged goose (*Cyanochen cyanoptera*) has disputed affinities. It is morphologically close to shelducks, and has closest relationship with the typical sheldgeese, like that of South American genus *Chloephaga* spp (Johnson and Sorenson, 1999). Studies have shown that, it has hybridized with the Orinoco goose and two species of Chloephaga. Many species of the entire genus *Chloephaga* spp are obviously a close-knit one and have minor differences from the others which are related to its high-montane ecological adaptations (Johnsgard, 1965).

The Abyssinian blue-winged goose is close to the South American sheldgeese, the Andean goose (*Chlophaga melanoptera*). The Andean goose is not a true goose but belongs to a clade of ecologically convergent, goose-like ducks (McCracken *et al*., 2010). It looms to be rather closely related to the Abyssinian blue-winged goose, by at least two indications. One of the indications could be the yellow facial markings and cheek patches of the downy young of both species. Additionally, the similarity of the two species in the general posture and shape of the adults (Johnsgard, 1965). However, mitochondrial DNA has unveiled that the Abyssinian blue-winged goose is most closely related to the Hartlaub's Duck (*Pteronetta hartlaubii*) than any other species (Mees, 2003). Moreover, it shares pale blue forewings which are a good morphological indicator of evolutionary relationships (Chandrasdkhar *et al*., 2015). Furthermore, this species is sympatric with the Egyptian goose, with which it has produced fertile hybrids in captivity. In many respects the Egyptian goose is regarded as a large shelduck and it is somewhat more distantly related to the other genera of sheldgeese (Johnsgard, 1965).

2.2. Physical description

Generally the family Anatidae comprises species that vary greatly in size. The females of all species have typically gooselike or duck like notes. Males are larger than the females, and in many instances differ noticeably from them in plumage. The wings are strongly patterned with white coverts and iridescent coloration on the secondaries or their greater coverts. In contrast

with various other cavity-nesting waterfowl, the downy young in the shelducks and sheldgeese, are also typically patterned (Johnsgard, 2010).

In particular, the Abyssinian blue-winged goose is the most generalized species of the present tribe. The absence of plumage dimorphism in the two sexes and the similarity in the behaviour and voices of males and females, are some of the manifestations. They are unmistakable medium-sized, with darker grey mantle (Redman *et al*., 2011). Head is plain ash grey with whitish forehead, face and throat. Unlike those of nearly all the other species of the tribe, the upper-wing coverts are not white but powder blue except for a small area at the bend of the wing (Plate 1). In flight, shows white under wing-coverts. The color is not particularly striking at distance. They were named for this distinctive pale blue forewing. The adult plumage is mostly grayish brown, but the secondary feathers have a slight metallic glossy green. The plumage of these birds is thick and loose, fur like as an adaptation to the cold of the Ethiopian highlands. Nonetheless, the lesser coverts and also the under wing linings are white (Johnsgard, 2010). The tail and primaries are black (Plate 1). The downy young show the typical contrasting sheldgoose pattern. Juvenile birds are somewhat duller in color and pattern than adults. Females are identical to males, but are considerably smaller. They have a small black bill and legs. These unique birds have a height range of approximately 60 - 75cm and Weight of 1.5 - 2.3kg. They have a wingspan of 32.5 to 37.5 cm and folded wing of males, 368-74 mm and females, 314-34 mm. The culmen of males is 32-33 mm and females 30-31 mm. Adult female weigh about 1,520 g.

Plate 1: Adult Abyssinian blue-winged goose (*Cyanochen cyanoptera*) (Photo: www.rockjumperbirding.com)

2.3. Habitat and distribution

Abyssinian blue-winged goose inhabits plateau marshes, rivers, swamps, water storage areas, streams and subtropical or tropical damp grasslands at about 2100-4100 m (Redman *et al*., 2011). It also inhabits the edges of highland lakes, bog pools, and streams with abundant grassland surroundings. It is rarely found in overgrown areas and does not venture into deep water (Johnsgard, 1978). They are limited to the highlands (above 2438.4 meters) of Ethiopia, primarily in the area between Lakes Zway and Tana, but extending north to about 15° north latitude (Fig 1) (Johnsgard, 2010). This makes them an ecological counterpart of the Andean goose (Johnsgard, 1965). Important concentrations of the Abyssinian blue-winged goose occur in the Sululta Plains area during the rains and post-rain period, with up to 350 birds seen in 1992 (Vivero Pol, 2001). Also in Gefersa Reservoir, Ankober, Debre Birhan, Bale Mountains National Park, Mount Zuqualla, Fincha and Chomen swamps, Akaki Wetlands, Sentara Plains, Wadala Delanta area, Jammu Valley and several mountains of Arsi Range (Chilalo and Kecha) (Weldemariam Tesfahunegny, 2016).

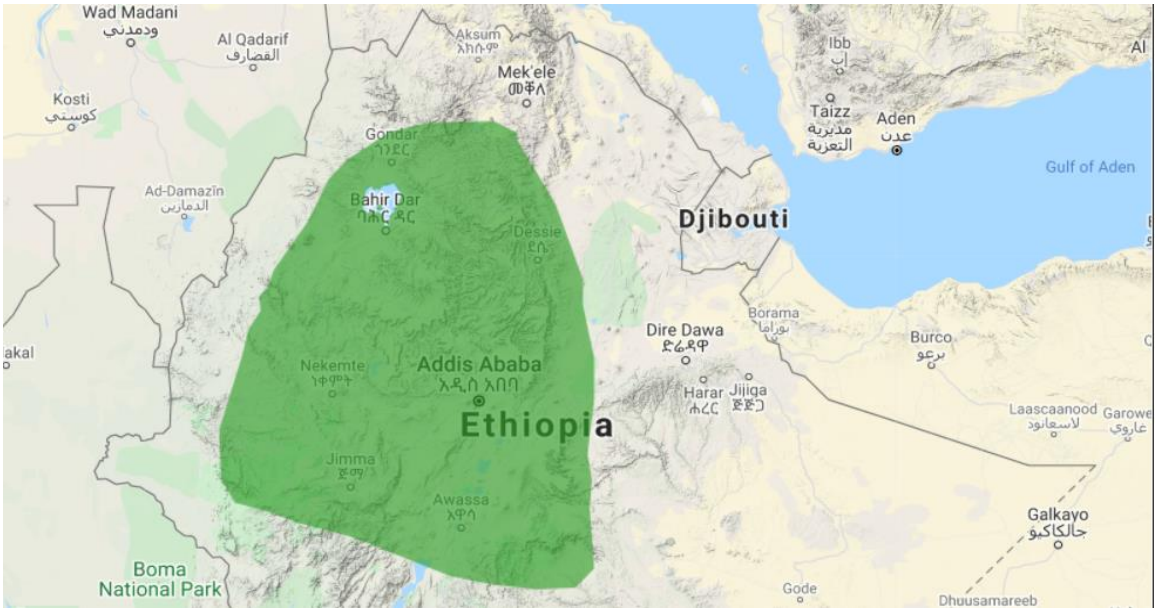

Figure 1: Distribution map of the Abyssinian blue-winged goose (BirdLife International, 2021)

2.4. Vocalization

Vocalization in waterfowl exhibit variety and include: trumpeting, whistles, twitters, honks, barks, grunts, quacks, croaks and growls. The voices of the sexes are generally quite dissimilar (Johnsgard, 1965). The wings of some species and the inflatable air sacs of others also produce non vocal sounds. Both sexes utter loud honking or gabbling cries while on the wing or when danger appears. Many vocalizations of waterfowl species are integral to courtship, territoriality and brood care, so as they vocalize notably during the breeding season. For instance, in many sheldgeese species the adult male has an enlarged bony bulla in the syrinx, which is evidently responsible for the whistling or whistle like sounds that are important in sexual and aggressive displays (Johnsgard, 2010).

Abyssinian blue-winged goose is a quiet species, but both sexes may give a soft whistle; it does not honk or cackles like the true geese (Weldemariam Tesfahunegny, 2016). Sometimes produce a rapidly repeated soft, barely audible whistle, a "wnee – whu – whu – whu –whu – whu – whu – whu" during pair formation. An alarmed goose produces a soft "whew – whu –whu – wliu" and, when forced into flight, a rather nasal bark, a "penk – penk – penk", uttered at takeoff but not in flight. Both sexes have similar high-pitched, almost whistling voices, and the female seems to lack the low guttural calls of most anatine females (Johnsgard, 1960).

2.5. Locomotion

Most waterfowl species are especially adapted for swimming, with their waterproof plumage, fat-insulated body, and powerful legs with webbed feet. The feet paddle alternately in slow swimming, but the whole leg is used when the bird is moving fast (Abourachid, 2000). All waterfowl are able to dive if pressed, and some use diving as their normal feeding procedure. They submerge by arching the body and propelling themselves forward with both feet so that entry is in a smooth arc. A duck dive underwater and the legs are sculled together. In some species the wings are opened and used as steering rather than as propelling devices. Walking on land is well-developed in gooselike species. Geese especially the heavier ones require a running start into the wind when taking off from water or land (Abourachid and Hofling, 2012).

The Abyssinian blue-winged goose walks and runs well, as it is a highland bird. They are also adapted for swimming. The way in which the bird holds its head back on its shoulders when at rest or while walking undisturbed; is the most characteristic aspect of its general behaviour. This posture is similarly adopted by the Andean goose. Lateral Head-shaking and Chin lifting as preflight movements are also some of the characteristics noted (Johnsgard, 1965).

2.6. Foraging behaviour and micro-habitat

Many waterfowls are herbivorous, although may also forage for aquatic invertebrates. They eat the seeds, roots, stems, leaves and flowers of aquatic vegetation (Olsen, 2017). For instance, the grazing geese take grasses and sedges on dry land or in marshes, where they seek roots both on land and under the surface. They have also adapted to various farm crops (Lisney *et al*., 2013). Other species of the waterfowls feed on plankton or algae. Other food items taken include: mollusks, aquatic insects, crustaceans and small fish. The ecological counterparts of the true geese, the typical sheldgeese are also grazing birds. On the other hand the shelducks, which are mostly wading and dabbling birds, frequently feed to a large extent on aquatic invertebrates (Johnsgard, 1965).

The Abyssinian blue-winged goose prefers the highland rivers of Ethiopia as its habitat. This is because the highland river areas are open and a place where meadows of short grass come down to the river banks. They also occur at the edges of swamps that are not overgrown with bushes or banks of reeds, but rarely if ever are they found in the middle of ponds or in deep water. They are also sometimes seen in mixed groups with Egyptian goose (Vivero Pol, 2001). These species are primarily herbivorous thus they feed by grazing short riverside grasses. Pairs or small parties of three to five of these geese are common and easily seen feeding on the moorlands where giant lobelia, *Alchemilla* spp and tussock grass predominate at high elevations. Their major foods definitely consist of grasses, sedges, and similar herbaceous vegetation of these areas; this can also be deduced from their bill shape (Kear and Hulme, 2005). In spite of that, they also feed on worms, insects and snails as occasional food as the stomachs of some wild birds shot in the wild have showed such animal life as worms, insects, insect larvae, and snails (Johnsgard, 2010).

2.7. Breeding behaviour

Waterfowls breed seasonally although some species maintain territories year round. Most species are considered seasonally monogamous as pair bonds are permanent. In spite of that, some species are polygynous, either mate may change from year to year, or multiple partner copulations may occur within a breeding season (Owen and Black, 1990). For instance, wild geese pair for life and associate as gaggles. Pair formation usually begins during the non-breeding season. Courtship displays include head and wing movements, vocalizations and swimming patterns. Nearly but not quite all species copulate in the water, with the pair in isolation. Regarding reproductive maturity, it is believed that all sheldgeese mature in the second year of life, and thus courtship probably occurs when the birds are about one and a half years old (Johnsgard, 2010).

Courtship display frequently occur in groups (Hamiliton *et al*., 2002) thus, preening dorsally, on the breast, and especially behind the wing can be seen in ritualized form in social situations. Likewise, the wing stretch and the general body shake occur in threat or sexual displays (Mckinney, 1965). Pair-forming are well developed and characteristics of each species. This is necessary if mating with closely related and coexisting species is to be avoided.

Nest building in waterfowls, is generally done by the female, though the male assists in some species. Moreover, the male defends the feeding territory and guards the female as she forages. For instance, some shelducks, and sheldgeese are highly aggressive and defend a territory around the nest (Johnsgard, 2010). Other geese likewise defend an area around the female as well as the immediate vicinity of the nest. Nest sites vary from shallow scrapes on land, mounds of plant material on land or water, to nest holes in trees. Nesting material includes vegetation and feathers. Nests built over water among marsh tipped evolution toward a more wholly aquatic existence. Many species nest on dry land, with some settling up to 1.6 km (1 mile) from water. On the other hand, shelducks use crevices and holes for nest sites, such as rabbit burrows. Most hole nesters, however, utilize preexisting tree holes and will quite readily adopt nesting boxes; old tree nests of other species are sometimes used (Hori, 1964).

Many species of the waterfowl usually lay egg early in the morning and takes only a few minutes, though the female remains on the nest for up to an hour. In most cases, one egg per day is laid, with occasional gaps. The number of eggs laid in a single brood is variable within a species, but ranges from 4-13 eggs with an egg-laying interval of 24 hours (Backues, 2015). Egg lying in nests other than their own is common among waterfowls. Furthermore, females of some species will deposit eggs in other female's nests. The egg shells vary from immaculate white, green, to brownish. Surface texture ranges from very smooth to dull and large-pored. The length of the incubation period shows little relation to taxonomic position or body size, but fledging period are correlated with the latitude at which breeding takes place. In most species females begin incubation after the last egg has been laid and continue to incubate for 22-40 days. After hatching, the female leads chicks on foraging forays, sometimes pointing out food items and always guarding the young (Johnsgard, 1965).

Abyssinian blue-winged goose is one of the monogamous species of waterfowl. It breeds near water. During courtship, the male struts around the female, his head bent over his back, and his bill pointed skywards or behind him. The female builds its nest in the midst grass tussocks (Weldemariam Tesfahunegny, 2016). In captivity, nests have been constructed under bushes, in a clump of sedge, and in boxes buried in a bank. Mating activities as well as nest building are evidently carried out at night, since almost none of these behaviour patterns have been observed by aviculturists. Abyssinian blue-winged goose lay eggs of 70 x 50 mm in size that are cream colored weighing about 85 g (Weldemariam Tesfahunegny, 2016). They lay four- nine cream-colored eggs between March-June and September-December and that only the female incubates from 30 to 40 days, though the mean average is around 30. Goslings hatch within 32 days meanwhile, the male stands guard (Johnsgard, 2010). Both birds will rear the young. Both parents defend their young in captivity. The male remains close to the nest and only moves to chase away geese or ducks, which may approach (Vivero Pol, 2001). The downy young grow fairly rapidly. In captivity completion of feathering, except for the wing feathers, is achieved at about six weeks, though the fledging period is probably appreciably longer. Specific data regarding the period to reproductive maturity seems lacking, but it is believed to be two years (Johnsgard, 2010).

2.8. Activity patterns

Activity time patterns data are useful in studying the ecological, behavioural and physiological aspects of birds. Thus, they can provide insight into the role of seasonally used habitats in relation to the annual cycle (Rave and Baldassarre, 1989). Knowledge of peak times of activity or conspicuousness can be helpful in planning the timing of field work and even in the selection of the most productive method (Robbins, 1981). Daily activity of birds can vary according to several factors including weather, season and habitat type (Pizo *et al*., 1997). For example, temperature, solar radiation and light levels are higher in exposed habitats (Reyes-Arriagadam *et al*., 2015). However, activity patterns are likely to differ among species.

Waterfowl species show daily pattern with regard to their behaviour, which might be modified by external factors such as weather, food availability, predation level or demands of the body (Włodarczyk, 2017). Additionally, their activity can be shaped by certain periods of their annual life cycle, like migration or breeding seasons as well as because of interspecific and intraspecific competition. For instance, some waterfowls spend much time walking, swimming, or diving. Others spend most of their time in the water besides spend a great deal of time on preening and feather maintenance. They coat their feathers with oil by using their bills from the uropygial gland (Robbins, 1981). They also roost during the day either on the water or on land. Some species forage or conduct courtship displays at night.

Social behavior

Waterfowls form mixed or monotypic flocks and appears socially active while feeding, roosting, and migrating, thus have well-developed social integration signals. For instance, indication to fly by head-shaking and chin-lifting, so that the group takes off together. In geese, vocalization also plays a part in group flight. Furthermore, formal aggressive displays such as increase the apparent body size; wing flaps and flicking of the folded wings are important in gregarious species to prevent actual fighting. Even though the head is thrust forward, often with the bill open, the chin may also be lifted during aggressive

display. The noticeable nature of these gestures is often accentuated by patches of color (Johnsgard, 1965).

The Abyssinian blue-winged gooses are mainly sedentary (Redman *et al*., 2011). They are often found in pairs or occasionally in large groups (Weldemariam Tesfahunegny, 2016). They apparently never move great distances, and even when frightened they do not fly very far. They are reportedly somewhat nocturnal under natural conditions. Nothing is known of seasonal movements, but these are likely to be small or lacking.

2.9. Economic value and conservation status

Waterfowl have a long association with man and are of important for various reasons. As most waterfowl are conspicuous, occur in open, treeless areas and often in large colonies, peoples can easily exploit by egg-collecting. For instance, many ducks and geese are challenging and worthwhile quarry to the sport hunter; domesticated species are reared for egg, meat, feathers and liver production, but to the farmer other species are considered pests and crop spoilers, to give an illustration, the largest and most-popular domestic meat goose is the Toulouse. In addition, most geese are sedentary and adaptable species and these have made them the most successful domestic ones, like that of the Egyptian goose which have been kept in semi domestication in Egypt for at least 4000 years (Owen and Black, 1990). This was by making them ease of exploitation but without intensive breeding to change their forms.

The major threats of waterfowl populations include: introduced species, human hunting and collection, habitat destruction (drainage of wetlands) and agrochemical use. There is no doubt that humans are a major predator of waterfowl. Adult ducks, other than nesting females, suffer relatively little natural predation unless they are sick or weakened by hunger. The main predatory impact comes on the eggs and young. Crows and gulls, mink, raccoons, coyotes, foxes, ground squirrels, snakes, snapping turtles, bullfrogs, pike, and carp all take some toll (Johnson and Owen, 1992).

The Abyssinian blue-winged goose is relatively abundant over most of its range. It is considered by sportsmen to be a good game bird; however, it has coarse flesh thus at times it is unpalatable. They are important to the balance of the ecosystem, by keeping bodies of

water clear and aquatic plants in check as well as being a prey item for larger carnivores. Due to their limited range, the population is especially vulnerable to human disturbance and habitat loss. It is almost certainly now under pressure from the rapidly expanding human population and resulting degradation of grasslands and increased levels of disturbance (Weldemariam Tesfahunegny, 2016). Formerly classified as a Near Threatened species on the IUCN Red List, new research has shown it to be rarer than it was believed. Consequently, it is up listed to vulnerable status in 2016 with the goose population on a decline (BirdLlife International, 2021).

3. MATERIALS AND METHODS

3.1. The study area

The study area was Menz-Guassa Community Conservation Area (MGCCA) located in Menz- Gera Midir Woreda, North Shewa Zone, Amhara National Regional State. MGCCA is 265 km North East of Addis Ababa that leads from Mezezo to Mehal Meda (Girma Nigussie *et al*., 2019). The area lies between 10°17.53′–10°26.00′N and 39°47.12′–39°48.74′E (Fig. 2). The altitude varies from 3,200 to 3,600 m a.s.l. The total area of the MGCCA is 111 km^2. Guassa area is characterized by hills and valley bottoms interspersed with swamps and opens areas of montane and afro-alpine grassland. It forms part of high altitude plateau of the central highlands of Ethiopia at the edge of the escarpment of rift valley. The Guassa ranges serve as a water catchment for many streams and rivers drainage into the low lying areas of North Shewa. It provides water to two major river systems: Abbay (Blue Nile) to west and the Awash to east (EWNHS, 1996).

The natural resource management system of the Guassa area dates back to the 17th Century. Over the last 400 years, the Menz-Guassa people conserved natural resources without outside assistance. Given that it still persists, this makes it one of the oldest conservation areas in Sub-saharan Africa. The area was set aside as a resource for the community, who use it for harvesting the "Guassa" grass (*Festuca* spp.) for thatch, for grazing livestock, and for harvesting shrubs for fuel wood as these are the main source of livelihood for the community (Getachew Mamo and Tilaye Wube, 2018). The Guassa area has been managed under an indigenous resource management institution known us the 'Qero system'. The Qero system operates as an indigenous common property resource management institution that arose based on the existing land tenure system. Following the 1974 popular revolution, the government nationalized all rural land in the country, resulting in the abolishment of the qero system. Today, the Guassa area is managed by a committee comprising of elected elders from each of peasant associations. The Guassa committee oversees the use of the area, guards it and prosecutes illegal users (Zelalem Tefera *et al*., 2012).

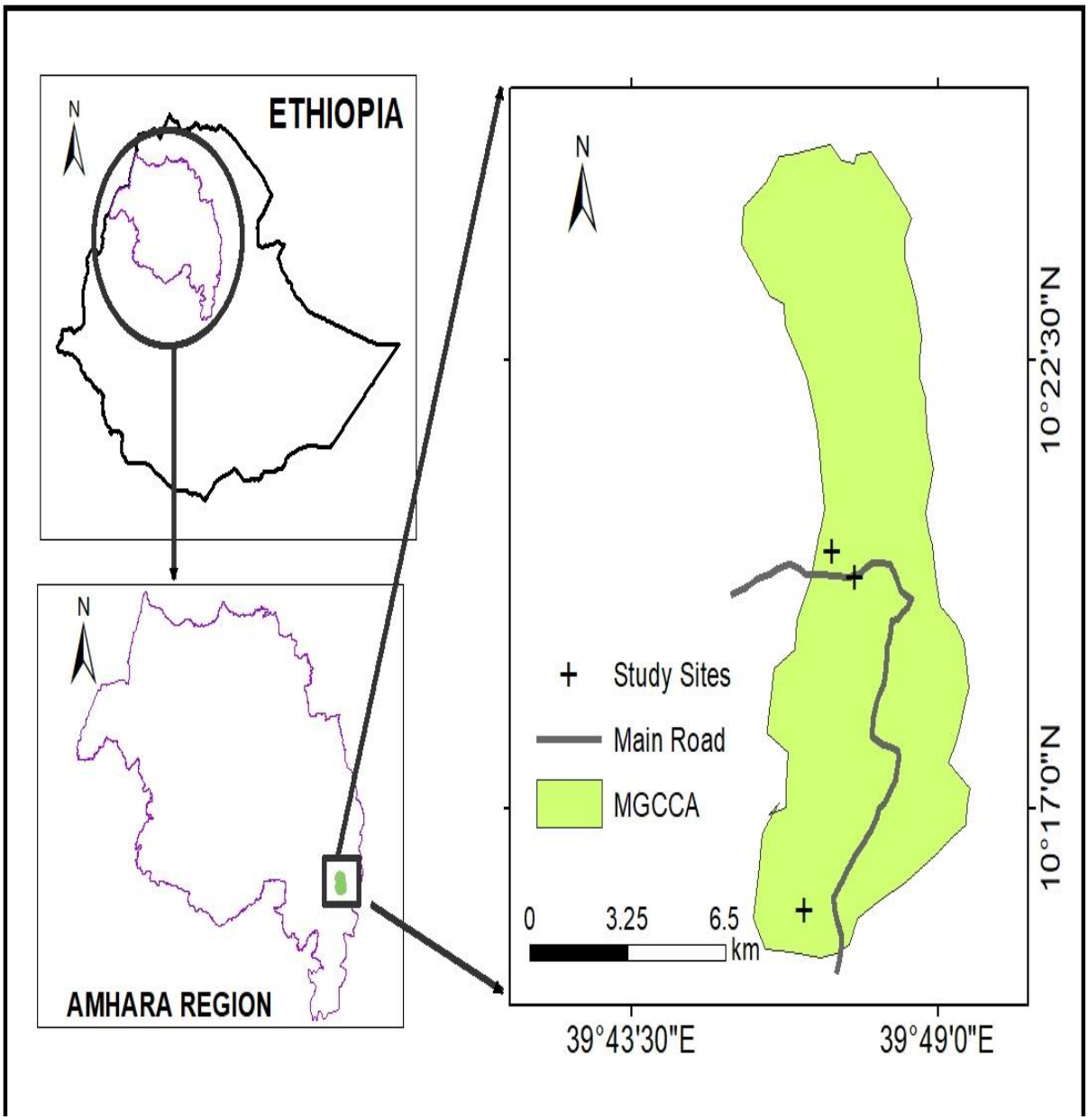

Figure 2: Location map of the study area

Climate

The high altitude plays a major role in determining the climate which belongs to the wet agro-ecological zone. The MGCCA climate varies considerably due to altitudinal gradients and the height of the mountain block (Zelalem Tefera *et al*., 2012). The wet season at MGCCA is characterized by combination of high rainfall, frequent hailstorms, fog and occasional snow while frosts are common during the dry season. Annual rainfall for Guassa averages 1,200 mm to 1,600 mm. Rainfall is bimodal: June – September is the main rainy season while February- April receives small rain. The annual humidity ranges from 55.18% to 80.90% (Hailu Beyene, 2010).

The temperature monthly mean ranges from 5.2 to 19.5 °C (Endalkachew Teshome *et al*., 2020). Mild day temperature and cold night temperature characterize the area. During the dry seasons (December - January), the temperature would rise up to 21˚C at daytime, but it falls to -7˚C at night. In the wet season, the daytime temperature is around 12˚C while the night temperature is 3˚C (Hailu Beyene, 2010).

Flora

The vegetation at MGCCA is the Afro-mountain vegetation type as about 86 plant taxa are found and of these more than 11 taxa are endemic to Ethiopia. The area is dominated by Guassa (*Festuca* spp.), Ttussock grasses (*Carex* spp.), Giant lobelia, Asta (*Erica* spp.), Everlasting flowers (*Helichrysum* spp.), Toseign (*Thymus* spp.) and lady's mantle (*Alchemilla* spp.). Other common plant species that are found in the area include *Carex monostachya A.Rich, Carex fischeri K.Schum* and *Kniphofia foliosa Hochst*. The shrub vegetation of *Euryops inifolius* is extensively used as firewood by the communities living adjacent to the MGCCA (Solomon Ayele and Demel Teketay, 2017).

Fauna

Guassa area harbors many of the endemic species of fauna associated with the Afroalpine ecosystem. For example, there are 22 mammal species found in the area, 27% of which are endemic to Ethiopia. These include the most endangered canid in the world, the Ethiopian wolf (*Canis simensis*) and Gelada baboon (*Theropithecus gelada*). Some other mammals

are Grey Duiker (*Sylvicapra grimmia*), Klipspringer (*Oreotragus oreotragus*), Leopard (*Panthera pardus*), Abyssinian Hare (*Lepus habessinicus*) and various rodent species (EWNHS, 1996).

The site hosts a minimum of 26 Highland biome species and it is also a home for many endemic bird species such as Abyssinian cat bird (*Parophasma galinieri*), Abyssinian long claw (*Macronyx flavicollis*), Ankober serin (*Crithagra ankoberensis*), Black-headed siskin (*Serinus nigriceps*), Abyssinian blue-winged goose (*Cyanochen cyanoptera*), Moorland francolin (*Scleroptlia psilolaema*), and Spot-breasted plover (*Vanellus melanocephalus*) (Yihenew Aynalem and Bezawork Afework, 2018).

3.2. Materials

Materials which were used during the study period include binoculars, a stopwatch to measure the time during their activities, field guide book (Redman *et al*., 2011), data sheets, notebooks, Garmin GPS, pencil and other stationary materials. In addition a smart phone camera was used to take pictures and confirm their activities.

3.3. Methods

A pilot survey was conducted to gather relevant information about the distribution, foraging habit and activities of Abyssinian blue-winged goose in MGCCA before the actual data collection. Information was collected from local people living around the study area. The topographical features as well as vegetation cover of the area was assessed.

Three sites, where the Abyssinian blue-winged gooses were particularly abundant were selected as data collection sites. Data were collected during the wet season (August, 2020) and dry season (January, 2021). Data were collected for a total of 20 days: 10 days during the wet season and 10 days during the dry season depending on weather conditions when the birds were active.

3.3.1. Activity patterns

The diurnal activity patterns of Abyssinian blue-winged goose were recorded for a total of 84 hours using a scan sampling method throughout the study period (Altman, 1974).

During the observation period, a group or an individual bird were followed at a time at a distance of 5-10 m, depending on their presence. The observations were made from morning to late afternoon dividing the day into three time blocks; morning 7:00-10:00hrs, mid-day 12:00-14:00hrs, and in late afternoon hours 16:00-18:00hrs.

During the observation period, the closest readily visible individuals in the habitat were scanned and activities of all the visible individuals were recorded in each scan. Five minutes scan samples were taken at an interval of 10 minutes. Activities were recorded as (i) foraging: feeding on grasses, (ii) scanning: the action of vigilance, (iii) flying: in flight, (iv) preening: when an individual show comfort movements like that of wing flapping, feather shaking, bill cleaning, (v) Resting: dozing with head retracted and eyes closed, (vi) Others: activities such as agonistic and calling (Asokan *et al*., 2010).

3.3.2. Foraging Habit

To collect data about the foraging habit of the Abyssinian blue-winged goose, repeated observation were carried out under good weather conditions during both the wet and dry seasons. Observation was made when the weather condition is not drizzling and raining (Schulze *et al*., 2000). Data were collected in the morning from 07:00-10:00hrs and late afternoon from 16:00-18:00hrs, when most of the avian species were engaged in foraging activities.

In order to collect the data a group or individual bird was followed from a distance of 5-10 m. When a single individual or a pair or flock was seen feeding, it was considered as one observation. The bird was first observed for 10 seconds without recording any data. This time period minimized the likelihood of recording only the conspicuous behaviour, and also ensured that the bird resumed normal activity patterns in the presence of the observer. Time data on foraging behaviour was collected (Kidest Ameha and Bezawork Afework, 2018). A stopwatch was used to record the start, stop and duration of activity. Observation began as soon as the focal bird began foraging. Each distinct pick at the foraging substrate was considered to represent a feeding hence number of picks per minute accurately represented feeding rates (Davis, 1997). Data was not considered for analysis, when a focal individual stopped foraging before 30 seconds (of the one minute observation). To

complete the observation period another individual bird which was foraging within the flock was selected as the focal bird (De Melo and Guiherme, 2016).

The type of food items were also collected by making a total of twelve 1m x1m quadrate (6 quadrates in each season) with 150m distant from each other and the type of plant species found at those particular areas were recorded (Plate 2). This was done as soon as the birds left the foraging area. Plant samples were later identified in the National Herbarium of Addis Ababa University.

Plate 2: 1m x1m sampling quadrant (Photo:Tsedenia Solomon, 2021)

3.3.3. Data analysis

Data collected were analyzed using statistical package for social sciences (SPSS) version 25 computer software programs and Microsoft Excel. Data were presented using descriptive statistics and tables. Results were compared using ANOVA test. The significance variation of activity patterns among the three time slots and between hours of the day were compared using a two-way analysis of variance (ANOVA). Significance variations of mean picking rate between the two seasons were compared using a one-way analysis. The overall different activities of the birds and mean rates in activity patterns recorded in the wet and dry seasons were compared using statistical package for social sciences (SPSS) software version 25. Significance of all tests was assessed at $p < 0.05$.

4. RESULTS

4.1. Activity Patterns

The Abyssinian blue-winged gooses group size was recorded ranging from 2 to 11 individuals. 2- 11 individuals were followed during the wet season and 2-6 individuals during the dry season in 3 flocks each. Abyssinian blue-winged goose were observed engaged in daily activities of foraging, scanning, flying, preening, resting, and showing other activities (Fig.3). The recorded data has shown variation between seasons and among day time duration. The study of the diurnal activity pattern in the Abyssinian blue-winged goose showed that foraging comprised 52.75 % of the activity budget over the study period in both the wet and dry seasons. It comprised 50.5% and 55% of the time during the wet and dry seasons, respectively. The rest of the activities (scanning, flying, preening, resting, and others) had low proportions. Foraging activity comprised highest (50.5%) followed by others (18.6%), scanning (17.4%), resting (8.9%), preening (4.1 %) and flying (0.4 %) during the wet season. During the dry season, foraging activity (55%) was the highest again followed by resting (18.5%), preening (11.9%), scanning (9.1%), other (4.8%) and flying (0.5 %)

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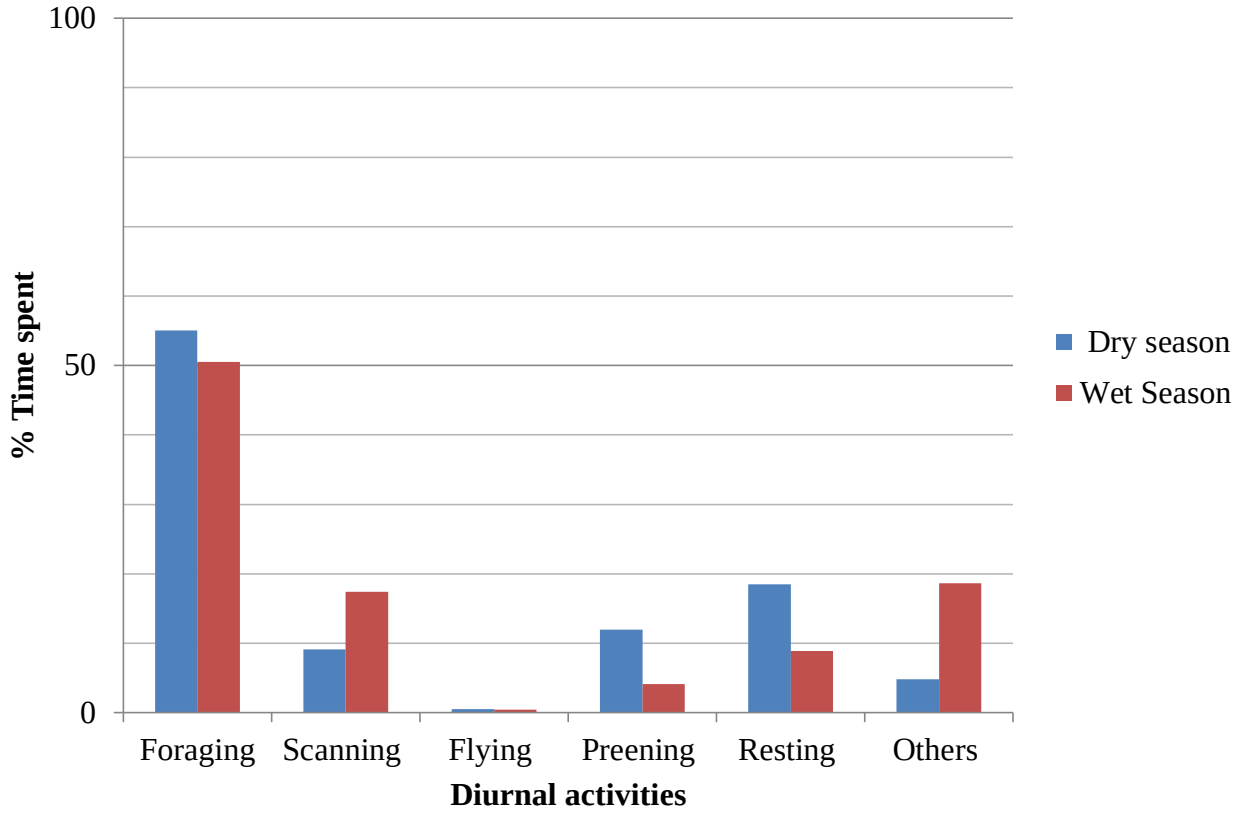


Figure 3: Percentage time spent for different activities in Abyssinian blue-winged goose during wet and dry seasons

The proportion of time allocated for different activity categories by Abyssinian blue-winged goose significantly varied statistically with season for foraging ($F_{1, 29}$= 4.328, p = 0.047). The times spent on scanning ($F_{1, 29}$= 16.261, p = 0.0009) and others ($F_{1, 29}$= 8.635, p = 0.007) also showed statistically significant differences between the dry and wet seasons, However, there was no statistically significant difference in the mean rates for flying ($F_{1, 29}$= 0.077, p = 0.784), preening ($F_{1, 29}$= 1.196, p = 0.283) and resting ($F_{1, 29}$= 0.374, p = 0.546) (Table 1).

Table 1.Mean proportion of time spent in different activities of Abyssinian blue-winged goose during wet and dry seasons

	Mean Proportion of time spent		ANOVA Test	
Activity	Wet season	Dry season	F	p
Foraging	22.07 ± 11.889	14.47 ± 7.671	4.328	**0.047**
Scanning	7.60 ± 4.763	2.40 ± 1.502	16.261	**0.009**
Flying	0.20 ± 0.775	0.13 ± 0.516	0.077	0.784
Preening	1.80 ± 1.859	3.13 ± 4.340	1.196	0.283
Resting	3.87 ± 5.579	4.87 ± 2.997	0.374	0.546
Others	8.13 ± 8.903	4.87 ± 2.997	8.635	**0.007**

Overall time spent for different activities in each hour of the day also varied with season. During the wet season, the activity foraging was highest (58%) between 17:00-18:00hr. scanning (31.5%) between 8:00-09:00hr; flying (2%) between 12:00h-13:00hr; preening (6.3%) between 9:00-10:00hr; others (32.7%) and resting (13.5%) between 13:00-14:00hr (Fig. 4).

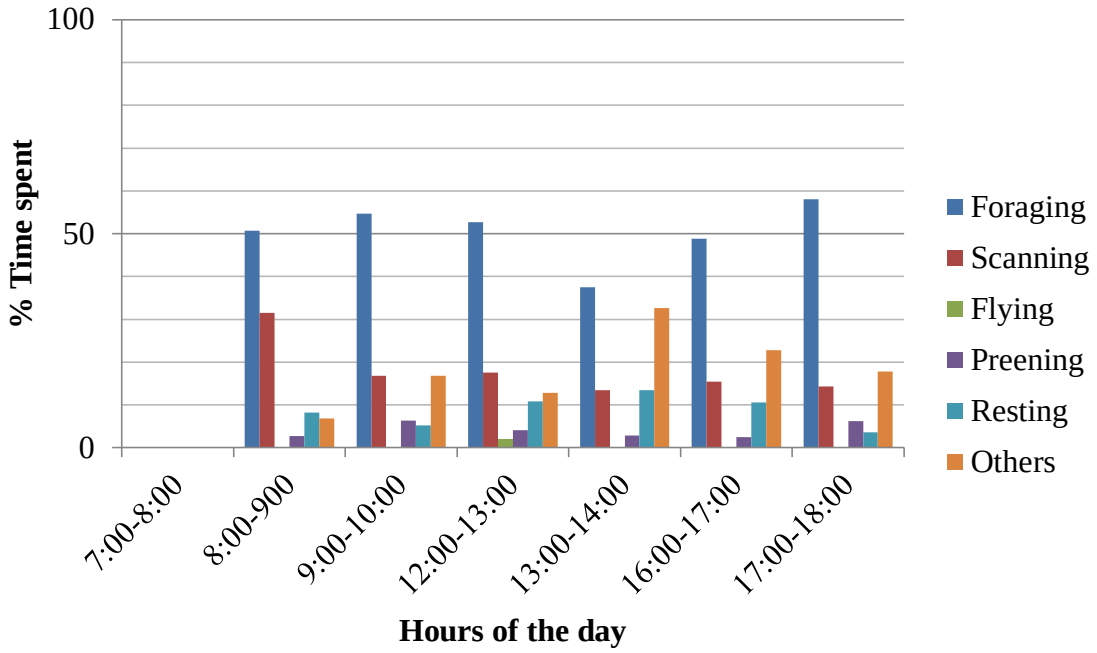


Figure 4: Diurnal activity patterns of Abyssinian blue-winged goose in different time of the day during the wet season

During the dry season, foraging activity was the highest (72.6%) between 8:00-9:00hr, scanning (17.3%) between 16:00-17:00hr, flying (3.2%) and others (12.9%) between 17:00-18:00hr, preening (20.9%) between 9:00-10:00hr and resting (31.5%) between 13:00-14:00hr (Fig.5).

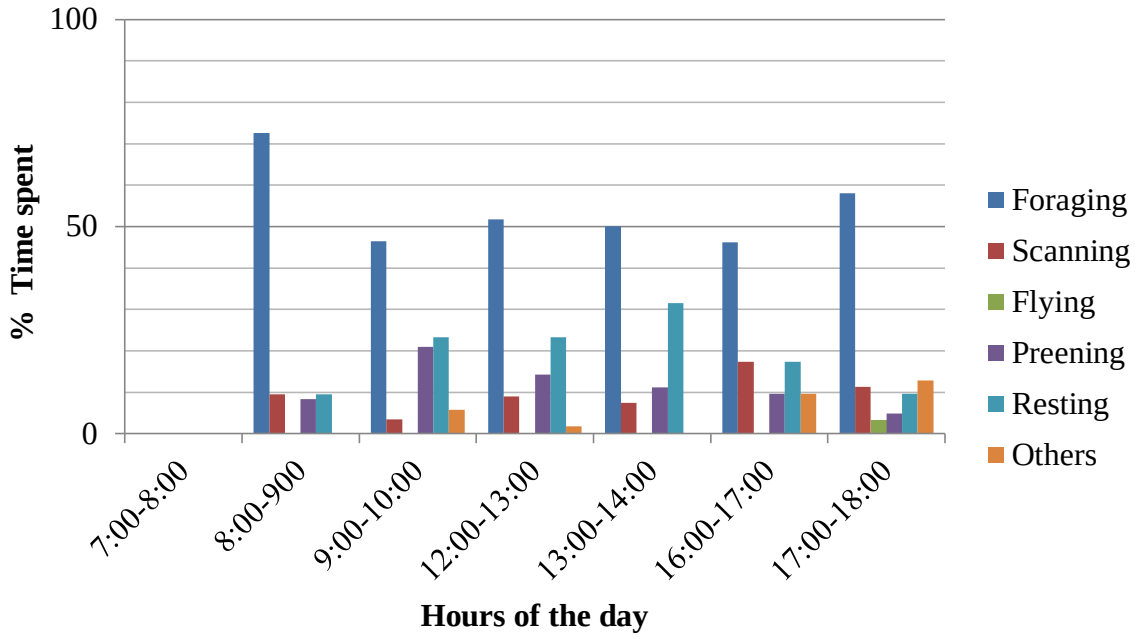


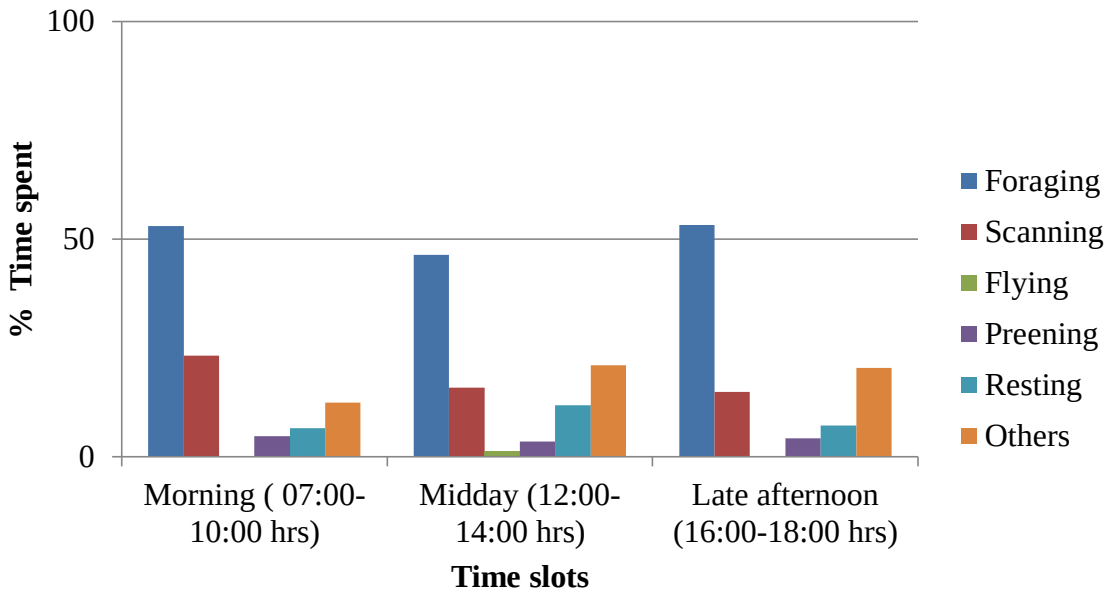
Figure 5: Diurnal activity patterns of Abyssinian blue-winged in different time intervals of the day during the dry season

The proportion of time allocated to different diurnal activities of Abyssinian blue-winged goose has also shown statistically significant variation with seasons, between hours of the day, for activities such as preening ($F_{1, 13}$= 8.97, p = 0.024), resting ($F_{1, 13}$= 10.25, p = 0.019) and others ($F_{1, 13}$= 8.40, p = 0.027). However, foraging ($F_{1, 13}$= 0.69, p = 0.438); scanning ($F_{1, 13}$= 5.46, p = 0.058) and flying ($F_{1, 13}$= 0.09, p = 0.779) activities were statistically insignificant (p > 0.05), between different hours of the day with seasons.

The mean proportion of time spent to different activities by the Abyssinian blue-winged goose varied within the three time slots (morning, midday and late afternoon) of the day during the wet and dry seasons, but it was not statistically significant (p > 0.05) (Fig. 6). In both seasons, Abyssinian blue-winged goose showed mean rates for foraging ($F_{2, 5}$= 4.37,

p = 0.186), scanning ($F_{2, 5}$= 0.15, p =0.872), flying ($F_{2, 5}$= 0.37, p = 0.732), preening ($F_{2, 5}$= 1.10, p = 0.476), resting ($F_{2, 5}$= 4.61, p = 0.178) and others ($F_{2, 5}$= 1.74, p = 0.365).

a)



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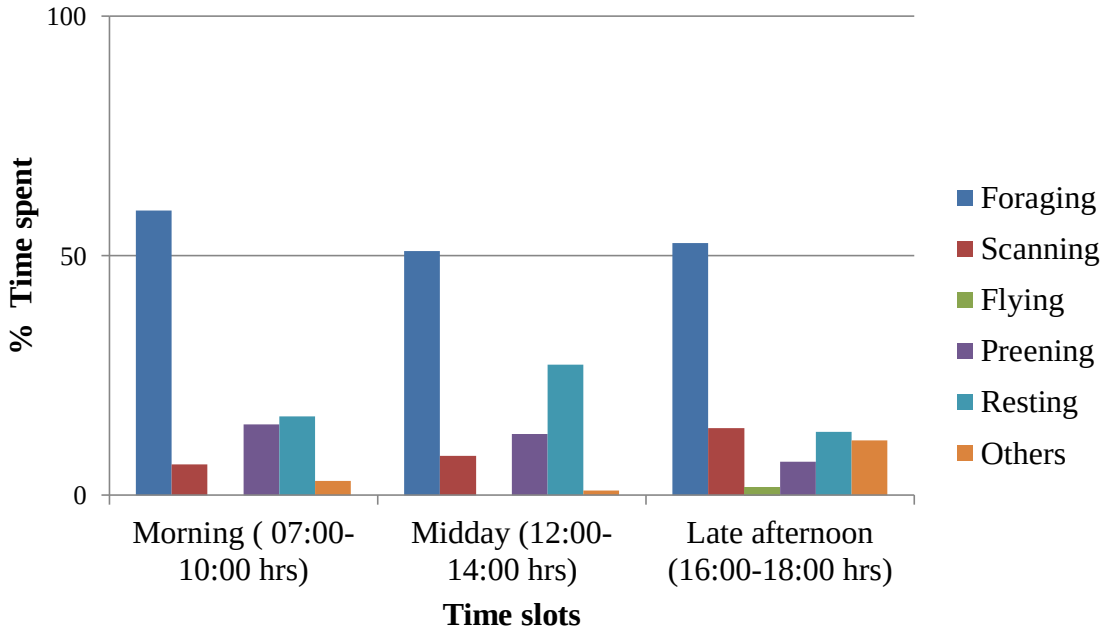

Figure 6: Activity patterns of Abyssinian blue-winged goose in three time slots during a) wet season and b) dry season

4.2. Foraging Habit

The Abyssinian blue-winged gooses were seen foraging on marshlands, at the edges of the ponds, on open grasslands as well as on the farm lands. They were not seen in the early hours of the morning in both seasons. They graze in pairs, family parties. After a drink, Abyssinian blue-winged goose shake their body and walking slowly; they patrol their foraging area and peck at the ground, randomly picking up food.

In both seasons, farmlands along the side of their habitat were frequented by a number of livestock. Other species like that of Wattled ibis (*Bostrychia carunculata)*, White-collared pigeons (*Columba albitorques*), Moorland Francolin (*Scleroptila psilolaema*) were also observed in the foraging area of the Abyssinian blue-winged gooses.

4.2.1 Food items consumed

The Abyssinian blue-winged gooses were observed grazing different types of plant species. The samples which were taken from their foraging area contain several plant species. The identified plant species were mostly from the families Asteraceae, Cyperaceae, Fabaceae, Lythraceae, Ranunculaceae, Rosaceae, Poaceae and Polygonaceae (Table 2). They were also seen consuming fallen or discarded wheat grains that were available on the farmlands.

Table 2.Plant species consumed by the Abyssinian blue-winged goose

Local Name	**Botanical Name**	**Family Name**	**Type**
Yemider koso	*Alchemilla pedata A. Rich.*	Rosaceae	Herb
	Alchemilla cryptantha A. Rich.	Rosaceae	Herb
Guden	*Ranunculus oreophytus Del.*	Ranunculaceae	Herb
Magit	*Trifolium multinerve A. Rich.*	Fabaceae	Herb
	Lythrum rotundifolium A. Rich.	Lythraceae	Herb
Geten	*Haplocarpha schimperi (Sch. Bip.) Beauv.*	Asteraceae	Herb
Geten	*Haplocarpha rueppellii (Sch. Bip.) Beauv.*	Asteraceae	Herb
Chernfe	*Euryops pinifolius A. Rich.*	Asteraceae	Herb
Nibagin	*Trifolium spp.*	Fabaceae	Herb

Dehanet	*Alchemilla cryptantha A. Rich.*	Rosaceae	Herb
Setie fafa	*Cyperus spp.*	Cyperaceae	Herb
Tult	*Rumex spp.*	Polygonaceae	Herb
Gich	*Cyperus spp.*	Cyperaceae	Herb
Teseri	*Pennisitum spp.*	Poaceae	Herb

4.2.2 Picking rate

Abyssinian blue-winged goose feeds by picking. It was their food capturing technique for both wet and dry seasons. They mainly used two types of foraging and feeding techniques to collect their foods: (i) foraging while walking which was mostly used by Abyssinian blue-winged gooses: to find out specific plant species effectively as they are chiefly grazers, (ii) foraging while wading which was very rare because they occasionally consume floating plants in a pond.

The number of average pick per minute by the Abyssinian blue-winged goose has showed no difference between time slots (morning and late afternoon) and seasons (Fig. 7). During the wet season the average feeding rate was 41.8 pick/minute in the morning and 39.73 pick/minute in the afternoon. Whereas, it was 43.68 pick /minute in the morning and 47.94 pick /minute in the afternoon during the dry season.

The average picking rate of the Abyssinian blue-winged goose was 44.57 pick/minute and has shown insignificant variation between the two seasons ($F_{1, 7} = 2.8$, $p = 0.1$). It has also shown insignificant variation between morning and late afternoon during both seasons ($F_{1, 3} = 4.5$, $p = 0.2$).

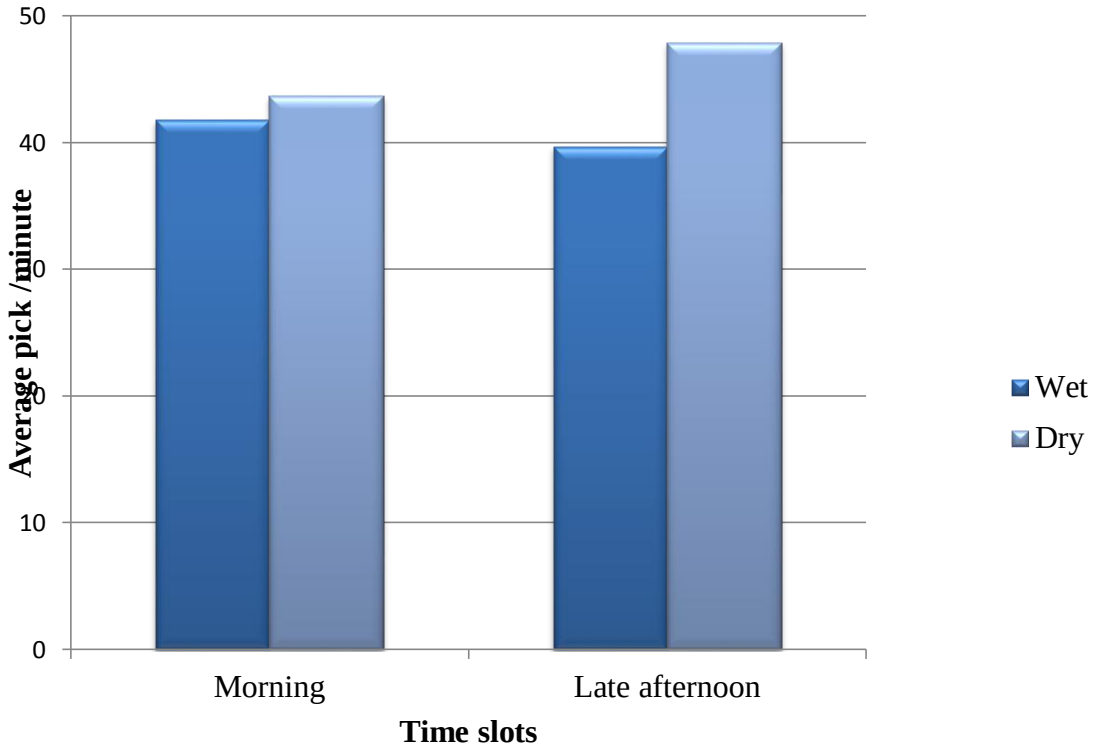

Figure 7: Mean picking rate food items in Abyssinian blue-winged goose in two time slots during wet and dry seasons

5. DISCUSSION

The activity patterns are defined as the proportion of time an animal spent in different activities that are important for its survival and reproduction (Akhtar *et al*., 2013). Abyssinian blue-winged goose exhibited various behaviours (foraging, scanning, flying, preening, resting and others) in response to its daily needs. Among all the diurnal activities surveyed in the study, foraging was dominant throughout the study season; it is followed by resting, then scanning, others, preening and flying.

The differences recorded in seasonal foraging activity indicate that Abyssinian blue-winged goose fed more often during the dry season and less in the wet season. This may reflect the due to scarcity of food items during the dry season that requires the birds to spend more time forging to fulfill their energy requirements (Kidest Ameha and Bezawork Afework, 2018). Furthermore, a wet season provides unfavorable weather condition to forage interrupted by the rain, giving less time for birds to forage. The diurnal time of foraging also varied between times of the day and it peaked at late afternoon between 17:00-18:00hr during the wet season, and in the morning between 8:00-9:00hr during the dry season. A later peak, occurring towards the end of the day may reflect, less human disturbance so that they can forage peacefully. Additionally, this may be due to that they are also active during the night and may start foraging actively in the afternoon which will help them through the night ahead (Kelly, 1998). The increase in foraging at the beginning of the day may be due to the start of their day-to-day activities, which have high energy requirements. It may be also an attempt by individual birds, emerging from their roosts to top up energy reserves lost the previous night.

Activity patterns of Abyssinian blue-winged goose are characterized by the predominance of resting next to foraging. The amount of time spent to resting between different hours of the day significantly varied with seasons. Resting peaked at mid-day between 13:00-14:00hr during both season. This may be due the increase in the heat load on the birds as an increase in resting is a mechanism to minimize the heat load on a bird at high environmental temperatures (Tamisier, 1976). The highest resting time budget during the midday could also be associated with limiting their energy expenditure, as other studies also showed that birds can avoid the adverse effect of ambient temperature by resting

during midday (Martínez, 2000; Brandt and Cresswell, 2009), and thus decrease energy expenditure (Reyes-Arriagada *et al*., 2015).

Scanning activity was the third pronounced activity by the Abyssinian blue-winged goose. This may be due to their small flock size. Since scanning behaviour is affected by flock size (Barbosa, 1995) and the presence of high predation risk in small flock size, the Abyssinian blue-winged goose increase their scan duration to reduce the risk of being taken by a predator. Moreover, Scanning activities by the Abyssinian blue-winged goose significantly differ between seasons. In seasons, scanning was higher during the wet season and lower during the dry season. This may be due to the presence of more chicks in the flocks during the wet season than the dry season, as scanning behaviour enables them to collect information, which is important for their survival, such as detecting predators (Magige, 2017). Additionally, it may be also due to that there is ample food during the wet season, they can get their energy demand with in short period so, they spend more time on scanning.

There was also statistically significant variation of preening activity in different hours of the day between the two seasons. It was highly pronounced in the morning between 9:00-10:00hr during both seasons. The morning peak during the wet season may be due to foraging activity was a peak in the morning and it was mostly accompanied by preening, as preening is the usual bird behaviour a bird performs, after foraging. This may also is due to the increase in temperature towards the midday as preening and plumage maintenance are very important routine activities in waterfowls, involved in thermoregulation. Additionally, the maintenance of plumage in individuals was a primary activity noted on the banks and in the water of pond during both seasons. Good plumage maintenance provides good thermal insulation against the outside cold weather and good insulation against water (Safford and Hawkins, 2020). Preening was also observed in the Abyssinian blue-winged gooses after bathing. This may help them to allay itching, remove ecto-parasites, and clean the feathers so that they can maintain their feather very well (Abadi Mehari Abrha *et al*., 2018). Comfort movements such as shaking (Body-shake, Head-shake, and Wing-flap), stretching (Wing-and-leg-stretch, Jaw-stretch), and cleaning

(Shoulder-rubbing) were also the most frequent activities observed in association with preening activity.

Other activities such as calling, showing agonistic activity were also observed by the Abyssinian blue-winged gooses. There was significant variation of these activities between seasons as well as between different hours of the day. Other activities were higher during the wet season than the dry season. Thus, may be due to that wet season is their breeding season and those agonistic activities such as aggressive behaviours are witnessed during the "breeding season" in defense of the chick, surrounding territory, food supply, and/or mate (Aissaoui *et al*., 2011). In this case, a pair may be bonded to each other but attack any other birds that they perceive as a threat. Regarding the variation between the different hours of the day, other activities were highest at the midday between 13:00-14:00hr during the wet season and in the late afternoon between 17:00-18:00hr during the dry season. Midday and a late afternoon peak of other activities may be due to increased human disturbance in relation with the grazing period of livestock, as the major grazing period of livestock is in late afternoon and less regularly around midday (Lyons and Machen, 2000), resulting in the production of high-pitched alarm calls by the birds.

Flying was the least activity of the Abyssinian blue-winged goose during both seasons. The birds usually fly when there is human disturbance, intra-specific and inter-species competition on their foraging area. Bensizerara and Chenchouni (2019) suggested that flying reflects behaviour of escape, avoidance or change of place in order to avoid being predated by terrestrial or aerial predators or to occupy other spots far from other bird species, which reduces competitions for food and partner choice/mate and also antagonistic behaviour. In fact, the Abyssinian blue-winged goose is a very shy species and on the slightest disturbance, either it flies to other locations quiet and secure or hide itself in the adjacent grasslands. Flying activity may also mean to search for suitable feeding habitats.

The Abyssinian blue-winged gooses main foraging habitats were marshlands, open grasslands and farmlands. There was variation observed in the group size and distribution of Abyssinian blue winged-gooses in these areas, during the wet and dry seasons. The

group size was more during the wet season than the dry season. This may be due to the changes of food source. The growth of different vegetation following the rainfall provided more food during the wet season, thus the Abyssinian blue-winged goose were distributed widely in all area in search of food in wet season than dry season (Tewodros Kumssa and Afework Bekele, 2013).

Abyssinian blue-winged gooses were solitary in their foraging habits. Thus, they were seen feeding in smaller and more dispersed flocks in their foraging area. Intraspecific niche partitioning was also observed as the birds were usually in flock size of two dispersed in long distance. During foraging, one of the two birds in a flock looks in all directions. When they spot a person or any other intruder, they watch suspiciously. In the meantime, the one gives call signal and fly then the other follows. Any sign of life or movement will drive them away from their foraging area.

Abyssinian blue-winged gooses were seen exploiting a wider range of plant species. This may be to adapt better by adjusting their diet or shifting their ranging patterns in their habitat. Additionally, foraging on different kinds of plant species may be in order to maximize their energy intake as well as to meet both energetic and nutritional demands (Prop and Vulink, 1992). Furthermore, they were observed foraging on the same ground that has similar type of plant species in both seasons. These may be due to that the plants inhabit aquatic environment and are present throughout the year (Njeri and Kinyamario, 2012).

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

The study provided knowledge about the poorly known diurnal activities of the Abyssinian blue-winged goose between seasons and between different hours of the day, as well as their foraging behaviour. Seasonality and the time of the day were taken as a key factor that influences the diurnal activity patterns of the Abyssinian blue-winged goose.

Abyssinian blue-winged goose spent different proportion of time in different activities. They spend most of their time on foraging activity during both seasons. Resting and scanning are also the two predominant activities throughout the study period. Foraging, scanning and others activities has shown statistically significant variations between the two seasons. With respect to the different hours of the day, preening, resting and other activities have shown statistically significant differences.

The Abyssinian blue-winged goose feed on plants. They feed by using picking technique and there is no significant variation in their mean average picking rate between the two seasons. Their foraging habitats are mostly marshlands, open grasslands and farmlands. Their diet preference are mostly from the families Asteraceae, Cyperaceae, Fabaceae, Lythraceae, Ranunculaceae, Rosaceae , Poaceae and Polygonaceae .

The study of Abyssinian blue-winged goose activity budget and foraging behaviour has increased our understanding of this species' habitat utilization and intraspecific niche partitioning, as well as their use of time among each activity, habitat, and climatic condition.

6.2. Recommendations

- It would be important to conduct detailed study on the population of the Abyssinian blue-winged goose throughout MGCCA as it is necessary in order to maintain the population of birds at the present levels and to improve future populations, since few sites were covered during the study period.
- Further investigations on the birds feeding behaviour such as stomach content analysis, fecal sample analysis, use of stable isotopes/mercury concentrations and next-generation sequencing (NGS), will be helpful in providing better understanding of dietary habitats and guide development of effective conservation strategies for the species.
- Additional future research is also likely to uncover interaction of Abyssinian blue-winged goose and other sympatric bird species in the MGCCA which will be important to conserve and maintain the ecological balance.
- Since, the Abyssinian blue-winged goose is endemic species; lots of attention should be given for the conservation and maintenance of their habitat type. The management and planning of their habitat should be the primary goal for the managers of the MGCCA, as this will be helpful in retaining the attractiveness of the area as an important tourist destination.

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APPENDICES

a) 

b) 

c) 

d) 

e) 

Appendix 1: Abyssinian blue-winged goose in different activities a) Foraging, b) Scanning, c) Resting, d) Preening, e) Others (Photo:Tsedenia Solomon, 2021)

a) 

b)

c)

d)

Appendix 2: Foraging habitats of the Abyssinian blue-winged goose a) Marshland, b) Water pond, c) Open grassland, d) Farmland (Photo:Tsedenia Solomon, 2021)

Appendix 3: Livestock grazing on the foraging areas of the Abyssinian blue-winged goose (Photo:Tsedenia Solomon, 2021)

a) Yemider koso (*Alchemilla pedata A. Rich*.)

b) Guden (*Ranunculus oreophytus Del*.)

c) Geten (*Haplocarpha schimperi (Sch. Bip.) Beauv*.)

d) Chernfe (*Euryops pinifolius A. Rich)*

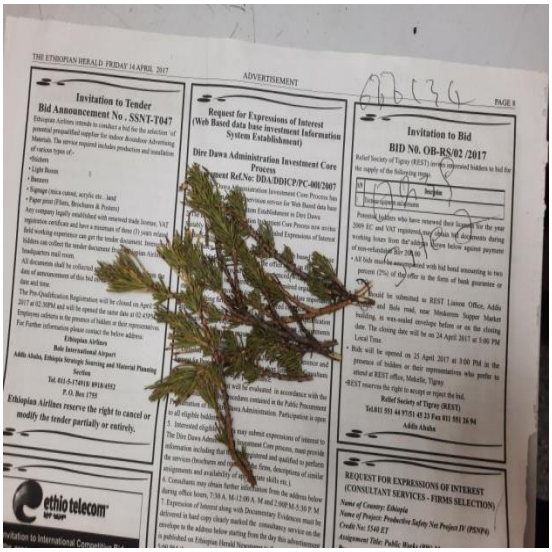
e) Nibagin (*Trifolium spp*.)

f) Dehanet (*Alchemilla cryptantha A. Rich.*)

g) Teseri (*Pennisitum spp.)*

Appendix 4: Plant species identified from the foraging area of the Abyssinian blue-winged goose (Photo:Tsedenia Solomon, 2021)

a) 

b) 

Appendix 5: Plant press for species identification (Photo:Tsedenia Solomon, 2021)