Addis Ababa University

School of Graduate Studies

College of Natural and Computational Sciences

Department of Zoological Sciences

Ecological Studies on Egyptian Goose (*Alopochen aegyptiacus*,Linnaeus, 1766) in the Boyo Wetland Hadiya Zone, Southern Ethiopia

By:

Mulugeta Kassa Aliye

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Biology (Ecological and Systematic Zoology)

Advisors: **Bezawork Afework (PhD)**

M. Balakrishnan(Prof.)

Addis Ababa, Ethiopia

August, 2020

Addis Ababa University

School of Graduate Studies

This is to certify that the dissertation prepared by Mulugeta Kassa Aliye, entitled: "Ecological Studies on Egyptian Goose (*Alopochen aegyptiacus*, Linnaeus, 1766) in the Boyo Wetland Hadiya Zone, Southern Ethiopia" and submitted in fulfillment of the requirements for the Degree of Doctor of Philosophy in Biology (Ecological and Systematic Zoology) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Approved by Examiner Board:

Advisor: Dr. Bezawork Afework Signature ________ Date _______

Advisor: Professor M. Balakrishnan Signature _______Date ________

External Examiner: Professor. Anil Kumar Chhangani Signature_______Date ________

Internal Examiner: Dr. Tilaye Wube Signature ________ Date _______

Chairperson: Professor Afework Bekele Signature ________Date ________

ABSTRACT

Ecological Studies on Egyptian Goose (*Alopochen aegyptiacus*, Linnaeus, 1766) in the Boyo Wetland Hadiya Zone, Southern Ethiopia

Mulugeta Kassa Aliye, PhD Thesis, Addis Ababa University, August, 2020

Egyptian goose (Alopochen aegyptiacus) is a resident bird species in Africa south of the Sahara occurring throughout the entire Nile Valley. Despite the wide distribution, the available information on its population and behavioral ecology is limited in Ethiopia. The present study was carried out in the Boyo wetland and surrounding farmland habitats.The population size, habitat preference, breeding, diurnal activity patterns, feeding ecology and attitude of local people towards Egyptian goose were studied.Total count method was employed to study population size. Breeding season was studied by locating and following active nests throughout the study area. Instantaneous scan sampling technique was used to study their daily activity patterns and foraging behavior. Questionnaire was used to study the attitude of the local people towards the wetland and Egyptian goose. In Boyo wetland, highest population (1652±312.375 individuals) was estimated in August and lowest (367.5± 8.271individuals) in January. Egyptian goose were more abundant during the wet season than during the dry season. The most frequently observed foraging habitat of Egyptian geese was mudflat (56.396%) during the dry season. During the wet season, the most frequently observed habitat of foraging was shallow water (45.25%). The active breeding season was from June to August with majority (55%) of the nests built on trees and 40% on house roofs. Nest materials used by Egyptian geese were grass (90%), branch/steam(90%), leaf (10%) and feather(95%). The mean clutch size of Egyptian goose was 7.43±0.68 (n=14). The mean egg length, width and weight were 67.85±0.32mm, 51.54±0.17mm and 94.11±1.06g, respectively. Hatching success was 67.39%. Resting and foraging behavior were predominant accounting for 39.81% and 32.64% respectively, of the diurnal time budget, followed by comfort movement (10.43%) and the rest was allocated for locomotion, vigilance, social behavior and other activities. Egyptian goose foraged on plant and animal materials including grains, grass, seeds, leaf parts of plants and invertebrates including worms and insects. Grass and seeds were major food sources of geese. Fecal analysis of geese revealed that the diet contained parts of plant matter including grass and seeds, animal matter and unidentified materials at different proportion. Grasses were most frequently observed food items during both wet (100%) and dry seasons (100%). However, seeds and animal matters constituted 95% and 10%, respectively during the wet season and 80% and 5%, respectively during the dry season. The percentage frequency of occurrence of unidentified matter constituted 65% during the dry season and 50% during the wet season. Majority of the local farmers in Boyo wetland had positive attitude towards the wetland habitats. However, 90% consider Egyptian goose as a pest causing high crop damage. Boyo wetland is the main roosting and feeding site for Egyptian goose and other birds. However, agricultural expansion, overgrazing and human population growth have negative impacts on the wetland habitats. Hence, conservation and intervention is required to mitigate these pressures on the habitat and the birdlife in this area.

Keywords: Activity patterns, Breeding, Boyo wetland, diet, Egyptian goose, egg and nest morphometry

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude and sincere appreciation to my advisors, Dr. Bezawork Afework and Professor M. Balakrishnan, for their encouragement, assistance and constant support from the beginning to the end of my research work. Without their help, this dissertation would not have been reached this final stage.

I would like to express my sincere appreciation to the authorities of Shashogo Woreda for sponsoring my graduate study program, and for their financial assistance during the project work. I also thank the School of Graduate Studies and the Department of Zoological Sciences of Addis Ababa University for providing financial and material support, which helped me to facilitate data collection and preparation of the dissertation. I am also grateful to the staff of the National Herbarium for their help in the identification of plant samples.

I would also like to express my appreciation to my field assistants, Yaekob Habebe and Tadele Elias for their continuous support during my field work. My sincere thanks are also due to W/o Mulu Berhe, Zoology Laboratory Assistant for her encouragement and support during laboratory activities.

My heartful gratitude and deepest appreciation go to my father, Kassa Aliye and my brother, Abenet Kassa for their unreserved moral support. I am highly thankful to my wife, Desalech Mustafa for her patience, encouragements and support for the successful completion of my research work.

Finally, I extend my appreciation and gratitude to all those who supported me in one way or the other during my PhD study.

DEDICATION

This dissertation is dedicated to my beloved father, Kassa Aliye and my mother, Worknesh Abode, for their unreserved support during my studies.

TABLE OF CONTENTS

Contents **Page**

LIST OF TABLES xi

LIST OF FIGURES xii

LIST OF PLATES xiii

ACRONYMS xiv

1. INTRODUCTION 1

1.1.Significance of the study 8

1.2. Objectives of the study 9

1.2.1. General Objective 9

1.2.2. Specific Objectives 9

1.3. Research Questions 10

2. LITERATURE REVIEW 12

2.1. Population and distribution of Egyptian goose 12

2.2. Breeding biology 15

2.3. Activity patterns and foraging behaviour 17

3.THE STUDY AREA 20

3.1. Fauna and flora 24

4.1. Materials 27

4.2. Methods 27

4.2.1. Population size 27

4.2.2. Breeding behaviour 30

4.2.3. Diurnal activity patterns 33

4.2.4. Foraging behaviour 36

4.2.5. Attitude of local people towards Egyptian geese 37

4.3. Data analysis 41

5. RESULTS 42

5.1. Population size 42

5.2. Breeding 45

5.2.1. Nest location and characteristics 45

5.2.2. Nest materials and nest morphometry 48

5.2.3. Egg morphometry 51

5.2.4. Breeding performance 52

5.3. Time budget 54

5.4. Foraging behaviour 61

5.5. Attitude of local people towards Egyptian geese 66

6. DISCUSSION 72

6.1. Population size 72

6.2. Breeding 75

6.3. Habitat association 80

6.4. Diurnal activity patterns 81

6.5. Foraging behaviour 84

6.6. Attitude of local people towards Egyptian geese 88

7. CONCLUSION AND RECOMMENDATIONS 94

7.1. Conclusion...94

7.2. Recommendations 95

REFERENCES 97

APPENDICES 118

PLATES 124

LIST OF TABLES

Table 1: Clutch size of Egyptian geese in the Boyo wetland 47

Table 2: Nest materials used by Egyptian geese... 50

Table 3: Nest morphometry of Egyptian geese.. 51

Table 4: Egg morphometry of Egyptian geese 52

Table 5: Nest success of Egyptian geese in different nest types...................................... 54

Table 6: Percentage of food items consumed by Egyptian geese during dry and wet seasons 63

Table 7: Percentage of geese observed foraging in the different habitats during dry and wet seasons... 64

Table 8: Percentage frequency of food items from fecal samples during dry and wet seasons 65

Table 9: Crop damage protection strategies of local people against Egyptian geese 68

Table 10: The major human induced factors which may cause threats to the wetland 70

Table 11: Farmers' participation in different biodiversity conservation activities in Boyo wetland and surrounding habitats.. 71

LIST OF FIGURES

Figure 1: Distribution range of Egyptian goose in the World. 13

Figure 2: Current distribution range of Egyptian goose. 14

Figure 3: Location map of Boyo wetland and the surrounding Kebeles 21

Figure 4: Mean monthly rainfall and temperature of Boyo wetland for ten consecutive years. 24

Figure 5: Different habitat types were used by Egyptian goose in and around Boyo wetland 29

Figure 6: Mean monthly population size of Egyptian goose in Boyo wetland................. 43

Figure 7: Mean population of Egyptian goose in Boy wetland during dry and wet seasons 44

Figure 8: Mean population size of Egyptian geese in different habitat types during dry and wet seasons and both... 45

Figure 9: Percentage proportions of time spent in daily activities of Egyptian geese in different habitat types during the dry season 56

Figure 10: Percentage proportions of time spent in daily activities of Egyptian geese in different habitat types during wet season 57

Figure 11: Percentage proportion activity of Egyptian geese in the different time periods during dry season 58

Figure 12: Percentage proportion of activities of Egyptian geese in the different time periods during the wet season 60

Figure 13: Respondents' view on the benefits of Boyo wetland 69

LIST OF PLATES

Plate 1: Egyptian geese. A) Adult B) Chick in the Boyo wetland habitat 30

Plate 2: Eggs and nest measurement at nesting sites at the Boyo wetland 32

Plate 3: Egyptian geese fecal sample and fecal sample analysis 37

Plate 4: Cattle grazing in the Boyo wetland... 40

Plate 5: Nests of Egyptian geese in different sites 49

Plate 6: A) Incubated eggs on house roof nest, B) newly hatched chicks 53

Plate 7: Different food items consumed by Egyptian geese 62

Plate 8: Egyptian geese damage on teff farm (Left) and harvested sorghum field (Right) 67

ACRONYMS

AEWA	African Eurasian Waterbirds Agreement
BOU	British Ornithologists' Union
CSA	Central Statistical Agency
EFAP	Ethiopian Forestry Action Programme
ENMSA	Ethiopian National Meteorological Service Agency
EWCA	Ethiopian Wildlife Conservation Authority
EWCO	Ethiopian Wildlife and Conservation Organization
EWNHS	Ethiopian Wildlife and Natural History Society
IBAs	Important Bird Areas
IUCN	International Union for Conservation of Nature and Natural Resources
SNNPRS	South Nations Nationalities and Peoples Region State

1. INTRODUCTION

Ethiopia has diverse sets of ecosystems, ranging from humid forest and extensive wetlands to deserts such as Afar depression supporting a wide variety of life forms (EWNHS, 1996; Viveropol, 2001). The high and rugged mountains, deep gorges and huge rolling plains of the country show its topographic diversity (Yalden, 1983). Altitudinal differences with the highest peak of Ras Dashen (4643 m asl) and the lowest in the Afar depression (120 m below sea level) are the reasons for the highest biodiversity in Ethiopia (Shibru Tedela, 1995; EWNHS, 1996).

There are over 1850 species of birds in Africa. Out of these, 926 bird species are found in Ethiopia. Among the bird species that occur in Ethiopia, 21 are endemic and 19 are globally threatened (Lepage, 2006; Redman *et al*., 2009). A total of 73 hotspots have been identified as Important Bird Areas (IBAs) in Ethiopia. Thirty of these sites (41% of the total) comprise wetlands, while the rest represent other types of ecosystems (Mengistu Wondafrash, 2003).

Ethiopia, with its different geological formations and climatic conditions, is endowed with substantial water resources and wetland ecosystems. It includes 12 river basins, eight major lakes, many swamps, flood plains and man-made reservoirs. According to Ethiopian Forestry Action Programme EFAP (1989), 110 billion cubic meters of water runs off annually from the above water body sources. Wetlands are productive ecosystems that can play important roles in socio-economic development, if they are efficiently used on a sustainable basis (Mengistu Wondafrash, 2003).

Ethiopian wetlands are currently being lost or altered by several factors. Some of the factors are water diversion for expansion of agriculture, urbanization, flood control activities, dam construction, pollution and other anthropogenic interferences. Human impacts have been substantially responsible for the increased rate of extinction in the recent past (Wilson, 1992).

Tesfaye Hundesa (1990) listed 58 major lakes and marshes in Ethiopia and Eritrea. Hillman (1993) listed a total of 77 wetlands in Ethiopia and Eritrea, together with their locations. He assessed that Ethiopian wetlands cover an area of 13,699 km^2 or 1.14 % of the country's land surface. At the local and more specific level, wetlands can be grouped according to their habitat type, physical and biological characteristics.

Wetlands have direct values that include both production and consumption of goods. These are the raw materials and physical products that are used directly for production, consumption and sale as well as those that provide energy, shelter, food, agricultural production, water supply, transportation and recreation. Wetland ecosystems provide ecological functions, which maintain and protect nature and human systems through services such as maintenance of water quality, flow and storage, flood control, sand storm protection, nutrient retention and microclimate stabilization, along with the production and consumption activities that they support (Tesfaye Hundesa, 1990).

Wetland is the collective term for an ecosystem whose formation has been dominated by water and whose processes and characteristics are largely controlled by water. The complex interactions between biotic and abiotic components of wetland systems make them amongst the earth's most productive ecosystems. Wetlands are very important for diverse values that they freely provide. They constitute a resource of great economic, cultural, scientific and recreational values. They are described both as 'the kidneys of the landscape' because of the functions they perform in the hydrological and chemical cycles, and as 'biological supermarkets' because of the widespread food webs and rich biodiversity that they support (Mitsch and Gosselink, 1993).

Wetlands are shelters for uncountable species of fauna and flora, including diverse species of birds (Carp, 1980). Many wetlands are well-known because of their birdlife. Around 12% of all African bird species are found in and around wetlands (Mafabi, 1995). In Ethiopia, 204 (around 25%) of bird species are wetland-dependent. While many of these birds are known, their habitats remain unexamined.

There are two categories of water birds; wetland specialists and wetland generalists. Wetland specialists are those birds that construct nest, feed and roost in wetland habitats. They are only dependent on aquatic habitats, and cannot survive in other habitats (Airinatwe, 1999). Examples are ducks, gulls, herons, waders, crakes, and the Black-crowned crane. Wetland generalists are those birds frequently found in wetlands, but are seen in other habitats as well, such as ibises, herons, some weavers, warblers, plovers, etc. Cranes, for example, are generally regarded as terrestrial birds, but breed solely in wetlands, particularly preferring seasonal grass swamps (Mengistu Wondafrash, 2003).

Birds can be used as bio-indicators with which to identify wetlands of international importance. International action for wetland conservation started with birds and the

Convention on wetlands become internationally important in the conservation of waterfowl habitat (Mafabi, 1995). Birds are the single cause for the formulation and development of Ramsar and Bonn Conventions and the African-Eurasian Migratory Waterbirds Agreement (AEWA). Presence of birds contributes towards the designation of important sites for conservation, lending support to the Biodiversity Convention.

Birds are excellent bio-indicators of healthy biodiversity or productivity in an area (Peakall and Boyd, 1987; Bibby *et al.*, 1992; EWNHS, 1996; Ash and Atkins, 2009). They are also important in monitoring environmental changes because of their ecological diversity (Jarvinen and Vaisanen, 1979; Kleinheinz *et al.*, 2006). But, there are some birds, which are on the brink of extinction due to several factors, particularly the human induced or anthropogenic factors (Dorst, 1971). Currently, habitat destruction is the largest single threat to biodiversity, and the spread of agriculture into natural habitats alone threatens 1,065 species of birds (BirdLife International, 2008). Ethiopia, like a number of other African countries, is experiencing serious environmental problems as a result of deforestation, overgrazing, agricultural encroachment and due to unregulated use of agrochemicals in farmlands.

Geese are grouped in two families; namely, Anatidae and Anseranatidae. Anatidae family includes ducks, geese, and swans. It includes 10 sub-families, three of these are Anserinae, Tadorninae and Plectropterinae, which are related to geese and swans. This group comprises 12 genera, 36 species, 47 sub-species and 44 extinct species of geese (Makram, 2018). Anseranatidae family includes one species of goose, Magpie goose

(*Anseranas semipalmata*) and three extinct genera; namely, *Anserpica*, *Anatalavis* and *Eoanseranas*.

Geese were one of the oldest birds that have been domesticated in the world and were a part of the history of several countries. This is evident from the archaeological sites in Egypt, in addition to the pictures on the walls of temples. Similarly, geese were holy birds of Romans. In several countries such as Egypt, China and Thailand, geese were the main birds in human settlements in order to utilize farm waste products efficiently, providing small-scale farmers with a source of additional income and a much needed animal protein source (Zhang Jian, 1991).

Geese are the most widespread bird in the world due to its ability to adapt for different environmental conditions. They are found in hot and cold areas. They are particularly well adapted to aquatic areas and marshlands, and are fully at home in warm and shallow water bodies. Some geese in breeding season have spread in several environments outside their original environment; for example, Toulouse goose in France, Chinese goose and African goose, because their ability to adapt on various environmental conditions (Makram, 2018). In southwestern United States, Cotton Patch goose breed were once used widely for weed control in special crops such as asparagus, berries, mint, tobacco, beets, beans, hops, onions and potatoes. They are useful for many purposes such as weeding, as a source of meat, eggs and feathers (Makram, 2018).

The Egyptian goose is placed in the family Anatidae, sub-family Tadorninae, genus *Alopochen* and species *Alopochen aegyptiaca*. This species is one of the birds that had been tamed in Egypt by the ancient Egyptians for a long period. Egyptian geese were raised because of the beauty and variety of the color of the feather, and hence raised for decoration in palaces and temples (Makram, 2018). They are no longer widely distributed in Egypt, but found in the south in Aswan governorate, widespread in the rest of Africa in the forests and migrated to Europe because of their ability to adapt to the hot and cold weather conditions (Makram, 2018).

Egyptian goose is one of the waterfowl species that occurs in Ethiopia and Africa generally south of the Tropic of Cancer in or near by open country wetlands, meadows and grasslands. Its distribution is known mostly in the upland or highlands of Ethiopia, recorded within an elevation of 4000 m, avoiding only densely-wooded country (Blair *et al*., 2000). Historical records show that this species occurred across large areas of Ethiopia with its largest number during the wet season in Boyo wetland habitat. It has become rare in the northern Nile Valley, but the population has increased in southern Africa, where extensive irrigation systems have provided suitable habitats around arable crops, where it grazes, becoming a pest (Blair *et al*., 2000).

Egyptian goose is an African species breeding south of Sahara and in the Upper-Nile Valley. This species is classified as “Least Concern”, not globally threatened under the revised IUCN Red List criteria (BirdLife International, 2018). It is a non-migratory and resident species (Johnsgard, 2010). African populations show no regular migration, but making irregular movements up to 1000 km in response to the change of wet and dry seasons such as to changes in water and availability of food and presence of breeding ground (Oatley and Prŷs-Jones, 1985).

The Egyptian goose is large (61-75cm long) and distinctively patterned. The adult plumage is predominantly grayish on the head, neck, breast, under parts, flanks, and back, with darker, chocolate brown tones around eyes, nape, on upper wing coverts, and with an irregular blotch on the lower breast. The primaries, tail feathers and rump are black, while the secondaries are iridescent green and the upper wing coverts are white except for a narrow black bar extending across the front of the greater secondary coverts (Johnsgard, 1978). Bill, legs, and feet are pink (Mackworth-Praed and Grant, 1980).

They can be conspicuous with features including shaggy, tan-colored neck feathers, a dark, glossy green speculum, and a chestnut patch around eyes. In general, males cannot be distinguished from females by plumage, although they may be somewhat larger (Johnsgard, 1978). Todd (1979) remarked that males are brighter in color and have a darker and larger chestnut patch on the breast. Among immatures the white upper wing surface is tinged with black coloration, and the brown marks around eyes and on breast are lacking.

Limited information is available on the population status and its ecology (Mangnall, 2001; Smith and Fames, 2012; Pranty and Ponzo, 2014; Chesbro, 2015; Callaghan and Brooks, 2016) and diurnal activity patterns. Studies on the breeding biology of Egyptian goose have been conducted mainly in captivity (Braun, 2004). But, detailed information on the population size and ecology in Ethiopia is lacking.

Egyptian goose is mostly dependent on perfect wetland ecosystem, which is the most productive ecosystems on earth. Unfortunately, these wetlands are also the most threatened ecosystems due to agricultural expansion, dam construction and unsustainable utilization of water as well as pollution and climate change related threats (Brinson and Malvárez, 2002; Mitsch and Hernandez, 2013). Application and implementation of any conservation measure towards a species or the habitat it depends, needs a scientific study of the target species and the habitat where they live and interact (Dugan, 1990).

In order to assess the total population, distribution, geographic range and movement, breeding behavior, diet and foraging behavior as well as habitat use and preferences and interaction with the environments ecological studies are required (MacMillan *et al*., 2004). But, information is lacking on the Egyptian geese population and ecology in Ethiopia. Hence, this study was aimed at investigating the population and behavioral ecology of Egyptian goose for the conservation of the species and the wetland habitat that it depends on.

1.1.Significance of the study

Results of the present study are expected to provide information about the population and ecology of Egyptian goose in Boyo wetland, Hadiya Zone, Southern Ethiopia. In addition, it will serve as a baseline data for other researchers interested to carry out further research on the ecology of the Egyptian goose in different habitats in Ethiopia. Furthermore, understanding population, breeding and feeding behavior of the species, habitat use and preference and its interaction with its local people are important for its conservation.

The above set of information had been lacking on the Egyptian goose population in Ethiopia, where it is vital to design a biologically sound conservation strategy for the species and its habitats to maintain its population and survival of the species and wetland habitat. Hence, this study is planned to gather detailed information on the ecology of the species, which are fundamental for the conservation of the species and the wetland habitat it depends on.

1.2. Objectives of the study

1.2.1. General Objective

The general objective of this study was to assess the population size, breeding season, diurnal activity patterns and feeding ecology of the Egyptian goose (*Alopochen aegyptiacus)* and to understand the attitude of local people towards this species in the Boyo wetland Hadiya Zone, Southern Ethiopia.

1.2.2. Specific Objectives

The specific objectives of the study were: To:

- ✓ study the population size of Egyptian goose in the Boyo wetland and surrounding farmland habitats
- ✓ study habitat preference of Egyptian goose in Boyo wetland

- ✓ study the breeding season of Egyptian goose
- ✓ investigate the time budget of Egyptian goose among the different habitat types in Boyo wetland
- ✓ assess diet composition of Egyptian goose
- ✓ assess the attitude of local people towards Egyptian goose and its habitat in the Boyo wetland

1.3. Research Questions

- ✓ What is the population size of Egyptian goose in Boyo wetlands?
- ✓ What factors influence the population dynamics of Egyptian goose during dry and wet seasons?
- ✓ What is the distribution pattern and habitat preference of Egyptian goose in Boyo wetland area?
- ✓ What is the reproductive ability of Egyptian goose nesting in and around Boyo wetland habitat?
- ✓ What type of nesting materials they use for nest construction?
- ✓ Where do Egyptian goose build their nest?
- ✓ What is the morphometric characteristics of Egyptian geese nest and eggs?
- ✓ What is the average clutch size, hatching success and survival of chicks to fledging in and around Boyo wetland habitats?
- ✓ What is the diurnal activity pattern of Egyptian goose in Boyo wetland habitats?
- ✓ What are the foraging strategies of this species during dry and wet seasons?

- ✓ What is the preferred food of Egyptian goose during dry and wet seasons?
- ✓ How do local people around Boyo wetland interact with Egyptian goose?
- ✓ What are the main threats and conservation practices of the wetland habitats in Boyo?

2. LITERATURE REVIEW

2.1. Population and distribution of Egyptian goose

The Egyptian goose is one of the non-native waterfowl species in Europe and in its native range in Africa, particularly south of the sub-Saharan Africa with a population greater than 500,000 individuals (Davies, 2005; Banks *et al*., 2008) (Figure 1). It is a widespread species. In addition to the native populations, they have successfully established populations in Europe and are considered one of the most rapidly spreading invasive species (Rehfisch *et al*., 2010; Gyimesi and Lensink, 2012). In North America, they occur in Florida, Texas and California, among other regions (Pranty and Ponzo, 2014). Egyptian goose is categorized as “Least Concern” by IUCN (BirdLife International, 2018).

Egyptian goose is found throughout Africa South of the Sahara, except in forests and deserts. Even in these areas, it is adaptable, capitalizing on forest clearance and in short-lived water bodies generated by restricted rains (Maclean, 1988). It occurs from the southern tip of Africa to the Sahel; being absent only from the most densely wooded parts of Angola (Dean, 2000) and the Congo basin, in addition to the most dry parts of Namibia and the Horn of Africa (Ash and Miskell, 1983) (Figure 2).

In its natural range, Egyptian goose population in West Africa has been estimated at 10, 000-20,000 individuals, with diminishing numbers (Gyimesi and Lensink, 2010). However, in East and South-Africa, the population is estimated at 205,000-510,000 individuals, increasing rapidly in numbers; i.e. more than 10% increase per year on average. The European introduced population was estimated at around 10, 000 breeding pairs (Bank *et al*., 2008; Gyimesi and Lensink, 2010).

Figure 1: Distribution range of Egyptian goose (*Alopochen aegyptiaca*) in the World (Source: BirdLife International, 2019).

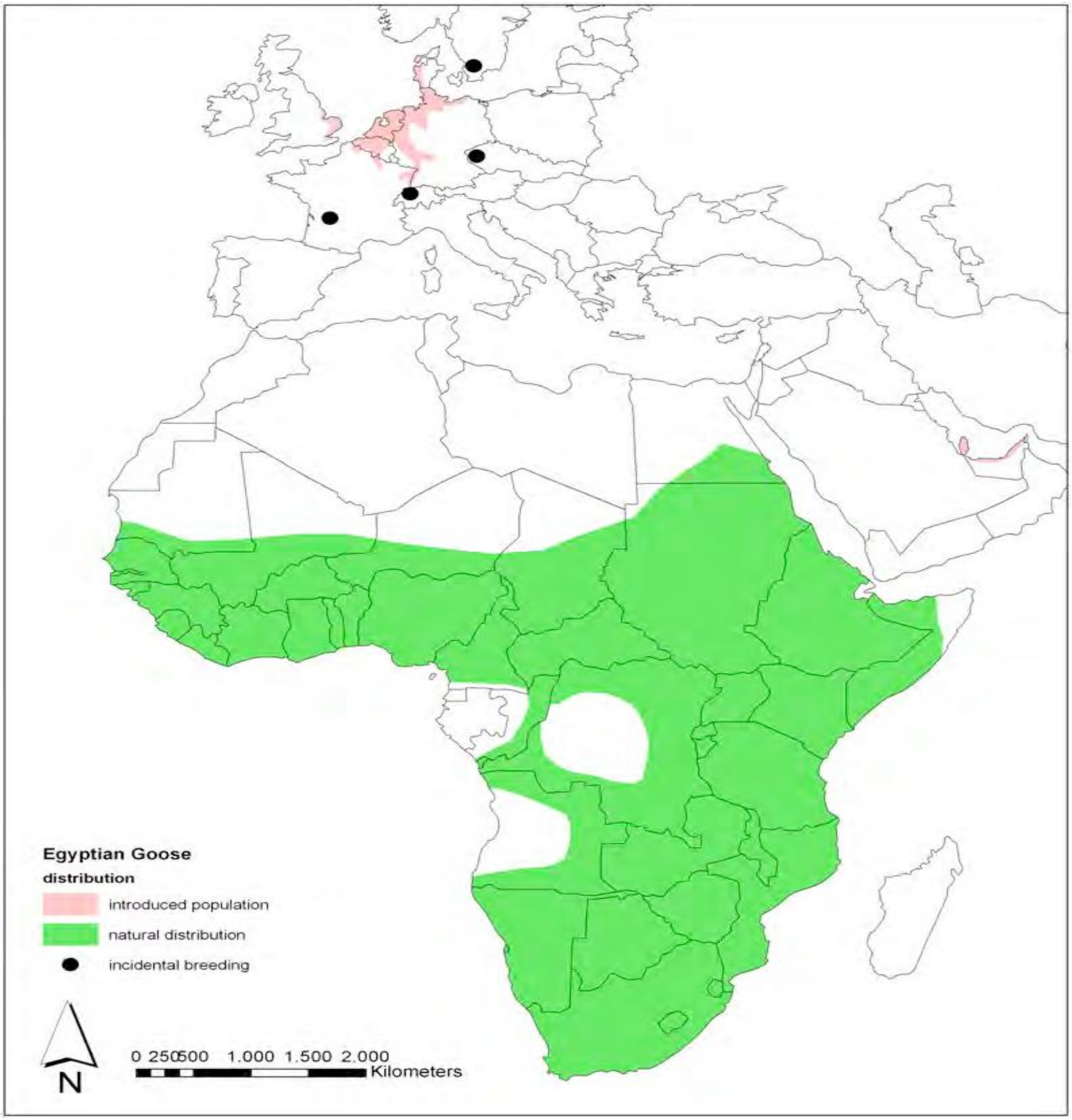


Figure 2: Current distribution range of Egyptian goose (*Alopochen aegyptiacus*); natural and introduced populations (Source: Banks *et al*., 2008).

2.2. Breeding biology

Egyptian geese form monogamous pair bonds and breed freely in nature and in captivity. In captivity, they do not breed before their second year. Pairs mate for life and flocks often consist of small family groups (Harrison, 1978). Johnsgard (1978) stated that they are territorial, and intensive threatening or fighting behavior among males is typical. Todd (1979) stated that they are among the most vicious of all waterfowl, especially when nesting.

Egyptian goose nesting is extremely extended in some areas: such as in Zambia, where it ranges from November to January, but the largest number of records is from June through September. In South Africa, the peak nesting activity occurs from July to October (Johnsgard, 2010). In tropical Africa, breeding activity occurs most of the year, whereas populations of Egyptian geese in the northern parts of Africa extend from July to October, in Senegal, July to September, Sudan, July to August, Ethiopia during the beginning of the wet season (Johnsgard, 2010).

Nest site is extremely variable, ranging from burrows or holes in the ground to nests in trees or on cliffs, among herbaceous ground cover, or on top of an old or incomplete nest of other birds, especially the Hamerkops (*Scopus umbretta)*. There are even records of nesting among colonies of cliff-nesting vultures (Johnsgard, 2010).

Nest is also usually well constructed of available nesting materials and lined with smoke gray down by the female. Egyptian geese have clutches containing 6-12 eggs; with average clutch size of seven, that are incubated by the female for 28 - 30 days (Tattan, 2004). The length of the incubation period varies among species and with the climatic regime. Both sexes aggressively defend the nest and young. Goslings leave the nest shortly after hatching and fledge after 70 days (Tattan, 2004). The sex of goslings is indistinguishable by plumage, but females are smaller than males. Juveniles resemble adults, but have greyer plumage that lacks the dark brown breast spot and eye patches (Mullarney *et al*., 1999).

In South Africa, an investigation of 654 clutches gave a range of 5 to 11 eggs and a mean clutch size of 6.7 (Maclean, 1993). In Netherlands, mean clutch size is higher, i.e. 7-8 eggs, with a maximum of 16 (Maclean, 1997). Eggs are creamy white and are rounded at both ends with an average size of 68.4x51.3mm (with a range of 57.9-75.8x46.0-57.7 mm in South Africa). Weight of eggs is on average 98g with a range of 78.5-110g. The newly hatched young leave the nest after about six hours by jumping in response to a call by the mother (Maclean, 1993). Both parents care for the young after they leave the nest, while the hatchlings feed on their own from almost day one. Goslings can fly at about 11 weeks; however, may continue to associate with the adults as a family group for several weeks, or even months (Brown *et al.*, 1982).

2.3. Activity patterns and foraging behaviour

Geese are highly selective herbivores. They can differentiate different plant species, individual plants of the same species, and different parts of the same plant (Prins *et al*., 1980; Owen, 1980). There can be several factors to influence a goose's food selection process. They select foods that are rich in protein and energy. They also avoid plants with high levels of secondary metabolites that are poisonous or interfere with digestion (Conover, 1991).

Egyptian geese feed by grazing on land, consuming grass, leaves, seeds, grain, aquatic rhizomes, and tubers and rhizomes of *Cyperus*. They have become pests in grain farming areas, where they occur in large numbers (Maclean, 1988).The diet of the adult Egyptian goose includes, shoots, seeds, grasses and flowers of herbs, as well as rhizomes and tubers of *Cyperus* (Johnsgard, 1978). Egyptian geese often feed in fields of emergent grain crops, and sometimes cause considerable damage to crops. Most of the time foraging is done in the early morning and in the evening hours, but they also forage at night and rest during the hottest periods of mid-day (Johnsgard, 2010).

Egyptian geese are primarily herbivores, feeding on grasslands at times far away from water bodies. They also feed on aquatic vegetation and animal prey such as worms, insects, and frogs (Tattan, 2004). Maclean (1988) listed the food items of the Egyptian geese as grass, seeds, leaves, grain, crop seedlings, aquatic rhizomes and tubers, and infrequently insects. Flocks of Egyptian geese loaf close to the shoreline during the mid-day and fly out from roosting habitat to feed in agricultural lands in the early mornings and late afternoons (Halse, 1985). In the Western Cape province of South Africa, farmers regard Egyptian goose as a serious pest, especially during the germination periods of the months of April-July and harvesting periods during October- December (Jancikova, 1996).

Studies have shown that grazing by geese causes significant reduction in grain yield (Patterson, 1991). Globally, the conflict between geese and farmers has increased over the past few decades as many goose species have evidently increased in numbers, particularly in Europe, and have, in some cases, caused serious damage and losses to cereal crops (Ankney, 1996; Vickery and Gill, 1999). Associated with these population increase are complaints by farmers of damage to crops and financial losses, and demands that something is to be done to reduce the damage. There have been increasingly frequent claims of agricultural damage, and different methods have been used and proposed to mitigate (Aguilera, *et al*., 1991).

Most traditional methods such as scarecrows and propane cannons are ineffective in the long term or are excessively costly; and mitigate the problem only partially, or effective for only a short period (Aguilera, *et al*., 1991). In addition, policy instruments and management measures involved in the mitigation of crop damage conflict should be developed in a way to encourage farmers to tolerate geese within limits (Van der Sar, 1992). Egyptian geese populations have increased with urbanization and agriculture (Scott and Rose, 1996; Hockey *et al*., 2005). Such increased populations have caused crop damage, as reported by Mangnall and Crowe (2001, 2002) for Canada geese (*Branta canadensis*) in the United States and Britain.

In South Africa, Egyptian geese cause damage to crops and agricultural lands, resulting in extensive economic losses (Mangnall and Crowe, 2002; Atkins, 2015). Their rapid population growth has led to an increase in the number of conflicts with people and human related activities, particularly within urban and sub-urban landscapes (Mangnall and Crowe, 2002; Stephen, 2008). They are also often observed as pests on golf courses and in public parks (Little and Sutton, 2013; Mackay *et al.*, 2014). In South Africa, such conflict exists between native Egyptian geese and the managers and users of golf courses (Little and Sutton, 2013).

3.THE STUDY AREA

Boyo wetland is located in Southern Nations Nationalities and Peoples Regional State (SNNPRS) of Ethiopia, about 300 km away from the capital city of Ethiopia, Addis Ababa, 60 km far to the north of Hosaena town and 26 km north of Hlaba Kulito town, in the Hadya Zone of Lemu District of Ethiopia.

Boyo wetland is located across the Great Rift Valley in the Central Rift Valley area of Ethiopia, between 07º28'-07º32'N and 38º00’-38º40'E (Figure 3) (EWNHS, 1996). The Central Rift Valley area of Ethiopia consists a chain of lakes, streams and wetlands with unique hydrological and ecological characteristics. Its wide diversity of landscapes and ecosystems comprise extensive biodiversity-rich wetlands, which support a wide variety of endemic birds and other wildlife (Dagnachew Legesse and Tenalem Ayenew, 2006; Jansen *et al.*, 2007). Altitudinal ranges of the wetland vary from 1850 to 1900 m asl. It is a fresh water wetland, and is swampy (Yilma Delelegn, 1998; Hadis Tadele, 2018).

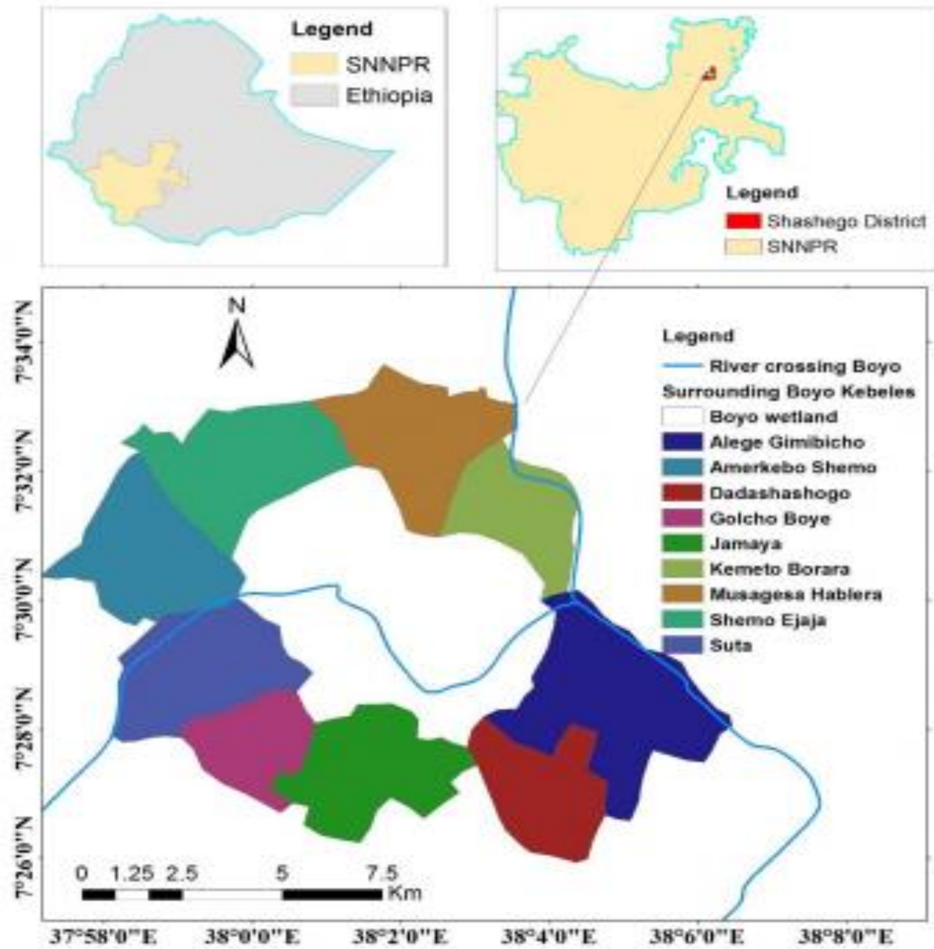


Figure 3: Location map of Boyo wetland and the surrounding Kebeles

During the peak wet season in August and September, the whole area of the wetland becomes flooded and the water level rises higher, causing huge area of farmlands and a number of houses submerged. Mostly, the farmland areas to the north, south and west of the wetland become submerged. It is during this time that the area of the wetland reaches its peak size covering around 4, 958 ha. During the peak dry season, a large part of the wetland dries out and changes to a vast area of grassland used for grazing by local communities living around the wetland. The wetland is surrounded by hills and mountains; Bele Mountains to the north, northwest and west as well as Ambericho Mountain to the southwest. The small town of Doesha is located along the northeast and Bonosha town to the east. Cultivation and human settlements on the lower altitude are found along the four directions of the wetland.

This wetland is part of the Bilate River basin that drains from the Gurage highlands south into Lake Abaya (EWNHS, 1996). It has two main inflows, Bilate River from the southern highland areas of the wetland and Guder River from the Western mountains, near the Zonal capital town of Hosanna and the two combine in Boyo wetland to join Bilate River in the eastern part of the wetland. Guder river is the main river of the wetland contributing a significant amount of water during both dry and wet seasons. Bilate river drains the area along the southeast to join at an easterly point on the edge of the wetland (Yilma Delelegn, 1998; Hadis Tadele, 2018). On the other hand, during the peak wet season, Bilate river diverts its direction and drains to Boyo wetland.

The surrounding highland areas especially those in the western and southern parts of the wetland are the major feeders or sources of flooding. The surrounding hills and highland mountain areas are intensively farmed, where deforestation rate is very high, increasing every year. Therefore, sediment yield to the wetland from these highland mountain areas is significantly high, causing the wetland to decrease its productivity (Hadis Tadele, 2018).

Excessive land degradation, deforestation and irrigation resulted in vast sedimentation, and increase in soil salinity (Dagnachew Legesse and Tenalem Ayenew, 2006). Boyo wetland also suffers a vast human induced factors affecting its long-term survival. Rapidly growing human population is the main factor where people are increasing settlements to the surrounding wetland, especially those people settling to the western and northern parts. The problem of soil erosion has also a substantial impact on the continuity of the wetland, where soil from the surrounding hills is being washed away to the wetland during the rainy season.

Climate around the Boyo wetland is generally characterized by warm, wet summers (most of the rainfall occurring from June to September) and dry, cold and windy winter (from the months of December to March). The mean monthly rainfall of the area ranges from 9 mm in December to 195 mm in July (Figure 4). Maximum temperature of the area reaches 27.4ºC during the warmest month of April and minimum in the coldest month of December (13.6 ºC). As a result, the area can be characterized as a semi-arid climate with a long summer season bringing heavy rains from the Indian and Atlantic oceans because of its location in the Central Rift Valley.

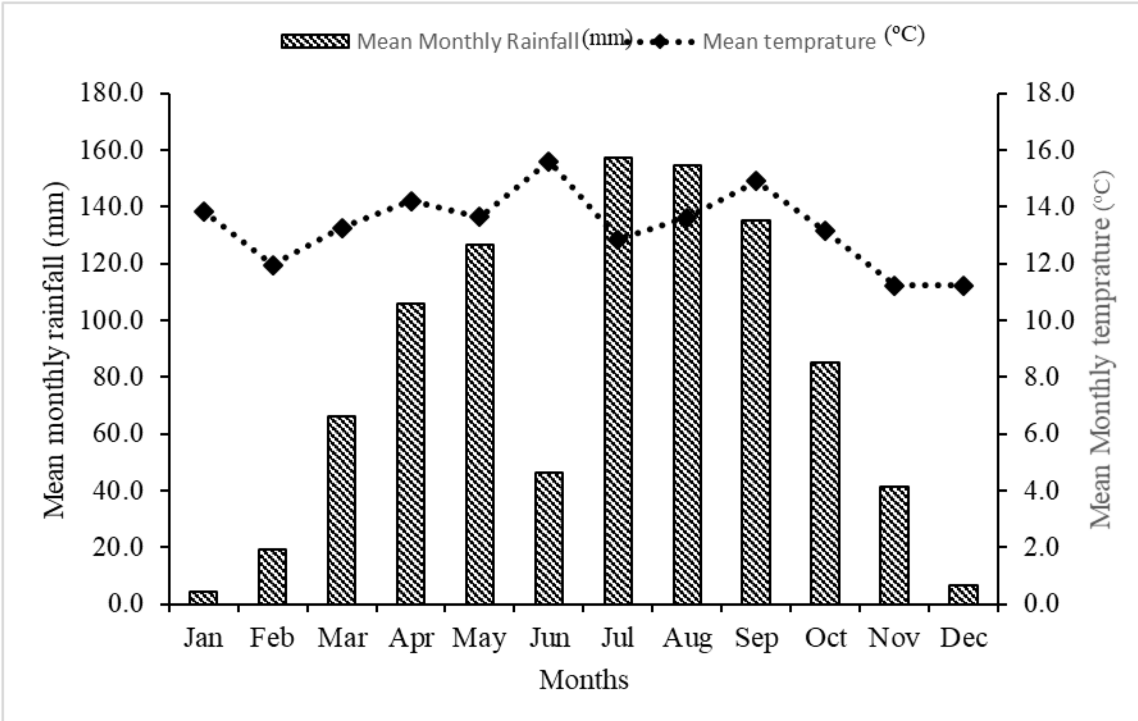


Figure 4: Mean monthly rainfall and temperature of Boyo wetland for ten consecutive years (Source: ENMA, 2008-2017).

3.1. Fauna and flora

Boyo wetland is surrounded by farmlands, human settlements and vast scattered patches of plantations of *Eucalyptus globulus*. In the surrounding farmlands, there are scattered trees of *Ficus vasta* and *Acacia* spp. The wetland is dominated by *Eriochloa fatmensis* and *Eriochloa meyeriana* grasses, which are important for cattle grazing, and *Typha angustifolia*, which is used for thatching of huts. *Aeschynomene elaphroxylon* is also present in the wetland, which local people use as firewood.

In terms of fauna, the area was known to harbor a large number of Hippopotamus *(Hippopotamus amphibius*). According to the local people, in the past, the wetland was full of grass and the number of hippopotamuses was high. As the availability of grass in the area declined due to sedimentation and overgrazing, the hippopotamus started causing damage to crops resulting in direct conflicts with farmers. As a consequence, farmers started killing the hippopotamus by shooting, as a result of which currently left with fewer than three adult hippopotamus in Boyo wetland.

This wetland is known as one of the 69 important bird areas of Ethiopia (Yilma Delelegn, 1998; Hadis Tadele, 2018). It supports a high concentration of water birds estimated to exceed 20,000. The wetland is one of the best wintering areas for Wattled cranes (*Bugeranus carunculatus*), Common cranes (*Grus grus)*, Black crowned cranes (*Pavonina pavonina ceciliae*), Egyptian geese (*Alopochen aegyptiacus)* and Spur-winged geese *(Plectropterus gambensis)*. In addition, this wetland is known for its suitable breeding ground for Black crowned cranes (*Pavonina pavonina ceciliae*) and Egyptian geese *(Alopochen aegyptiacus)*.

3.2. Human population

Boyo wetland is bordered by more than 10 Kebeles (villages). People from these Kebeles directly or indirectly use the wetland to graze their cattle, to cut grass either for traditional house construction or for their cattle as fodder, collect firewood and fetch water for their household use. According to the data from the district office, the wetland is surrounded by a population of more than 42,014 individuals (22,079 males and 19,935 females). Surrounding the wetland, more than 99% of the people are farmers, where they depend on subsistence agriculture (crop farming and cattle rearing). Major crops grown around the wetland are maize (*Zea mays*), wheat (*Triticum aestivum*), sorghum (*Sorghum bicolor*), teff (*Eragrostis tef*) and green chilli (*Nahuati chilli*).

4. MATERIALS AND METHODS

4.1. Materials

During the study period, a telescope (20-60x Swarovski model), binoculars (10x42 Bushnell model), measuring tape and pressing materials were used for observation, for taking measurement and for sample collection, respectively. Compound microscope, glass petri dishes, forceps, slide, cover slip, tray, test tube, distilled water, 75% ethanol alcohol, and small plastic pans were used for fecal sample collection and identification.

A six inch 150 mm Carbon Fiber Composite Verner Digital Electronic Caliper Ruler with accuracy of ±0.2 mm was used to measure length and width of eggs. Digital Pocket Scale was used to measure the weight of eggs at nest site. Garmin GPS 72 was used to record the geographic coordinates of different positions in the study area.

4.2. Methods

4.2.1. Population size

The present study was carried out from October 2016/17–August 2017/18. Population size and seasonal distribution of Egyptian geese were studied during the dry season (December to May) and during the wet seasons (June to November) except in the month of September. The number of geese in the morning and in the afternoon was counted for four days per month. Total counts in all sites were made on the same dates (unified count date). When it was impossible to complete a count in the morning due to bad weather condition, geese were counted as they returned to the same roosting area in the evening the same day, based on the hypothesis that geese generally return to the same location on successive nights to roosting areas (Hadis Tadele, 2018).

Study areas were systematically surveyed on foot monthly and seasonally. All individual geese observed were counted. A telescope (20-60x Swarovski model) and a pair of binoculars (10x42 Bushnell) were used to make clear observations of the species from a distance. To avoid repeated counting of birds, areas were divided based on their distribution and habitat types. For larger number of birds (>4,000 birds), poor visibility, or both, geese were counted in groups as suggested by Bibby *et al*. (1992). This was achieved by counting birds in estimated groups of 10, 100 or 1,000 (depending on flock size) (Hepworth and Hamilton, 2001). Geese were counted individually, when they were in small flocks, and in units of 10 or 100 in large flocks. Each count was done with the help of at least two field assistants, and the mean was used as the abundance.

To minimize disturbance during counting, movements were silent followed by 3-5 minutes of waiting period to allow them settle down (Sutherland, 1996; Bibby *et al*., 2000). Census data were collected twice a day early in the morning (06:30-10:00 h) and in the afternoon (14:00 - 18:00 h) from all census routes, when most of the avian species were most active (Sutherland, 2000; Shimelis Aynalem and Afework Bekele, 2008). Individuals of adults and chicks were recorded to determine the proportion. The edges of sub-areas were determined beforehand. Inorder to avoid double counts, moved to the next point as rapidly as possible without disturbing birds.

Habitat preference was recorded during census as observed in farmland, grassland, mudflat and shallow water (Figure 5).

A. Farmland B. Grassland

C. Mudflat D. Shallow water

Figure 5: Different habitat types were used by Egyptian goose in and around Boyo wetland (Photo: By Mulugeta Kassa)

Individuals observed were grouped as adults and chicks. Adults were distinguished by their larger size, greyish brown with reddish brown tones on the upper wing coverts, nape and around eyes, a blotch on the lower breast, pink beaks with a black 'frame', light to dark reddish pink legs, dark primaries, rump and rectrices, and large inner secondary feathers. Juveniles were distinguished by smaller size, brown patches around eyes, absence of breast, a double black bar on the white part of their wings, light orange beak and legs, and small inner secondaries (Johnsgard, 2010) (Plate1A and B).

A B

Plate 1: Egyptian geese. A) Adult B) Chick in the Boyo wetland habitat (Photo: By Mulugeta Kassa)

4.2.2. Breeding behaviour

To study the nesting and clutch size of Egyptian geese, field work was conducted for two successive breeding seasons (April through September of 2017 and 2018) in Boyo wetland and surrounding farmland habitats. During these two breeding seasons, intensive ground searching to locate the possible nests of Egyptian geese was undertaken.

During April-August of 2017, preliminary survey for nest searching was done at different sites in the Boyo wetland and surrounding farmland habitats considered to be potential breeding sites based on the presence of grasses, trees and extensive water body, including the availability of food source, which were basic requirements for nesting of Egyptian geese (Johnsgard, 2010). The search involved direct observations from vantage points and from the ground using a telescope and binoculars. Information provided by local people, seasonal and permanent settlers in the Boyo wetland and surrounding farmlands was used as a primary source of information.

When nests were observed, the nest location was recorded with GPS. At the same time, nest platforms were classified and recorded as active (when breeding pairs were observed with eggs or while incubating, hatched or inactive (when breeding pair was observed without egg, but with a nest) (Bêty *et al*., 2001). Whenever nests with cold, uncovered and complete eggs with no goose present were found, such nests were recorded as abandoned. Such nests were repeatedly checked to confirm the nest status (van Kleef *et al*., 2007).

Nests constructed in different sites were measured since the initiation of nesting in April. Nest dimension such as the nest length, width, height from the ground up to the end of nest edge or rim were recorded. A total of 20 nests were measured using measuring tap to determine the nest morphometry. In addition, nesting materials and their surrounding vegetation were carefully noted. Plants used as the nesting materials were collected and identified using the Flora of Ethiopia (Hedberg and Edwards, 1989; Phillips, *et al* 1995; Edwards *et al*., 1997; Hedberg *et al.*, 2003).

When active nests were located, clutch size was recorded. For those pairs located before egg laying, their egg laying dates were recorded accurately through intensive follow-up. The dimensions of egg length, width (maximum diameter) and egg weight were measured using a Carbo Fiber Composite Vernier Digital Electronic Caliper Ruler and Digital Pocket Scale, respectively (Plate 2).

Plate 2: Eggs and nest measurement at nesting sites at the Boyo wetland (Photo: By Mulugeta Kassa)

Active nests were monitored by visiting four to six times during the incubation and post hatching period (April-September each year) to determine reproductive outcome (hatching success and fledging success). Hatching or nesting success was determined by examining the fate of eggs laid at the end of the incubation period or early hatching time and those nests which were considered successful were those which have hatched ≥ 1 eggs (Lensink, 1999; Towery, 2015). Young birds reaching the height of their parents and starting to fly were considered as fledged individuals (Lensink, 1998; Lensink, 1999).

Nest or clutch initiation was defined as the date the first egg was laid in a nest. This was determined through a series of weekly checks (Petersen, 1992; Holderby *et al.*, 2012). For those nests which were found with incubating pairs, dates of nest and clutch initiation were extrapolated deducting from the dates of hatching to determine the peak breeding season (Little, 1995; Lensink, 1999).

Presence of predators (a mammal or birds of prey) either during incubation or during the post-hatching period was recorded through repeated observations during the study period. Predators were considered if they showed frequent presence in the nests site (Bêty *et al.*, 2001). Birds of prey or other animals, which try to take chicks from the parent during post-hatching period were recorded as predators (Eisenhauer and Kirkpatrick, 1977). During the survey period, careful observation was followed to reduce disturbances to the breeding pairs in their breeding habitat as Egyptian goose in particular and geese in general are highly sensitive to disturbances, and they abandon their nest during the nesting period (Petersen, 1992).

4.2.3. Diurnal activity patterns

Behavioral observations were made during dry and wet seasons. Dry season observations were from December 2016/17-May 2017/18 and the wet season observations were from June to November of 2017 and 2018 in the Boyo wetland habitats. Observations were made using a pair of binoculars from early in the morning to late in the afternoon (06:00-18:00 h).

Once flocks or pairs of individuals of geese were located, instantaneous scan sampling was carried out (Altmann, 1974; Sutherland, 2004) to collect the daily activity time budget of the species. This was separately recorded for both dry and wet seasons. Instantaneous scan sampling provides an overall estimate of proportions of an individual engagement in different behaviors (Webb *et al.*, 2011). This involved scanning each individual in turn and categorizing its major activities (e.g. feeding, resting, locomotion, alerting and others behaviors).

Individuals were scanned or observed for five minutes, during which instantaneous behavioral observations were recorded at 15minute intervals (Döpfner *et al.*, 2009; Chudzinska *et al.*, 2013). Total number of birds present in each flock and the habitat were recorded. Observations were restricted to adult birds only as there were only few juveniles in the Boyo wetland habitat to collect data. Thus, age was omitted from the analysis as an explanatory variable. In addition, sex was not considered during data collection, as male and female Egyptian geese look almost similar in size and plumage.

Most diurnal behavior observations were performed from a vantage point outside the wetland edge to avoid disturbance to birds. The observer waited approximately five minutes after the arrival at an observation point to begin behavioral observations, thus minimizing potential observer influence on bird behavior (Webb *et al.*, 2011).

The following seven major behavioral activities of the Egyptian geese were distinguished: foraging, resting, comfort movement, locomotion, vigilance, social behavior and other behavior. Foraging behavior refers to a goose actively searching for food while walking with lowered head or head down, picking food items and ingesting (Jónsson and Afton, 2006; Döpfner *et al.*, 2009; Webb *et al.*, 2011). Resting behavior refers to a goose pausing, sleeping or loafing. Locomotion includes flying, swimming or walking while raising the head, running, flight and flapping. Comfort movements refer to cleaning or preening as well as muscle stretching. Vigilance or alert behavior refers to scanning or observing the surrounding area by raising its head upward or neck extended (Caithameer *et al*, 1996; Döpfner *et al*., 2009). Social behavior refers to behaviors of aggression such as chasing, pecking or biting and courtship such as sexual or mating behavior. Vocalizing, bathing and drinking were grouped as other behavior (Webb *et al.*, 2011). While recording behavioral activities, whenever more than one behavioral states occurred at the same time, the more frequent one was taken (Edroma and Jumbe, 1983).

In order to determine the influence of the time of the day on behavioral activities, days were divided into three four-hour time blocks from sunrise to sunset: morning (06:00-10:00 h), mid- day (10:00-14:00 h) and afternoon (14:00-18:00 h), following Shimada (2002). Likewise, to see variation on the preference of Egyptian geese across the different habitats and their activity period, the type of habitat for each flock located was recorded. Furthermore, observations were reasonably well-balanced across time periods, among habitats and between seasons, to see variation and relationship of activities to varying variables.

4.2.4. Foraging behaviour

Data on the food and foraging behavior was recorded during the dry and wet seasons in Boyo wetland. To investigate and study what type of food items Egyptian geese forage on, groups or individuals randomly observed in the foraging habitat were followed and carefully observed. Information on the food items consumed was obtained by direct observation in different habitat types where the birds forage (Adeyemo and Ayodele, 2005). Unidentified food items such as grains, roots, stems, worms, insects and plant parts encountered were collected for identification. Feeding techniques or type of foraging adopted by Egyptian geese to obtain different parts of a plant and animal were recorded as graze and pick foraging, following the classification by Jónsson and Afton (2006).

All observations on diet studies were carried out between the hours of 06:30-11:30 h and 14:30-18:00 h. These time periods were selected as found to be active foraging times of the species (Bibby, 1992). Data collection was made once per week from October 2016/2017 to August 2017/2018. Identification of plant items foraged was done using the flora of Ethiopia (Hedberg and Edwards, 1989; Hedberg *et al.*, 2003).

Fecal samples were collected during dry and wet seasons. Collected samples were separately put in plastic jars, labeled for further diet composition analyses. Fecal sample analysis was carried out using dissecting light microscope and food items were classified as grass, seeds, leaves and other plant materials and fragments of animal mater (Owen, 1975) (Plate 3 a, b and c).

A. Old fecal sample B. Freash fecal sample C. Fecal sample analysis

Plate 3: Egyptian geese fecal sample and fecal sample analysis

4.2.5. Attitude of local people towards Egyptian geese

To study and understand the levels of interactions between local farmers and Egyptian geese in Boyo wetland, communities surrounding the wetland were contacted and interviewed. First, an introductory description about the study was made to the randomly selected respondents to familiarize with the aims of the study to invite their participation. Local farmers were clearly informed that the data would be available, and assured of confidentiality.

A total of 60 farmers were randomly selected from the study area. Then, semi structured and face to face interviews were conducted to collect data, which have the power to elicit landholders'attitudes and perceptions accurately than posted questionnaires, telephone, or electronic surveys (McDowell, 1988). Half of the interviews were conducted during April-July 2017 and the other half was conducted during April-July 2018.

To compare and determine the differences between farmer's perception and attitude towards Egyptian geese and their damage, their level of understanding with the species and the wetland and its conservation in general, equal number of farmers (15) was selected from different Kebeles surrounding the wetland habitat. A map showing houses from the four regions of the wetland was taken out from google earth, then houses were selected and marked randomly. Then household heads were selected from the selected houses. If household heads were not present, the next one in the family was selected for the interview.

The strategy used in this study was, semi-structured interview combined questions of more quantitative, close-ended with less qualitatively oriented, open-ended questions aiming at collecting both accurate and attitudinal data (McNeill and Chapman, 1985). The close-ended questions provided a greater uniformity of responses, which were more amenable for quantitative analysis, whereas the open-ended questions allowed access to certain issues in more depth (Kelley *et al.*, 2003).

The questionnaire was divided into four main sections with interview duration varying from 30 to 40 minutes depending on the discussion the interviewee needs to share and the quality of data generated. General observation of the fields affected or damaged by

Egyptian geese during dry and wet seasons as well as informal discussion with elderly and credential farmers were made to get evidence-based results to confirm the responses and have direct information on the damage (Wang *et al.*, 2006). A justification for the presence of sets of questions and the way in which important variables were measured were provided, and the questions were pretested with randomly selected farmers and then edited.

Section A. Attitude, knowledge and understanding of farmers about Egyptian goose and the damage it caused

The purpose of this set of questions was to get a clear understanding on how farmers and Egyptian geese are living together in the wetland and farmers' knowledge and understanding of the species. It also gives a brief understanding on the type of crops they cultivate in the localities and which type of crops are affected by Egyptian geese. Respondents were also asked which months of the year Egyptian geese cause severe damage to their farms. Finally, respondents were asked if their attitudes towards geese are negative or positive.

Section B. Views of farmers on Boyo wetland and its conservation

Farmers were asked potential benefits they get from the wetland and their knowledge and understanding on the value of the wetland to their livelihood. This is a variable where willingness of farmers to conserve the wetland in the future is inquired. Current uses were grouped and arranged by presenting a list of possible Boyo wetland uses such as for grazing and drinking by cattle, cutting grass for construction of traditional houses, sale in the market and as cattle feed (Plate 4).

Plate 4: Cattle grazing in the Boyo wetland (Photo: By Mulugeta Kassa, 2018).

Local people were asked to mention the major threats affecting the wetland which will help to create awareness for the local people and having such information is important for the success of conservation activities (Wang *et al.,* 2006). Farmers were also asked their knowledge and level of understanding on any type of sustainable natural resource or biodiversity conservation such as flora and fauna and utilization.

4.3. Data analysis

Data collected were organized in an excel sheet for statistical analyses. Data normality were checked using a Shapiro-Wilk's test, the Kolmogorov-Smirnov test (K-S) and Cramervon Mises family test (C-von M-test) (Ghasemi and Zahediasl, 2012). Following this, those data, which had satisfied the standard normal distribution criteria were subjected to parametric tests such as ANOVA and Independent Sample t-test, for analyses. However, for those data that were not normally distributed, a non-parametric statistical tests such as Kruskal-Wallis test and Independent Sample Mann-Whitney U test were used. Mean comparisons were made using Tukey HSD for variables, whose F-values showed a significant difference. To compute all statistical analysis, SPSS Version 24 was used.

5. RESULTS

5.1. Population size

Egyptian geese in Boyo wetland were recorded in all months of the year, except in the month of September. Maximum flooding of the wetland during September made it difficult to observe and count birds in the wetland. Mean total population size of 1033.59 ± 88.846 individuals (range 243-2470) of Egyptian geese were recorded between 2016/2017 and 2017/2018.

The population size showed significant difference during the months of the study ($F=3.103$, $df=10$, $P = 0.003$). The mean maximum monthly population was recorded in August (1652 ± 312.375 individuals). The mean minimum monthly population was recorded in January (367.5 ± 8.271 individuals) (Figure 6).

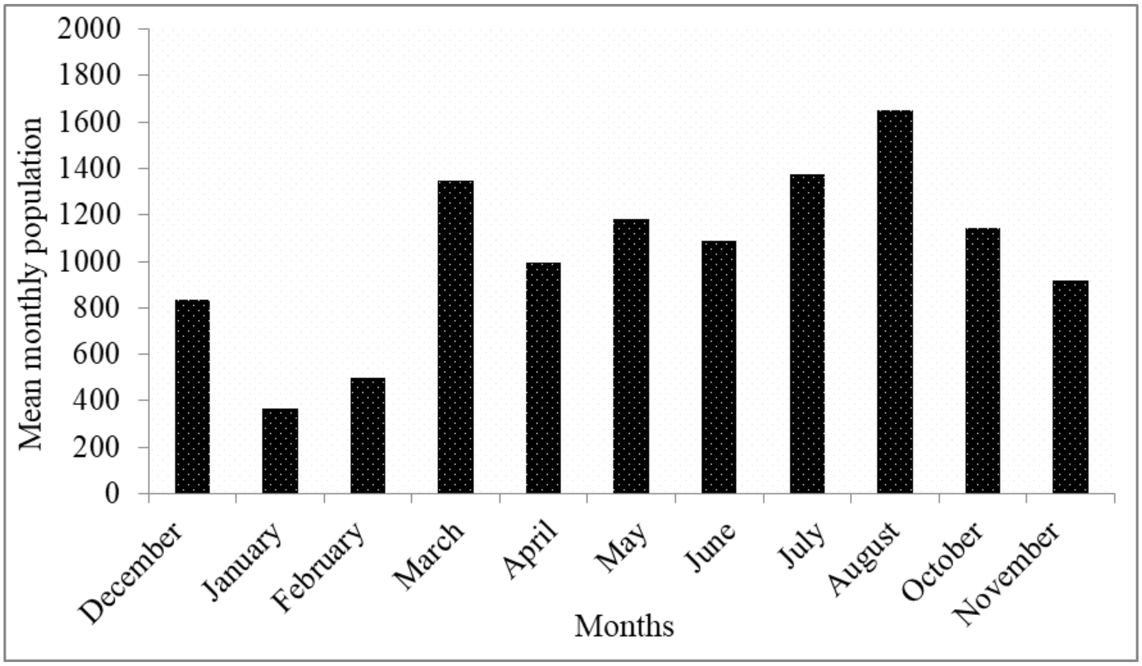


Figure 6: Mean monthly population size of Egyptian goose in Boyo wetland

The highest mean population size of Egyptian geese was 1208.82 ± 118.981 individuals (range 460-2293) during the wet season while the lowest record of 872.96 ± 124.125 individuals (range 243-2470) were during the dry season (Figure 7). The population size showed that there was a significant difference between dry and wet seasons (U = 155, df = 1, P= 0.017).

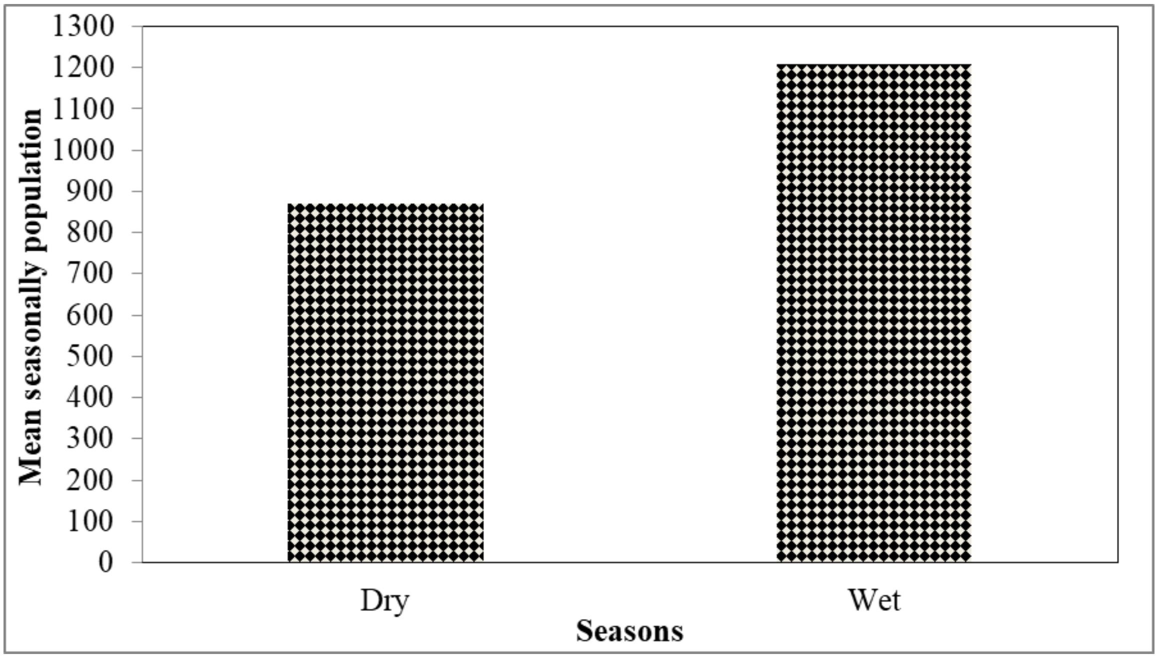


Figure 7: Mean population of Egyptian goose in Boy wetland during dry and wet seasons

Difference in the number of Egyptian geese was observed among the four habitats. During the dry season, mudflat habitats had more individuals (549.58± 97.799) when compared to farmland (7.25±1.865), grassland (64.88±19.896) and shallow water habitat (251.25±37.099). On the other hand, during the wet season, the number of Egyptian geese recorded was 458.73±101.63, 447.09±58.228, 284.18±70.217 and 18.82±8.244 individuals in shallow water, grassland, mudflat and farmland, respectively (Figure 8).

During both seasons, mudflat, shallow water and grassland habitats recorded the mean maximum number of 422.65± 63.573, 350.48 ±53.953 and 247.67±40.894 individuals, respectively. Mean minimum number of 12.78±4.104 individuals were recorded in farmland habitat. During both seasons, the abundance of Egyptian geese was high in the mudflat, shallow water and grassland habitats, but low in farmland habitat (Figure 8).

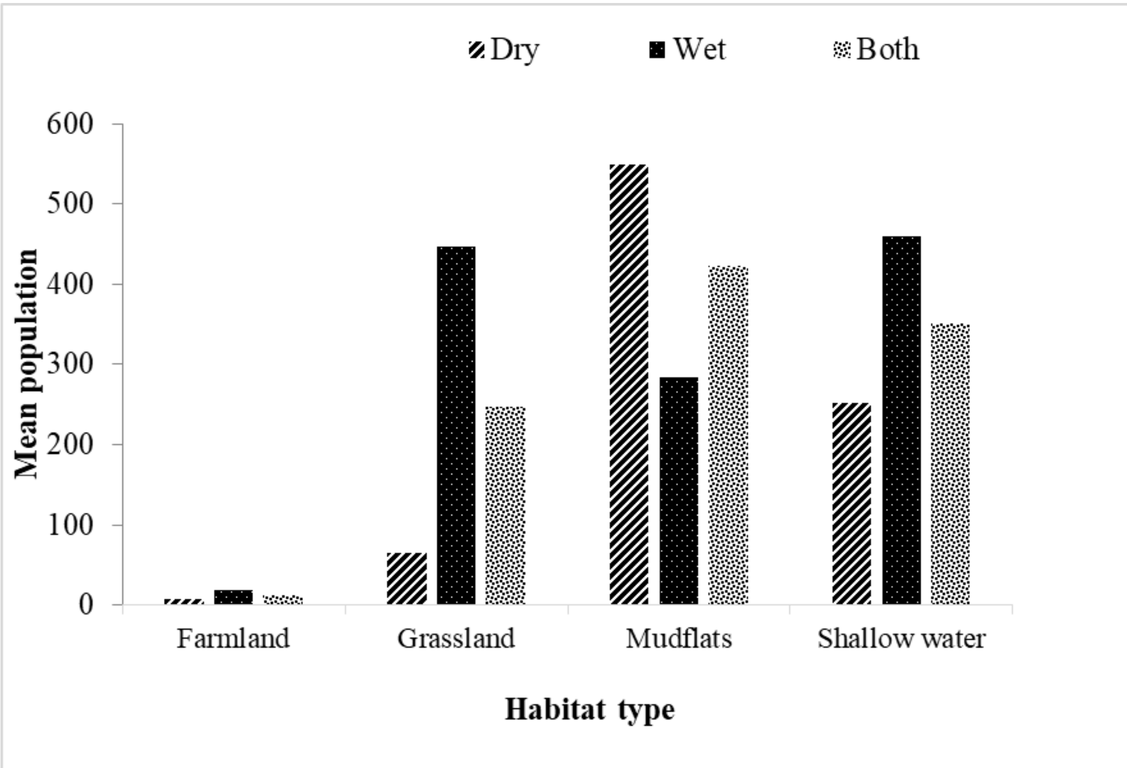


Figure 8: Mean population size of Egyptian geese in different habitat types during dry and wet seasons and both

5.2. Breeding

5.2.1. Nest location and characteristics

During the two breeding seasons in and around Boyo wetland habitats, a total of 20 Egyptian geese nests with 20 breeding pairs were recorded. From the total nests, 16 nests (80%) were found in farmland or human settlement habitats, one nest (5%) was found in grassland habitat and the other three nests (15%) were located in the mudflats. Out of the observed nests, 11 (55%) were built on trees, eight (40%) were built on house roofs and one (5%) was built on ground.

The active breeding season of Egyptian geese in and around Boyo wetland habitat was from May to September, when intensive egg laying was observed. Three (15%, n=20) had their first clutch during May, two (10%, n= 20) had during June, five (25%, n= 20) had during July, three (15%, n= 20) had during August, five (25%, n= 20) had during September, and one (5%, n= 20) with egg and one nest (5%, n= 20) with clutch initiation was observed during April (Table 1).

During the breeding season of 2017, eight of the eggs were laid during the month of May and ten eggs were laid during the month of July. While during 2018, eight eggs were laid in the month of April, 17 eggs were laid in the month of May and seven eggs were laid in July, 24 eggs were laid in August and thirty eggs were laid in September. Of the 20 nests observed, five nests had eggs of unknown clutch size (not determined) i.e. the clutch size were predated by either birds or mammals of prey and one nest had no eggs. The number of eggs per clutch ranged from 1-12 eggs (Table 1).

Table 1: Clutch size of Egyptian geese in the Boyo wetland

Year	Nest number	Clutch size	Months
2017	N1	8	May
	N2	9	July
	N3	1	July
2018	N4	8	April
	N5	No eggs found	April
	N6	8	May
	N7	9	May
	N8	Unknown egg number *	June
	N9	Unknown egg number *	June
	N10	7	July
	N11	Unknown egg number *	July
	N12	Unknown egg number *	July
	N13	8	August

N14	8	August
N15	8	August
N16	6	September
N17	8	September
N18	12	September
N19	4	September
N20	Unknown egg number *	September
Total number of eggs observed	104	
Mean ± SE	7.43± 0.68	
Range	1-12	

* = Egg numbers unknown due to damage by predators or others

5.2.2. Nest materials and nest morphometry

Egyptian geese in the surrounding Boyo wetland habitat built nests on trees and in tree holes (55%, n= 20), house roof (40%, n= 20), in the farmland or human settlement habitats and on the ground (5%, n= 20), in mudflat and grassland habitats (Plate 5). Nests built in farmland and human settlement areas were on tall trees and in areas with vegetation cover. However, nests on the ground had only few vegetation cover around.

Predominantly used nesting materials were *Eriochloa fatmensis* and *Eriochloa meyeriana*. Egyptian geese utilized nesting materials from around the nest site. The kind of nesting material is dependent on the type of vegetation near in the nesting area. Breeding pairs cut and pull grasses from the surroundings to build nest. They continuously collect fresh grasses throughout the incubation period. In addition, tree nest and house roof nest were built from grasses of *Eriochloa fatmensis* and *Eriochloa meyeriana*, where grass, branches or stems, leaf and other nesting materials such as feathers were used to create comfort. The Egyptian geese nest constituted grass (90%), branch or steam (90%), leaf (10%) and feather (95%) (Table 2) (Plate 5a, b and c).

A B C

Plate 5: Nests of Egyptian geese in different sites. A) Tree nest B) Tree hole nest C) Roof top nest

Table 2: Nest materials used by Egyptian geese

Sample (n= 20)	Nest materials used			
	Grass	Branch/Steam	Leaf	Feather
Frequency	18	18	2	19
Percentage	90%	90%	10%	95%

The mean nest depth was 27.75 ±1.38cm, (n=20 range 20-50cm), mean nest width was 48±1.38cm, (n=20 range 30-50cm) and the mean nest height from the ground was 8.18±0.89m, (n= 20 range 0.5-15m) (Table 3). Using Independent Sample Mann-Whitney *U* test, the nest morphometry parameters showed no significant difference in nest tree height (U=12, df= 1, P= 0.144), nest depth (U= 20, df= 1, P=0.527) and nest width (U= 18.5, df= 1, P= 0.154), between the two breeding seasons.

The maximum nest depth, width and height was recorded on tree and house roof nest (50cm, 50cm and 15m, respectively). Also, the minimum nest depth (20cm) and width (30cm) was also recorded from tree and house roof nest. The minimum nest height (0.5m) was recorded from the ground nest.

Table 3: Nest morphometry of Egyptian geese

Sample(n=20)	Nest measurement (mean ±S E)		
	Nest tree height (m)	Nest depth(cm)	Nest width(cm)
Mean ± SE	8.18±0.89	27.75 ±1.38	48±1.38
Range	0.5-15	20-50	30-50

5.2.3. Egg morphometry

Egyptian geese eggs were long and oval shaped. The egg morphometric measurements of 104 eggs showed that the mean egg length was 67.85 ±0.32mm (range = 61.94-78.27mm). The mean egg width was 51.54±0.17mm (range = 48.04-56.57mm) and the mean egg weight was 94.11 ±1.06 g (range = 72 -121 g) (Table 4). There was a significant variation in egg length (x^2 = 14.103, df =1, P= 0.00) and egg width (x^2 =4.487, df =1, P= 0.034), but there was no significant difference in egg weight (x^2 =0.093, df =1, P= 0.76) during the two breeding seasons (Table 4).

Table 4: Egg morphometry of Egyptian geese

	Egg measurements (mean ±SE, n=104)	Range	df	x^2	Sig.level
Egg length (mm)	67.85 ±0.32	61.94-78.27	1	14.103	0.00
Egg width (mm)	51.54±0.17	48.04-56.57	1	4.487	0.034
Egg weight (g)	94.11 ±1.06	72-121	1	0.093	0.76

5.2.4. Breeding performance

5.2.4.1. Hatching success

From the total of 20 nests recorded, only six nests (30%) have hatched chicks, while the other 13 nests (65%) were destroyed due to the different factors and one nest had no eggs (5%) (Table 5). Re-nesting was not detected. Nest predation by African fish eagle (*Haliaeetus vocifer)* (28.57%), human beings (57.14%) and due to unknown factors was recorded (14.29%). Out of the 14 nests, where 104 eggs were recorded, 46 eggs in six nests were incubated of which only 31 eggs (67.39%) were hatched successfully (Plate 6 a and b). Independent Mann-Whitney U test showed that there was no significant difference in the hatching success of Egyptian geese between the two breeding seasons in 2017 and 2018 (U = 7.5, df = 1, P = 0.120).

Egyptian geese were observed using different strategies to defend goslings. One strategy was direct confrontation, where one of the parents defend chicks by loud voice or calling, when the other parent led the young hiding in grasses such as *Eriochloa fatmensis* and *Eriochloa meyeriana*.

A B

Plate 6: A) Incubated eggs on house roof nest, B) newly hatched chicks

Table 5: Nest success of Egyptian geese in different nest types

	Nest status			
Nest type	Succesful	Un succesful	Inactive	Total
Tree	3	7	1	11
Roof top	3	5	0	8
Ground	0	1	0	1
Total	6	13	1	20

5.3. Time budget

A total of 26, 231 behavioral scans were recorded during 4,320 minutes of observations. A total of (31.5%) scans were conducted in the grassland habitat whereas (38.45%) and (30.03%) in the mudflat and shallow wetland habitats, respectively. Egyptian geese spent most of their time resting (39.81%), followed by foraging (32.64%). They spent 10.43% in comfort movement (preening or stretching). The rest of their time was allocated for locomotion (6.63%), vigilance (5.75%), social behavior (1.59%) and in other activities (2.86%).

The time spent on foraging in three different habitats (grassland, mudflat and shallow water) showed peak at grassland followed by shallow water habitat during the dry season. During the wet season foraging peaked at grassland followed by the mudflat habitat. Time spent for resting peaked at the mudflat followed by shallow water during the dry season. However, during the wet season resting peaked at shallow water followed by mudflat habitat (Figure 9 and 10).

During the dry season, there was a significant difference in frequency of foraging, resting and comfort movement of Egyptian geese among the three habitat types (F= 8.729, df =2, P= 0.001), (F=7.318, df =2, P=0.002) and (F=7.173, df =2, P= 0.003), respectively. However, there was no significant difference in the activity level of locomotion, vigilance, social behavior and other behavioral activities (F= 1.327, df =2, P= 0.279), (F= 0.429, df =2, P= 0.655) ,(F= 0.102, df =2, P=0.904) and (F= 0.523, df =2, P= 0.598), among the different habitat types of the study area.

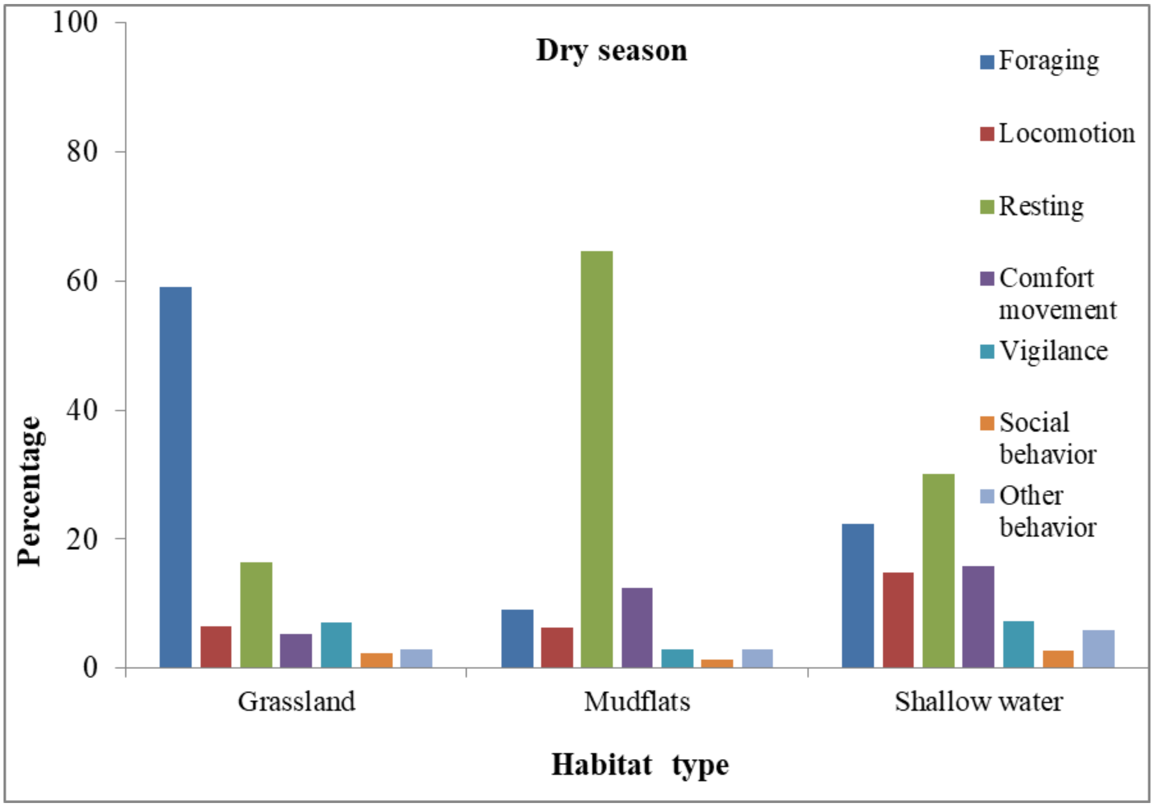


Figure 9: Percentage proportions of time spent in daily activities of Egyptian geese in different habitat types during the dry season

Comparison of behavioral activity in to the three different habitat types during the wet season showed that there was a significant variation in frequency of foraging, resting, comfort movement and vigilance behavior (F=11.914, df=2, P= 0.000), (F= 8.271, df= 2, P= 0.001) and (F= 3.344, df= 2, P= 0.048), (F=7.274, df= 2, P= 0.002), respectively. However, there was no significant variation in locomotion, social behavior and other behavioral activities (F= 0.933, df =2, P= 0.403), (F= 0.823, df= 2, P= 0.448) and (F= 1.962, df= 2, P= 0.157), among the different habitat types of the study area.

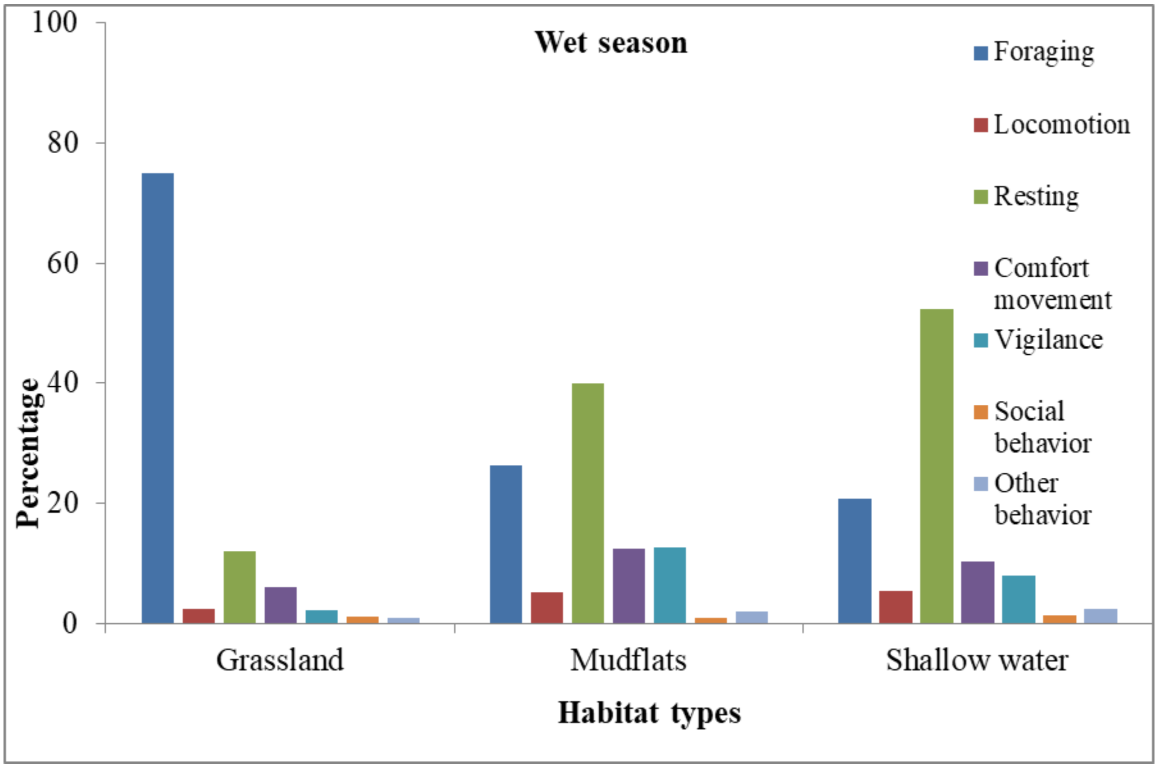


Figure 10: Percentage proportions of time spent in daily activities of Egyptian geese in different habitat types during wet season

During dry season, behavioral activities in the three different time blocks showed that foraging activity peaked in the late afternoon hours (16:00 - 18:00 h) and in the morning hours (07:00-9:00 h), while they foraged least during the mid-day hours (11:00-13:00 h). Resting activity peaked during mid-day, followed by morning hours. Locomotion and comfort movements were highly pronounced during the late afternoon hours in the dry season (Figure 11).

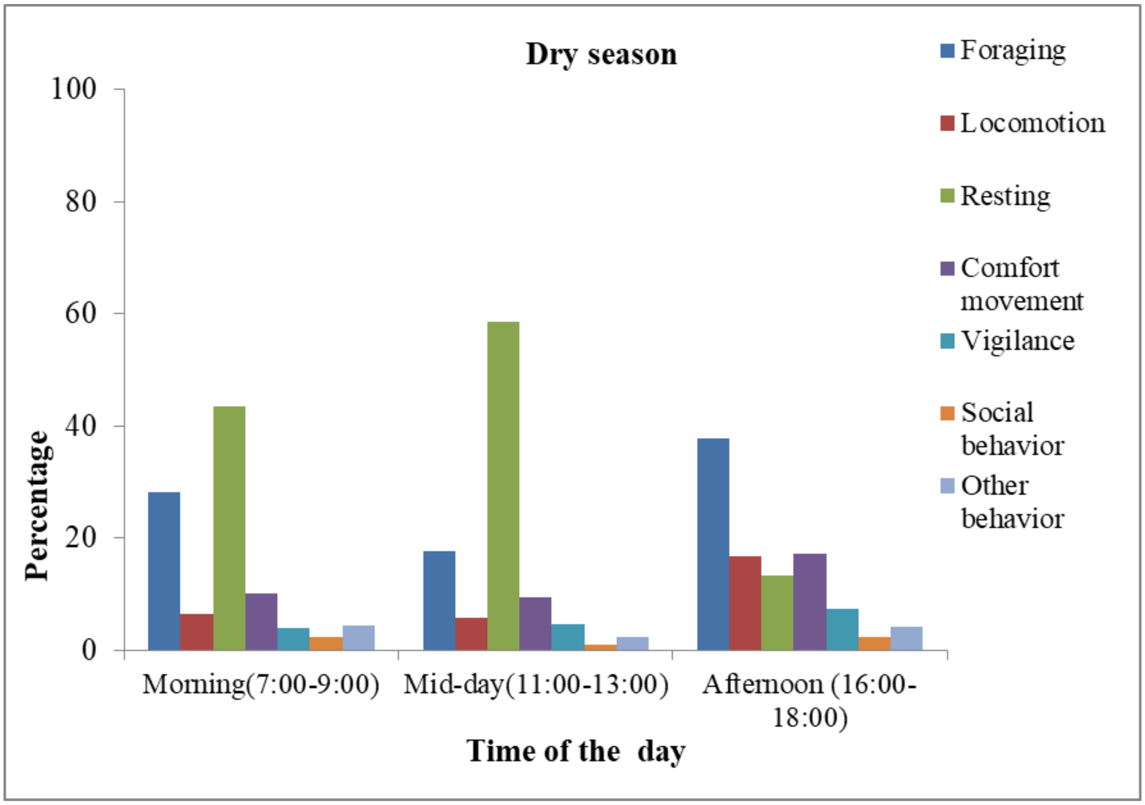


Figure 11: Percentage proportion activity of Egyptian geese in the different time periods during dry season

During the dry season, time spent for foraging (x^2= 1.073, df =2, P =0.585), comfort movement (x^2=0.702, df =2, P= 0.704), vigilance (x^2=2.035, df=2, P=0.362) and locomotion activity (x^2=2.558, df=2, P= 0.278), showed no significant variation with the time blocks of the day. However, time spent for resting (x^2=10.738, df=2, P=0.005) showed a significant variation with the time blocks of the day.

With regard to time spent on social and other behavioral activities, the difference was not significant across the time blocks of the day (x^2= 3.875, df =2,P=0.144) and

(x^2=4.203, df =2, P=0.122), even if the frequency of time spent for the social behavior and other behavioral activities was higher in the morning and in the afternoon than during the mid-day.

During the wet season, foraging activity peaked in the late afternoon (16:00 -18:00 h), followed by morning (07:00-9:00 h) than during the mid-day hours (11:00 -13:00 h). Resting was most frequent during the mid-day hours, followed by morning hours. In addition, rhythm of vigilance behavior and other behavioral activities peaked in the morning and were less in the mid-day and reached its lowest level in the afternoon during the wet season. Locomotion was significantly higher in the morning than afternoon and mid-day hours (Figure 12).

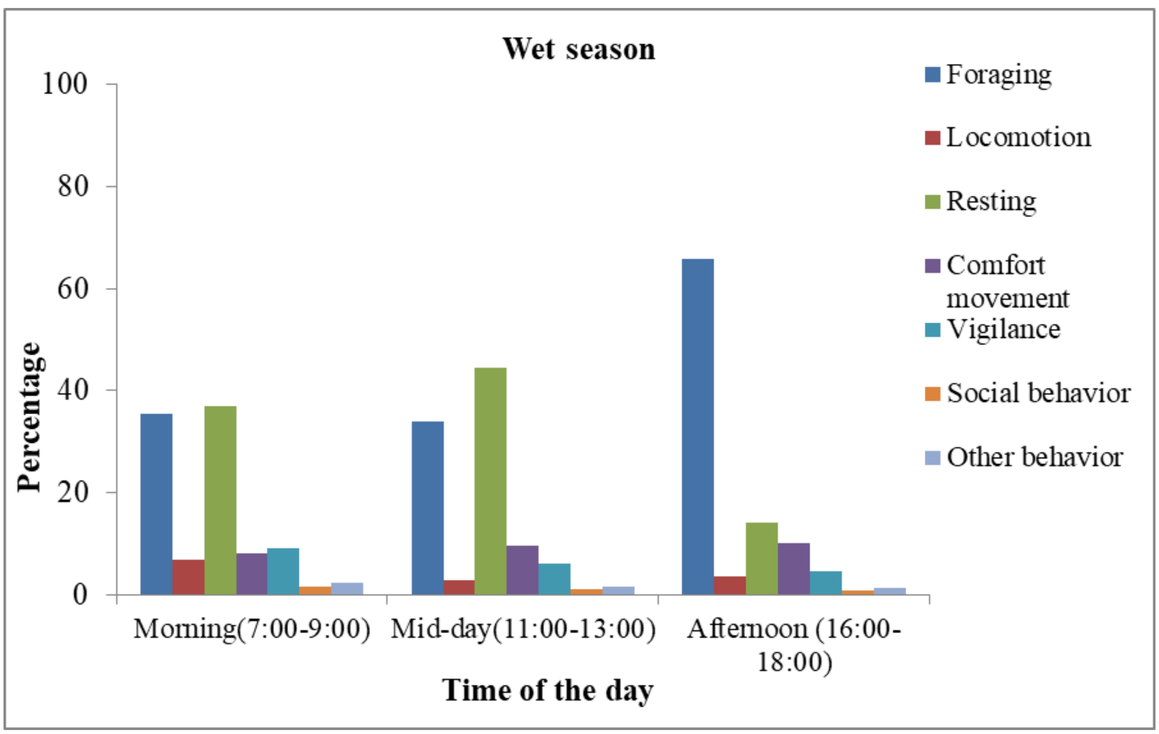


Figure 12: Percentage proportion of activities of Egyptian geese in the different time periods during the wet season

During the wet season, time spent for foraging (x^2= 6.049, df=2, P= 0.049), resting (x^2=14.102, df =2, P= 0.001) and other behavioral activities (x^2= 9.556, df=2, P= 0.008), showed a significant variation with the time blocks of the day. However, time spent for locomotion (x^2 = 4.036, df=2, P= 0.133), comfort movements (x^2= 3.252, df= 2, P= 0.197) and vigilance (x^2=5.06, df=2, P= 0.08), showed no significant variation with in the time blocks of the day. With regard to time spent in social behavior, the difference was not significant (x^2= 3.83, df=2, P= 0.147), even if the frequency of time spent for the social behavior was higher during the morning than during the mid-day and afternoon hours of observation.

A comparison of different activities between dry and wet seasons showed that, foraging time did not differ between seasons (U= 568, df=1, P= 0.368) although it was pronounced during the wet season, which is also the breeding season. The time spent for foraging behavior, resting activities, comfort movement and vigilance behavior were not significantly different with the time blocks of the day between the dry and wet seasons with (U= 568, df=1, P= 0.368), (U= 639.5, df=1, P= 0.924), (U= 506.5, df = 1,P = 0.111) and (U= 619, df= 1, P= 0.744), respectively. However, time spent for locomotion, social behavior and other behavioral activities were higher during the dry season than the wet season with (U= 351.5, df =1, P= 0.001), (U= 350, df =1, P = 0.001) and (U= 308.5, df = 1, P = 0.00), respectively.

5.4. Foraging behaviour

Egyptian geese in Boyo wetland were observed feeding on a wide variety of food items, including different plant and animal items. In the surrounding farmland habitats of Boyo wetland, Egyptian geese mainly fed on grains, such as maize (*Zea mays*), sorghum (*Sorghum bicolor*), wheat (*Triticum aestivum*), after harvest periods. In addition, they were also observed feeding on un harvested teff (*Eragrostis tef*) and soybean (*Glycine max*) fields during dry and wet seasons. These grains are the major cultivated crops surrounding Boyo wetland.

Egyptian geese feed at the edge of crop fields than in the middle for better observation of their environment. Hence, they are frequently observed consuming teff to the other crops. Wheat and sorghum prohibit observation; therefore, shorter crops were more preferred. During the brief periods of the day when they return to the wetland from the farmland habitat, they feed predominantly on the grasses and seeds of *Eriochloa fatmensis* and *Eriochloa meyeriana* (Plate 7 a, b and c).

During May, farmers surrounding the wetland start growing soybean, following a brief rainfall. Then, Egyptian geese start to feed on the leaf part of seedlings of soybean in the agricultural lands. Apart from feeding on cereals, grass and seeds, they were sometimes observed feeding on animal matter.

A B C

Plate 7: Different food items consumed by Egyptian geese, A) *Eriochloa meyeriana* B) *Eriochloa fatmensis* C) *Eragrostis tef*

During the dry season, the maximum percentage of foraging food items of Egyptian geese was grass (93.62%), followed by invertebrates (5.56%), leaves (0.55%) and seeds (0.27%). During the wet season, the highest percentage of Egyptian geese diet constituted grass (59.52%) and invertebrates (40.5%) (Table 6). The proportion of grass, seeds, leaves and invertebrates in the diet were not statistically different between seasons (U = 6, df =1, P= 0.564; U = 6, df =1, P= 0.317; U = 6, df =1, P= 0.317 and U = 8, df =1, P= 1.000) respectively.

Table 6: Percentage of food items consumed by Egyptian geese during dry and wet seasons

Seasons	Foraging food items				
	Grass	Invertebrate	Seeds	Leaf	Total %
Dry	93.62%	5.56%	0.27%	0.55%	100%
Wet	59.52%	40.5%	0%	0%	100%

The most frequently used foraging habitat of Egyptian geese was mudflat (56.396%), followed by grassland habitat (36.74%), shallow water (5.74%) and farmland (1.12%) during the dry season. During the wet season, the most frequently used habitat of foraging was shallow water (45.25%), followed by grassland (35.64%), mudflat (19.0%) and farmland (0.07%) (Table 7). The use of these habitats by geese were not significantly different between seasons (U = 0.000, df =1, P= 0.317).

During both seasons, the mean percentage of flocks of geese observed foraging for per habitat was, mudflat (37.713±37.71%), followed by grassland (36.19±36.19%), shallow water (25.495± 25.495%) and farmland (0.595±0.595%).

Table 7: Percentage of geese observed foraging in the different habitats during dry and wet seasons

Seasons	Habitat type				
	Farmland	Grassland	Mudflats	Shallow water	Total%
Dry	1.12%	36.74%	56.396%	5.74%	100%
Wet	0.07%	35.64%	19.0%	45.25%	100%
Mean	0.595%	36.19%	37.71%	25.495%	100%

Results of analyses of fecal samples showed that the diet of Egyptian geese contained mainly parts of plant matters including grass, seeds, and animal matters and unidentified matters. During the dry season, highest frequency of grass (100%) and seeds (80%) was observed followed by unidentified matter (65%) and animal matter (5%). During wet season also their was a highest frequency of occurrence of grass (100%) and seeds (95%) followed by unidentified matter (50%) and animal matter (10%) (Table 8).

Table 8: Percentage frequency of food items from fecal samples during dry and wet seasons

Seasons	Sample(n= 20)	Observed food items from fecal samples			
		Plant matter		Animal matter	Unidentified
Dry		Grass	Seeds		
Frequency		20	16	1	13
% Frequency of occurrence		100%	80%	5%	65%
Wet					
Frequency		20	19	2	10
% Frequency of occurrence		100%	95%	10%	50%
Mean		100%	87.5%	7.5%	57.5%

5.5. Attitude of local people towards Egyptian geese

5.5.1. Demographic characteristics of respondents

From the total respondents, 43.33% were in the age categories of 25-35 and 40-50, each, and the rest were between ages of 51-60 (6.67%) and older than 60 (6.67%). The average age of the respondents was 41.9 ± 1.59 years (range 25-70). The average age of male respondents wetland was 41.07±1.54 years (range 25-70) and it was 49.33±7.67 years (range 28-70) for females. Most of the respondents (93.33%) were married. Among the respondents, 20% never went to school and 36.67% had attained secondary level of education. High number (40%) of the respondents attained primary level of education.

5.5.2. Livelihood activities and conflict wth geese

Majority of the respondents (90%) were dependent on farming and cattle herding, where 85.9% had no alternative income sources. The major crops grown were maize, sorghum, green chilli, soybean, wheat and teff. The mean farm size owned by the respondents was 0.975±0.092ha (range 0-3.5). Average number of cattle possessed by respondents in the study area in 2015-2016 was, 11.53±1.34 (range 0-38) and in 2017-2018 was 8.87±0.86 (range 0-29).

Majority (90%) of the respondents reported crop damage by Egyptian geese, whereas, 10% did not report any crop damage. Among the respondents, 90% reported that Egyptian geese were more harmful during the wet season than any other period of the year. In addition, 50% of the respondents who suffered crop damage considered Egyptian geese as a pest, which causes damage to crops. The main crops primarily damaged by Egyptian geese were teff and soybean (Table 9). Farmers surrounding Boyo wetland also reported that Egyptian geese cause damage during pre-harvesting and during harvesting time.

A flock size of up to 2293 Egyptian geese were reported visiting farms during the wet season and caused damage on grains of teff and sorghum, and leaves of soybean(Plate 8).

Plate 8: Egyptian geese damage on teff farm (Left) and harvested sorghum field (Right)

Most respondents (95.6%) reported using crop protection strategy. Particularly, 80% of the farmers reported scaring and chasing Egyptian geese from their farms and guard their soybean and teff fields. Among the respondents, 10% use scarecrows and 10% use both, guarding and scarecrows (Table 9).

Crop protection strategy by famers in the study area was strongly associated with the attitude of famers to Egyptian geese (x^2 (2) = 1.093, P =0.579), where most of those respondents who consider Egyptian geese as harmful or a pest use a protection strategy and vice-versa. However, there was no significant association in using crop protection strategy and the rate of visit of Egyptian geese in their farms (x^2 (2) = 0.711, P= 0.701).

Table 9: Crop damage protection strategies of local people against Egyptian geese

Protection techniques	Frequency	Percent (%)
Guarding	48	80
Scare crows	6	10
Guarding and scare crows	6	10
Total	60	100

5.5.3. Perception of respondents to wetland and wetland resources

Majority (70%) of the respondents living around the wetland habitat had good awareness about the potential benefits from wetlands for their survival and the rest have responded as it had nothing to do to their survival. With regard to their perception about the wetland habitat, there was no significant variation between sex (U= 154, df= 2, P= 0.815). However, there was statistically significant variation (x^2 (2) = 12.643, P= 0.002) in the perception of respondents overall with regard to the value of the wetland for their survival (Figure 13).

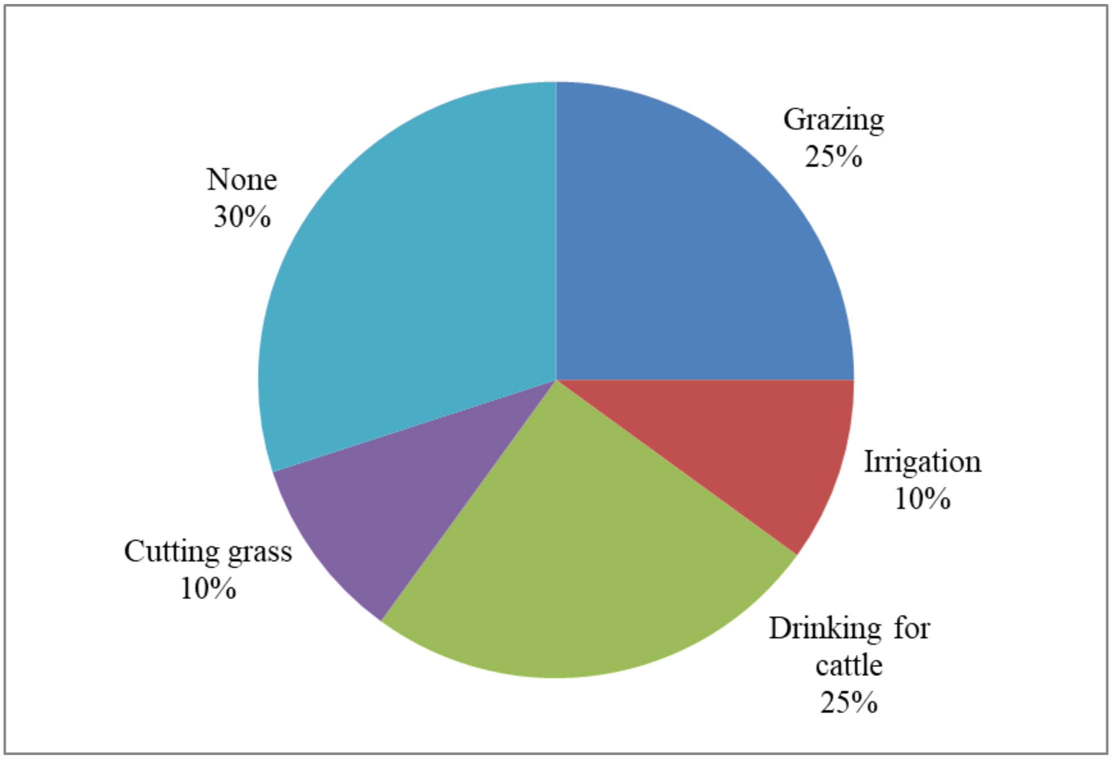


Figure 13: Respondents’ view on the benefits of Boyo wetland

Most of the respondents (63.3%) reported that they get high levels of benefits from the wetland and as 33.3% and 3.3% reported that they get medium and low level of benefits from the wetland habitat. Majority of the respondents (80%) believed that if any conservation activity is made in the wetland, their livelihood would have been improved.

Most respondents (83.33%) believed that the wetland and surrounding habitats do not face any threat. But, the wetland is under extensive pressure from human encroachment (16.67%) and associated agricultural expansion (25%) and both human encroachment and associated agricultural expansion (25%) in the surroundings. Overgrazing is also a threat to the wetland as the area has shown a 33.33% increase in the number of cattle population only in the last 5-10 years. But, the main threat, which is heavily degrading the natural quality of the wetland is siltation and sedimentation from the catchment area due to problem of deforestation and associated agricultural expansion (Table 10).

Table 10: The major human induced factors which may cause threats to the wetland

Human factors	Number of repondents	Percent (%)
Human encroachment	10	16.67
Agricultural expansion	15	25
Both human encroachment and agricultural expansion	15	25
Overgrazing	20	33.33
Total	60	100

Most of the respondents (70%), living around the wetlands were willing to participate in a community-based conservation activities, without any support from the government body or from non-governmental organizations. The majority (58.5%) of the respondents living around the wetland have the knowledge of sustainable natural resource utilization and wetland conservation activities. But, only 53.34% of the respondents have been previously involved in natural resource conservation activities (Table 11).

Table 11: Farmers' participation in different biodiversity conservation activities in Boyo wetland and surrounding habitats

Conservation activities	Frequency	Percent (%)
Soil and water conservation	13	21.67
Afforestation	6	10
Both Soil and water conservation and afforestation	13	21.67
None	28	46.67
Total	60	100

6. DISCUSSION

6.1. Population size

Selection of migration directions, ending over areas and wintering sites are determined based on the availability of food resources and roosting sites (Nilsson *et al*., 2016). Movements of animals, whether it is dispersion or migration, were mainly induced by environmental factors and the annual cycle in rainfall in relation to the occurrence of green grasses as feeding sites (Eltringham, 1974; Brown *et al.,* 1982).

In the present study area, Egyptian geese were more abundant in the wetland habitats than in the surrounding farmland habitats. Earlier studies in Britain have revealed that the Egyptian geese are more in wetlands (Sutherland and Allport, 1991). In farmland habitats, they are less, which might contribute for less use of croplands than wetland habitat. It is more common to find large number of geese during the wet season than during the dry season. This might be due to the food availability in the wetland habitat during the wet season than during the dry season. During the dry season, less number of geese was observed. This could be limited to food availability and reduced amount of water in the wetland habitats. Sutherland and Allport (1991) reported that geese are more dispersed during the dry season due to competition for resources and food shortage. Cattle were allowed to graze in agricultural fields during the dry season after harvest, when fallen grains will be more abundant on the ground than during the wet season. Similar findings were also reported by Shimelis Aynalem (2017).

In the present study, there was a significant variation in the population size of Egyptian geese between the dry and wet seasons. The Boyo wetlands were the most suitable area where most geese occurred. The suitability of the study area in terms of grass or vegetation cover, food availability, less disturbance and population size could account for the higher number. Similarly, Lensink (1998) and Lensink (1999) have reported that there was less competition for resources in larger areas than small areas. Gyimesi and Lensink (2012) also found more density of geese in areas with abundant food resources. They also reported that the location of feeding sites in relation to roosting sites influence the foraging ranges of individual geese.

Large flocks of Egyptian geese were frequently observed during the rainy season. Water level in the wetland increases during this time and grasses such as *Eriochloa fatmensis* and *Eriochloa meyeriana* grow fast in the area and the geese get abundant food during this period. *Eriochloa fatmensis* and *Eriochloa meyeriana* were the major food sources and nesting materials of Egyptian geese. Therefore, abundance of food during the rainy season might have influence to increase the Egyptian geese population in the wetland and this time might be an attraction for Egyptian geese from different habitat types. Similarly, Gyimesi and Lensink (2012) reported that peak number of Egyptian geese occurred near water bodies in open grasslands with a few trees in Netherlands is association with the availability of water and grasses in wetland habitats. In contrary, the highest number of Egyptian geese was recorded in Netherlands during the months of November and December, the peak wintering period (Lensink, 1998).

Population dynamics in animals can be influenced following the variation of habitat quality both in terms of availability of food and shelter. In addition, Gyimesi and Lensink (2012) reported that the most important factor regulating goose numbers in one area is habitat availability. The dispersion factor could be scarcity of food resource in the wetland due to sharp decline in water level of the wetland habitat and farmland as farmers begin to cultivate. In addition, the farmland area had no food during this period. Similarly, Sutherland and Allport (1991) reported that geese are more dispersed during the pre-rainy season or towards the end of the dry season due to competition for resources due to food scarcity.

During the study period, the highest mean population size in Boyo wetland was 1208.82± 118.981 individuals (range 460- 2293) during the wet season than during the dry season, due to availability of food resources and high rainfall during the wet season. Similarly, Mangnall (2001) reported largest numbers of Egyptian geese during wet season when they foraged on growing plants or grasses. Likewise, Mangnall and Crowe (2002) also stated that numbers of Egyptian geese were highest during the wet season. Lensink (1998) reported highest numbers of Egyptian geese in November and December. This result disagrees with Shimelis Aynalem (2017) where more Black crowned cranes were recorded in Lake Tana during the dry season than during the wet season, due to food availability during the dry season. This result also disagrees with Hadis Tadela (2018) where more population size of Wattled cranes were recorded in Boyo wetland and surrounding farmland habitats during winter months.

6.2. Breeding

Egyptian geese are known to breed during the wet season, when water level in the area is high. In South Africa, the peak nesting activity occurs from July to October (Johnsgard, 2010). In tropical Africa, this species can breed all year round, whereas most breed just before the rainy season (Eltringham, 1974). In the Boyo wetland and surrounding habitats, Egyptian geese were observed breeding during the short rainy season of April to the long rainy season of August – September.

In the Boyo wetland and surrounding habitats, Egyptian geese prefer to build their nest on trees and house roofs. Pranty and Ponzo (2014) have noted that Egyptian geese in Southeastern Florida built nests on the roof of houses and on trees. Similar to Cattle egrets, usually prefer to breed in tree nests with their relatively large canopy spread and great height. Such locations on trees reduce visibility of nests to potential predators such as birds of prey, domestic cats from both the top of the tree and the ground. Furthermore, the well supported trunks and relatively strong branches of trees may be better to support the weight of large number of nests and their contents (Ashoori and Barati, 2013). Gyimesi and Lensink (2012) have stated that Egyptian geese are well-known for their wide preference for breeding habitats. They mostly prefer to stay close to < 1 km freshwater bodies (Harrison, 1978).

Egyptian geese utilized nesting materials collected from the wetland habitat around the nesting site. Nesting materials used were grasses of *E. fatmensis* and *E. meyeriana*, which were locally available in plenty in the study area. Similarly, Pitman (1965) described that nests are of grass and similar material, abundantly lined with which they used to cover eggs when the bird is away from the nest. Nests close to these grass species might be related to the feeding behavior of Egyptian geese, as it provides adequate feeding ground close to their nest. This result agrees with the nest site selection behavior by Cattle egret (Hilaluddin *et al*., 2003). These grasses provide cover and protection against predators and exposure to wind, which the nest site selection behavior is associated with (Rounds *et al*., 2004).

Location of the nest height from ground up to the top of the nest in the study area ranged from 0.5 to 15m, which was higher than that of Wattled crane (40-140 cm) (Hadis Tadele, 2018), Black crowned crane (30-130 cm) (Shimelis Aynalem, 2017) and Sarus crane (41-95.67 cm) (Mukherjee *et al*., 2000). This might be due to the difference in the nesting behavior of the species, particularly the location of nests (Hadis Tadele, 2018 and Shimelis Aynalem, 2017), Egyptian geese in the Boyo wetland and surrounding habitats nested mostly (55%) on trees.

The clutch size of Egyptian geese ranged between 1-12, with an average clutch size of 7.43. Majority of the nests had a clutch size of eight. Johnsgard (2010) reported that clutch sizes of Egyptian geese in the world are quite variable, ranging from 6 to 12 eggs and an average of around seven. This was also similar with Egyptian geese in Southeastern Florida, where majority of the pairs in Martin County south through Miami-Dade County population lay 6-12 eggs and an average clutch size of seven eggs similar to the present findings (Pranty and Ponzo, 2014). Contrary to this, in the Netherlands, Egyptian geese with a maximum clutch size of 16 eggs and an average clutch size of 7.8 eggs were observed (Gyimesi and Lensink, 2010). In Southern Africa, the clutch size of Egyptian geese was 5-11 eggs with an average of 6.7 (Mangnall, 2001). On the other hand, Braun (2004) reported in Africa clutch size is typically 6-10. This variation in the clutch size might be due to the difference in the availability of food and rainfall during the breeding season.

During the present study, peak egg laying in the Boyo wetland and surrounding habitats was between April to September. This peak egg laying period agrees with peak rainfall time of the year in the wetland and surrounding habitats (Yilma Delelegn, 1998). Similarly, the Dutch population has a breeding season of six months (Lensink, 1999), but can basically breed throughout the year if environmental conditions are favorable. Contrary to this, information collected from the breeding season of the Egyptian geese in Europe, most geese and waterfowl species have a relatively short breeding period, which lasts on average 2-3 months between the earliest and latest pairs (Lensink, 1999). This might be due to seasonal differences in the two areas, which determine the amount of rainfall in the breeding habitat directly affecting the breeding performance and availability of food for their chicks. This was also true in Texas Egyptian geese, where their reproduction was stimulated when there is high rainfall in March and May (Callaghan and Brooks, 2006).

The mean egg weight in the study area was 94.11±1.063 g ranging from 72 to 121 g. Similar findings were reported in the Netherlands with a range of 78.5 to 110 g (Gyimesi and Lensink, 2010). Gyimesi and Lensink (2010) have also stated an average egg weight of 98 g, but, slightly larger than the weight recorded in Boyo wetland. According to Pranty and Ponzo (2014), the incubation period for the Egyptian geese is 28-30 days. Incubation period from this study shows a similar result where average incubation period of the six nests was 28.67 ±0.49 days with maximum incubation period of 30 days and minimum incubation period 28 days.

Hatching success in Egyptian geese was 67.39%, which seems very low compared to Lesser Snow geese (69.2%) (Ryder, 1971) and Emperor geese (74.43%) (Eisenhauer and Kirkpatrick, 1977). This indicates that, they have a low reproductive rate compared to other geese. Similarly, Sutherland and Allport (1991) have also stated that Egyptian geese have the lowest reproductive rate compared to other geese species. Nest failures are common in birds in general and geese in particular. This might be due to predators like mammals including human beings, birds of prey or other unknown factors. In Emperor geese, Cackling geese and Black brant geese, some mammals such as arctic fox*(Alopex lagopu)*, human induced, unknown, predator induced and infertile eggs as well as birds such as Glaucous gulls (*Larus hyperboreus*) and parasitic jaegers (*Stercorarius parasiticus*) were the most important mammalian and avian predators (Eisenhauer and Kirkpatrick, 1977).

Mammalian nest predators such as Arctic fox (*Alopex lagopu*) were responsible for 44% of loss of eggs, Parasitic jaegers (*Stercorarius parasiticus*) for 30%, Glaucous gulls (*Larus hyperboreus*) for 16% and Common ravens (*Corvus corax*) for 10% (Bety *et al.*, 2001). Similarly, Hanson and Eberhardt (1971) have reported that Coyotes (*Canis latrans*), Raccoons (*Procyon lotor*) and Magpies (*Pica pica*) were important mammalian and avian predators during the breeding seasons of Emperor geese (*Chen canagica*) in Alaska. In the Boyo wetland and surrounding farmland habitats, African fish eagle (*Haliaeetus vocifer*) was observed predating on eggs and chicks of birds in general and Egyptian geese in particular. As nests of Egyptian geese are found on tree and house roofs in the present study area, they may be more exposed to predation.

As Egyptian geese are breeding in the wetland and surrounding habitats in the present study area, which are not protected from human disturbances, might have adverse effects leading to lower percentage of hatching success in Boyo wetland. Hanson and Eberhardt (1971) have reported that humans occasionally removed eggs from nests, broke eggs, or destroy nest markers on the lower islands of Canada goose population, which enhanced mortality rate of eggs leading to decreased hatching success. Human related mortality of chicks in Emperor geese due to increased vulnerability of chicks to predation (Eisenhauer and Kirkpatrick, 1977) and Canada geese population due to deliberate killing of chicks by local communities (Hanson and Eberhardt, 1971) have decreased the fledgling success. Eberhardt *et al.* (1989) have also reported that breeding success of Great basin Canda geese broods were influenced by human disturbances.

High level of rainfall during the breeding season could also have affected Egyptian geese breeding success. Birds in general are sensitive to a high rainfall, which could lead flooding of their wetland nest.

6.3. Habitat association

Egyptian geese are considered as the most highly wetland-dependent bird species because of their dependency on wetlands for foraging and breeding (Pranty and Ponzo, 2014). However, during the study period in Boyo wetland, they were observed spending majority of their time foraging on grass, grass seeds and leaf parts of plants and invertebrates such as worms and insects on the grassland and also feeding on farmland habitat. Despite this, they were heavily dependent on Boyo wetland and surrounding farmland habitats. The same was true for Spur- winged geese wintering in Boyo wetland, where they spend majority of their time feeding in the farmland and roosting in the mudflat and shallow parts of the wetland.

Egyptian geese populations of Britain and Netherlands depend highly on extensive floodplains which are the preferred habitats for feeding and nesting (Lensink, 1998; Lensink, 1999). On the other hand, during the dry season, limited food availability and water in the wetland explains why Egyptian geese spend more time in the farmland than the wetland habitat. Similarly, Gyimesi and Lensink (2012) have reported that Egyptian geese were feeding in agricultural fields in England, the Netherlands and in the Belgium, although damage to crops was not directly measured. Hadis Tadela (2018) reported that

Wattled cranes were more distributed in the farmland habitat than in the wetland due to the limited food availability associated with high level of sedimentation in the wetland. But, during the wet season, more food and water was available in the wetland. Hence, Egyptian geese spend more time in the wetland than in the farmland habitat during this season. Shimelis Aynalem(2017) reported that Black crowned cranes were more distributed in the wetland habitat than in the farmlands due to good vegetation cover and food availability as well as less disturbances.

6.4. Diurnal activity patterns

The major activity of Egyptian geese during the study period was resting, to which they devoted 39.81% of their daily time budget. Similarly, Burton and Hudson (1978) stated that resting constituted a major portion of flock activity at all times. Snow geese spent most daylight hours resting including sleeping and loafing during winter and spring migration (Davis *et al*., 1989). They may spent a greater proportion of the day time sleeping and loafing in winter, when no increase in body weight occurs and when there is a need to conserve energy to withstand periods of harsh weather (Davis *et al*., 1989). Similarly, Datta (2014) reported that resting, being the main diurnal activity of wintering Ferruginous duck (*Aythya nyroca*), which accounts for more than half of the time budget. Resting also exhibited bimodal patterns with lower percentages at the start and end of the day.

Another main activity of Egyptian geese during the day was foraging, to which they devoted 32.64% of their daily time. Edroma and Jumbe (1983) stated that Egyptian geese feeding were almost throughout the day with peaks during the early morning, midday and the cool evening hours. Similar results were also reported for Brent geese in Norfolk, UK, which spent most of their time feeding on meadows and on saltmarsh habitats (Riddington *et al*., 1996).

But, contrary to the probability, usually diving duck spends less than 25% of diurnal hours feeding (Aissaoui *et al*., 2011). As observed in this study, spending less diurnal time feeding may be a direct attribute of consuming high caloric animal matters. Muzaffar (2004) also reported that inland diving ducks of the genus *Aythya* usually spend less than 30% of diurnal time feeding; Tufted duck *(Aythya fuligula*) in Switzerland spend 21%, Ferruginous pochard in Bulgaria spend 23% and Ferruginous pochard in Bangladesh spend 17% of the time feeding. Ferruginous ducks (*Aythya nyroca*) foraging in shallow water by diving rather than up-ending or dabbling due to the result of spending less time feeding (Datta, 2014). Ferruginous ducks mainly use night hours for feeding.

Diurnal activity budget of Egyptian geese varies in relation to varying habitat types, across the time intervals of the day as well as seasonally. Egyptian geese in Boyo wetland spent more time foraging and resting in all habitats; shallow wetland, the mudflat or grassland habitats, whereas they spent less time for other activities such as locomotion, social behavior and other behavioral activities. Similarly, diurnal time-activity budget of wintering waterfowl (Crook *et al*., 2009) revealed that they spend most of their time in feeding and resting than any other activities. Feeding and resting were the most common behaviors of dabbling duck.

Time spent for locomotion was more in the morning and in the afternoon than in the mid-day during both seasons. This might be due to the fact that in the morning and in the afternoon, Egyptian geese spent more time searching for food, but less time during the mid-day. This is true also for wintering Snow geese (Davis *et al.*, 1989).

Time spent for vigilance was higher during the breeding season (wet season) than during the dry season. This might be due to flock size difference where at breeding area, Egyptian geese mostly occur in pairs due to their territorial behavior and small flock size. However, during the wet season, the flock size was large. Similar results were obtained in studies of Brent geese and Egyptian geese, where as flock size increased, the time spent for alert decreased (Riddington *et al*., 1996; Mackay *et al*., 2014).

The proportion of vigilance behavior (18.4%) in Brent geese (*Branta b. bernicla*) on meadows and on saltmarsh areas (21.2%) (Riddington *et al*., 1996), seems higher than that of Egyptian geese (5.75%) in the Boyo wetland. Percent time spent for vigilance was more frequent in the morning (9.2%) and in the afternoon (7.5%) than in the mid-day. This might be due to the adaptive behavior of Egyptian geese to humans in Boyo wetland and surrounding farmland habitats. Similarly, vigilance was more pronounced in areas where there are human and non-human disturbances, which had forced Brent geese and Egyptian geese to spent more time on scanning for danger and less time foraging on meadows and on saltmarsh habitats in Norfolk, UK and in South Africa (Webb *et al*., 2011; Mackay *et al*., 2014).

Egyptian geese spent large amount of time foraging during the wet season than during the dry season. This might be either due to the high energy demand during the breeding season. Similar results were obtained by Hohman and Rave (1990), where the difference in time allocation for foraging between sites was due to characteristics of the food, mode of foraging, disturbance level and characteristics of the habitat.

Energy requirements in low altitude birds or lowland tropical birds is too low compared to highland birds because of lower basal metabolism, due to higher temperatures leading to slow life history or to a warm, stable environment (Londoño *et al.*, 2015). This might be the other reason behind Egyptian geese, which spent higher percentage of time in foraging in Boyo wetland with better food resources than in the surrounding farmland. During the wet season, Egyptian geese feed mostly on grass and seeds of plant parts. During the dry season, Egyptian geese mostly feed on farmlands searching for grains, feeding by pick foraging strategy. Hence, geese should spend more time to feed in wetland habitats, than the time spent for picking grains from the ground in the farmland.

6.5. Foraging behaviour

Availability of food, suitable feeding and breeding sites and protective cover are the most important factors influencing habitat selection of birds (Read, 1999). Therefore, it might be this factors, which influenced Egyptian geese preference to wetland habitat and surrounding farmland habitats for feeding and breeding. Similarly, Laing and Raveling (1993) reported that habitat and food selection by Emperor geese (*Chen canagica*) goslings were to increase nutrient content of potential food plants on the Yukon-Kuskokwim Delta, Alaska. Halse (1984) noted that Egyptian geese are primarily grass and seed eating species with only few records of feeding on invertebrates such as worms and insects. Similarly, the present study has revealed that the most important food items of Egyptian geese were plant parts such as grass, seeds, leaves and grains in the Boyo wetland and surrounding farmland habitats. Similar to this, other geese such as Hawaiian geese and Canada geese were also reported to feed more on plant parts (Craven and Hunt, 1984).

Egyptian geese also feed on invertebrates in both seasons, but the frequency of animal food was very small. Similarly, Spur-winged geese were feeding plant parts including grass, seeds and leaves, and rhizomes of various terrestrial and aquatic plants in addition to few animals (Halse, 1985). The quality and quantity of food items selected at any given time are influenced by the biological demands and morphological adaptations of the bird, its behavior and ecology (Swanson *et al*., 1974). Food items selected and consumed by Egyptian geese in Boyo wetland and surrounding farmland habitats were different both in composition and availability.

During the dry season, water level decreases in Boyo wetland and the number of Egyptian geese feeding in the wetland also decreases dramatically. This might be a clear indication of reduction in the amount of food such as grasses and invertebrates in the wetland habitat. Similar results were observed in sub-Arctic regions of Canada where Canada geese (*Branta canadensis interior*) were observed foraging plant species during summer with large amount of high quality food than in winter months (Cadieux *et al*., 2005). The present result also indicated that Egyptian geese highly depend on food items in the wetland habitat than food items in the agricultural habitat.

However, during the end of the dry season, farmers surrounding the wetland start growing soybean following a brief rainfall, and Egyptian geese increase their number and start foraging on the newly growing soybean leaves in the farmland. During the end of the dry season of the year, farmers complain on the damage caused to their crops. The reason behind foraging on newly growing soybean might be due to limited alternative food availability in the wetland because of the shortage of rainfall, heavy sedimentation, wetland canalization and overgrazing. Mangnall and Crowe (2001, 2002) stated that human activities such as rapid population growth, expansion of cereal production and dam construction, irrigation projects, transformation of uncultivated land to farmland, river canalization, overgrazing and sedimentation pose serious threats to natural wetlands habitats.

Zheng *et al*. (2018) noted that when natural food sources are insufficient to meet demands, agricultural lands on the edge of wetlands become the new food sources for geese. Similarly, on the Agulhas Plain, Western Cape in South Africa, extensive loss of wetland and grazing land led Egyptian geese to forage on surface seeds, growing plants and windrows from agricultural lands, causing significant economic loss to local farmers, leading to competition for crop fields between humans and geese (Mangnall, 2001).

Egyptian geese were especially dependent on graze and pick or walk foraging than dig foraging to obtain their diet. Up-ending, dipping, surface dabbling and surface filter-feeding, diving and grazing were feeding modes used by waterfowl on pond. Similarly, Hamilton *et al.* (2002) noted that most of the time, waterfowl spend in foraging modes, mainly by dabbling to picking the surface of the water and grazing to feed on vegetation. But, feeding activities can be changed significantly when food availability within the aquatic ecosystem changes (Swanson *et al*., 1974; Webb *et al*., 2011). The same was true for Egyptian geese, where there was a difference in the foraging behavior adopted to obtain food items in the two habitats. In Boyo wetland, they were mostly dependent on graze and pick or walk foraging than dig foraging. This might be due to seasonal difference in food availability in the two different habitats.

Analyses of feces revealed that the diet of Egyptian geese contained plant matter including grass and seeds, animal matter including worms and insects and unidentified materials (Owen, 1975; Ralph *et al*., 1985). This result is similar to fecal analyses of geese in the present study in Boyo wetland habitats, when plant matter such as grass and seeds were found. Foraging behavior and availability of food resources could account for this difference.

Juvenile geese utilize more grass in the wetland than seeds in the farm. The reason could be the unfledged juvenile geese spend mostly in wetlands during the wet season than adults, which mostly account for crop foraging. Eberhardt *et al.* (1989) have reported that in Canada geese after fledging, began to forage in agricultural fields close to wetlands. But, there was little change in the composition of plant matter such as grass and seed diets during wet and dry seasons. This indicates that geese are still dependent on wetland plant food resources that made up the major proportion of food items throughout the year.

6.6. Attitude of local people towards Egyptian geese

Human - wildlife conflict incurs a substantial amount of economic cost to farmers. Crop damage by wildlife affects livelihoods of local farmers (Wang *et al*., 2006). In addition, regardless of the economic loss, human - wildlife conflict has impact in supporting negative attitude among farmers and other stakeholders against wildlife (Thirgood *et al*., 2005). Surrounding Boyo wetland, majority of the respondents (90%) had experienced crop damage particularly in their pre-harvested teff field, and in newly growing soybean field during the wet season. Majority of them consider Egyptian geese as pests due to the extent of crop loss they inflict, as most of the farmers have no alternative livelihood options.

Little and Sutton (2013) experimentally measured perceptions of local people towards Egyptian geese by users and residents of a golf estate in the Western Cape. They concluded that geese were viewed as pests by the majority of respondents with 84%

considering geese as problem birds. Likewise, local farmers in some of the Great Rift Valley areas dislike Common cranes, as flocks arrive when cereal crops are close to harvest and they destroy some crops to such an extent that farmers in areas where cranes are regular visitors have had to abandon sorghum cultivation and go for alternative crops such as maize (EWNHS, 1996).

But, the attitude and perception of some farmers to the species and wetland habitat were not negative. This could be due to low level of damage as a result of small population during the wet season in farmland habitat, which might be very easy to protect. Little and Sutton (2013) stated that perception and attitude of farmers to Egyptian geese damage are dependent on the extent of loss they make to their farms in the area. Farmers in South Africa were also complaining more on Egyptian geese damage due to increasing population, which is difficult to manage (Mangnall and Crowe, 2001, 2002). The increase in geese population in Europe and North America in the last 50 years and the damage to crops were severe (Tombre *et al.*, 2005; Tombre *et al.*, 2013; Simonsen *et al.*, 2016).

There was significant difference in crop damage suffered by Egyptian geese surrounding Boyo wetland. The reason for this could be the close proximity of their agricultural land to the main roosting sites of Egyptian geese in the wetland. Similar studies by Mangnall and Crowe (2001) showed that the most severe annual damage by Egyptian geese to farms was positively related to the proximity of their agricultural land to Egyptian geese habitat. Similar observations were made by Nilsson *et al.* (2016) on cranes, geese and swans visiting a field or causing damage is linearly and negatively related to distance of the roosting site, with a probability increase of crane, geese and swans presence from 0.05 to 0.09 when distance decreased from 5 to 1 km.

Selection of suitable roosting habitat by geese in a wetland is dependent on grasses and vegetation for grazing, and protection mechanism from predators, where they prefer mudflat and shallow wetland within close nearness to appropriate feeding grounds (Gill, 1996; Zheng *et al*., 2018). The same is true also for farmers in South Africa, who have farms close to roosting habitats of geese where they have a different relationship (Mangnall and Crowe, 2001). Furthermore, it could be also due to the difference in flock size visiting these regions, which indirectly result in differences in the perception of crop damage by farmers. Little and Sutton (2013) revealed the presence of damage and attitudinal score of farmers related to the size of flocks on the farms.

The main crop, which was raided by Egyptian geese, causing major crop damage about which farmers had major complaint was pre-harvested teff and newly grown soybean. They do not cause damage to other crops in the present study area. Similar findings were reported for other geese species, where they make extensive damage to growing crops (Harris, 2010). The reason behind the damage to growing soybean and pre-harvested teff could be due to the loss of the wetland grass species such as *Eleochrea spp*. (particularly *Eriocholoa fatmensis* and *Eriochola meyeriana*), which were once dominant in the wetland habitat according to farmers. These are the main natural food resources of Egyptian geese and other wetland birds. The loss and decrease of these dominant grass species are due to high siltation levels and short rainfall as well as overgrazing (Hadis Tadele, 2018). Similarly, the loss of natural wetland vegetation has forced Bar-headed geese in Qinghai Lake region to move to nearby farmlands and to increase their use of agricultural areas in wintering grounds (Zheng *et al*., 2018). It is also true that the conflict with Sandhill cranes along the western United States was serious due to loss and degradation of wetlands (Austin, 2010).

In addition to this, at the end of the dry season, Egyptian geese shift feeding habitat moving from wetland in to farmlands during the time of newly growing soybean fields. This might be due to the low level of food availability in the wetland and surrounding farmlands. Similar result has been found by Mangnall and Crowe (2002), where Egyptian geese have moved from harvested areas to newly sown fields during December - March as crop fields being cultivated shortly after harvesting, and flocks of many geese fed regularly in fields with newly growing soybean leaves. During this time, Egyptian geese disappeared from the wetland and moved to their surrounding farmland habitats.

Most respondents use nonlethal methods as a protection strategy such as guarding, scare crows and both guarding and scare crows to protect their teff and soybean field. Similar strategies were applied in the Jigme Singye Wangchuck National Park in Bhutan, where farmers use nonlethal methods to protect problem animals from their farms (Wang *et al*., 2006). Farmers in northern Norway and South Africa have also reduced the impact of geese damage in their farms through nonlethal intensive scaring (Tombre *et al*., 2005;

Mackay *et al*., 2014). Such methods were found effective to alleviate geese - agriculture conflicts (Simonsen *et al*., 2016). But, as the most successful control measures, local farmers in golf courses in the Western Cape in South Africa relocate or haze the geese from foraging in their agricultural land (Stephen, 2008; Mackay *et al*., 2014). On the other hand, many of the geese in South Africa were killed by farmers at the time when they stop over to feed on grains in agricultural lands (Mackay *et al*., 2014).

Farmers living in the western direction of the Boyo wetland have good access to the grass available in the wetland due to low level of siltation, where they use the grass for their livestock grazing and for thatching traditional houses, in addition to selling in the market for their livelihood requirements. The same is true with the farmers living in the southern direction of the wetland, where they use the wetland grass for grazing purpose regardless of the impact of marginal flooding. However, those respondents living in the northern direction of Boyo wetland are those who are negatively impacted due to heavy flooding. They abandon their area and farm, particularly during the wet season. The low level of grass in the eastern direction could be due to the heavy siltation, which indirectly affects the amount of grass in the area and indirectly affects the amount of grass available for their livestock or for other purposes.

Majority of the respondents have agreed that there is a possibility of the wetland protection and conservation in the future, if the combinations of education and awareness creation were implemented. If community-based conservation programs such as direct involvement of local communities in conservation activities of the wetland resources and sustainable resource access are applied, local communities will have positive attitude towards the wetland in general, and the wetland birds in particular. Such activities and programs have brought positive support from local communities in a number of African conservation areas including lake Mburo National Park, Uganda (Infield and Namara, 2001).

Boyo wetland is one of the main spots in Ethiopia to see the largest aggregation of the Egyptian geese with large population of Spur-winged geese, Common cranes, Black crowned cranes and Wattled cranes as well as other wetland and forest birds. It is very wise to increase crane-based tourism in the area, where local communities can get benefits and farmers can protect the wetland and conserve birds in the area for sustainable living (Hadis Tadele, 2018). This will indirectly reduce the confrontation and conflict of farmers, and bird species including Wattled cranes, Black crowned cranes, Egyptian geese, Spur-winged geese and other wetland bird species in Boyo wetland. Such crane-based tourism is functional in many areas around the world; for example in the Rügen-Bock region of northeast Germany (Nowald, 2012).

Also, incorporating Boyo wetland as a Ramsar wetland will have a positive impact on the protection of wetland birds including Egyptian geese, Spur-winged geese, Wattled crane, Black crowned cranes and other wetland birds. Increasing the number of habitats to be protected under Ramsar Convention helped recovering populations of some wetland birds including cranes in Japan (Amano, 2009).

7. CONCLUSION AND RECOMMENDATIONS

7.1. Conclusion

Findings of this investigation showed that Egyptian geese require a protected and undisturbed area for breeding, as they are very sensitive for disturbances. For breeding, they prefer an area, which has an elongated rainy season, food resource as well as tall trees, traditional houses, grasses or vegetation to construct their nests. Geese utilize nest materials collected from in and around the Boyo wetland areas. The presence of adequate vegetation or grass cover, water depth, availability of food for chicks, and less chance of human disturbances were determinant factors for Egyptian geese breeding performance and survival in Boyo wetland and nearby areas.

Therefore, protection and conservation of geese and their habitats should be matched and associated with the peak nesting and breeding time during the rainy season. Most of the time, they spent resting and feeding in the grassland habitat, shallow wetland and mudflat habitat in Boyo wetland. Boyo wetland harbors the largest population of Egyptian geese and supports the population for longer period of time providing a food resource and roosting sites.

The types of food resources distributed in the study area differ spatially and seasonally. The type of food preference by geese might be associated with the foraging behavior as the functional structure of a bird influences the type of food consumed. During the breeding time, the wetlands are more important places because the chicks are entirely dependent on it to get all the requirements until they fledge. The habitats and seasons have affected the distribution of geese across the study area significantly. It is common to find maximum number of geese during the wet season than the dry season.

Local farmers in the surroundings of Boyo wetland are suffering crop damage by Egyptian geese, and hence their attitude towards the species is negative. Moreover, the local farmers living around Boyo wetland are not aware of the value of the wetland and wetland bird species for conservation. The wetland is under threat due to heavy sedimentation from the surroundings. Furthermore, the natural flow of water from the wetland has been changed by draining the wetland to control flooding. Therefore, the two main grasses of the wetland habitat, *E. fatmensis* and *E. meyeriana*, which are the natural food items of Egyptian geese in the wetland habitat are affected. Boyo wetland and surrounding habitats are main feeding and roosting sites of Egyptian geese.

7.2. Recommendations

Therefore, the following recommendations are suggested to conserve Boyo wetland habitat and wetland bird species including Egyptian geese:

- ❖ In the Boyo wetland habitat, grazing inside the wetland should be controlled.
- ❖ Habitat restoration programm should be implemented in Boyo wetland area to rehabilitate natural food items of the geese.
- ❖ Human and geese conflict, and the impact of geese in the cultivated fields should be extensively studied.

- GIS-based land-use/land-cover changes in and around Boyo wetland should be conducted in order to evaluate land-use/land-cover pattern changes in the past and to take corrective measures.
- Boyo wetland is one among the 69 important bird areas and is known as a Key Biodiversity area harboring a large diversity of birds. The area is known for having a large aggregation of Egyptian geese. An ecotourism project, which can enhance the socio-economic status of local community through active participation should be considered.
- Awareness creation among the local communities should be carried out to understand the essence of conservation and sustainable use of natural resources in the Boyo wetland area.
- Alternative crop protection strategies should be studied and implemented to decrease the damage by Egyptian geese to help local farmers.

REFERENCES

Adeyemo, A. I. and Ayodele, I. A. (2005). Food and feeding ecology of the rock fowl (*Picatthartes oreas)* in Old Oyo National Park, Nigeria. *Afri. J. Ecol.* **43:** 1-6.

Aguilera, E., Knight, R. L. and Cummings, J. L. (1991). An evaluation of two hazing methods for urban Canada geese. *Wildl. Soc. Bull.* **19:** 32-35.

Airinatwe, J. (1999). *Wetlands and Water bird Conservation in East Africa: Strategies for Conserving Migratory Waterbirds*. Wetlands International Publication No. 55. Wageningen, the Netherlands, pp. 71.

Aissaoui, R., Tahar, A., Saheb, M., Guergueb, L. and Houhamdi, M. (2011). Diurnal behaviour of Ferruginous Duck (*Aythya nyroca)* wintering at the El-Kala wetlands (northeast Algeria). *Bulletin de l'Institut Scientifique, Rabat, section Sciences de la Vie* **33:** 67-75.

Altmann, J. (1974). Observation study of behavior, sampling methods. *Behaviour* **49:** 227-267.

Amano, T. (2009). Conserving bird species in Japanese farmland: past achievements and future challenges. *Biol. Conserv*.**142:** 1913-1921.

Ankney, C. D. (1996). An embarrassment of riches: too many geese. *J. Wildl. Manag*. **60:** 217-223.

Ash, J. and Atkins, J. (2009). *Birds of Ethiopia and Eritrea*. Christopher Helm, London. pp. 463.

Ash, J. S. and Miskell, J. E. (1983). *Birds of Somalia: their habitat, status and distribution.* Scopus African Publishers, Johannesburg, South Africa. pp.1-97.

Ashoori, A. and Barati, A. (2013). Breeding success of Black-crowned Night Heron (*Nycticorax nycticorax*), Little Egret (*Egretta garzetta*) and Cattle Egret (*Bubulcus ibis*) (Aves: Ardeidae) in relation to nest height in the South Caspian Sea. *Ital. J. Zool*. **80:** 149-154.

Atkins, A. (2015). An experimental assessment of the efficacy of falconry to mitigate human-wildlife conflict: Egyptian Geese (*Alopochen aegyptiaca*) at golf courses. PhD thesis, University of Cape Town, Cape town. pp.7-13.

Austin, J. E. (2010). Conflicts between Sandhill cranes and farmers in the western United States: Evolving issues and solutions. **In:** *Proceedings of International Workshop on "Cranes, Agriculture and Climate Change*", pp. 131-134 (Harris, J. ed). Baraboo, Wisconsin.

Banks, A. N., Wright, L., Maclean, I. M., Hann, C. and Rehfisch, M. M. (2008). Review of the status of introduced non-native waterbird species in the area of the African-Eurasian Waterbird Agreement: 2007 update. Norfolk, United Kingdom: British Trust for Ornithology. pp. 489.

Bêty, J., Gauthier, G., Giroux, J. F. and Korpimäki, E. (2001). Are goose nesting success and lemming cycles linked? Interplay between nest density and predators. *Oikos* **93:** 388-400.

Bibby, C. J., Burgess, N. D., Hill, D. A. and Mustoe, S. (2000). *Bird census techniques*. Elsevier. pp. 257.

Bibby, C.J., Burgess, N.D. and Hill, D. (1992). *Bird census Techniques*. Academic Press, London. pp. 239-241.

BirdLife International (2008). *State of the world's birds: Indicators for our changing world*. BirdLife International, Cambridge.

BirdLife International (2018). Egyptian Goose (*Alopochen aegyptiacus)*. The IUCN Red List of Threatened Species 2018: Downloaded from http://www.birdlife.org on 27 January 2019.

BirdLife International (2019) Species factsheet: *Alopochen aegyptiaca*. Downloaded from http://www.birdlife.org on 27/01/2019. BirdLife International (2019) IUCN Red List for birds. Downloaded from http://www.birdlife.org on 27/01/2019.

Blair, M. J., McKay, H., Musgrove, A. J., and Rehfisch, M. M. (2000). Review of the status of introduced non-native waterbird species in the agreement area of the African-Eurasian waterbird agreement research contract CR0219. *BTO Research Report*. pp. 229.

Braun, G. D. (2004). First documented nesting in the wild of Egyptian Geese in Florida. *Florida Field Naturalist* **32:** 138-143.

Brinson, M. M. and Malvárez, A. I. (2002). Temperate freshwater wetlands: types, status, and threats. *Environ. Conserv*. **29:** 115-133.

Brown, L.H., Urban, E. K. and Newman, K. (1982). *The Birds of Africa.*Vol.1. Academic Press, London.

Burton, B. A. and Hudson, R. J. (1978). Activity budgets of lesser snow geese wintering on the Fraser River Estuary, British Columbia. *Wildfowl* **29:** 111-117.

Cadieux, M. C., Gauthier, G. and Hughes, R. J. (2005). Feeding ecology of Canada Geese (*Branta canadensis interior*) in sub-arctic inland tundra during brood-rearing. *The Auk* **122:** 144-157.

Caithameer, D. F., Gates, R. J. and Tacha, T. C. (1996). A Comparison of Diurnal Time Budgets from Paired Interior Canada Geese with and without Offspring (Comparación de Presupuestos de Tiempo Diurnos de Individuos de *Branta canadensis interior* Con y Sin Polluelos). *J. Field Ornithol.***67:** 105-113.

Callaghan, C. T. and Brooks, D. M. (2016). Ecology, behavior, and reproduction of invasive Egyptian Geese (*Alopochen aegyptiaca*) in Texas. *Bull. Texas Ornithol. Soc.***49:** 37- 45.

Carp, E. (1980). *A Directory Western Palearctic Wetlands.* Compiled for UNEP, Nairobi and IUCN, Gland, pp. 506.

Central Statistical Agency (CSA) (2006). National Population Statistics. Federal Democratic Republic of Ethiopia, Central Statistical Authority, Addis Ababa.

Chesbro, C. (2015). Distribution of the Egyptian goose (*Alopochen aegyptiacus*) in northwestern Arkansas and in the United States of America.

Chudzinska, M., Madsen, J. and Nabe-Nielsen, J. (2013). Diurnal variation in the behaviour of the Pink-footed Goose (*Anser brachyrhynchus*) during the spring stopover in Trøndelag, Norway. *J. Ornithol*. **154:** 645-654.

Conover, M. R. (1991). Herbivory by Canada geese: diet selection and effect on lawns. *Ecol. Appl*.**1:** 231-236.

Craven, S. R. and Hunt, R. A. (1984). Food habits of Canada Geese on the coast of Hudson Bay. *J. Wildl. Manag*. **48:** 567-569.

Crook, S. L., Conway, W. C., Mason, C. D. and Kraai, K. J. (2009). Winter time-activity budgets of diving ducks on eastern Texas reservoirs. *Waterbirds* **32:** 548-558.

Dagnachew Legesse and Tenalem Ayenew (2006). Effect of improper water and land resource utilization on the central Main Ethiopian Rift lakes. *Quaternary International* **148:** 8-18.

Datta, T. (2014). Time-activity budgets of wintering Ferruginous Duck, (*Aythya nyroca*), at Gajoldoba wetland, Jalpaiguri, India. *Turk. J. Zool.* **38:** 538-543.

Davies, G. (2005). Egyptian goose (*Alopochen aegyptiacus*). *Ducks, swans, and geese (J. Kear, editor). Oxford University Press, Oxford, United Kingdom*. pp. 401-407.

Davis, S. E., Klaas, E. E. and Koehler, K. J. (1989). Diurnal time-activity budgets and habitat use of Lesser Snow Geese (*Anser caerulescens*) in the middle Missouri River valley during winter and spring. *Wildfowl* **40:** 45-54.

Dean, W. R. J. (2000). *The birds of Angola: an annotated checklist*. British Ornithologists' Union. pp. 433.

Del Hoyo, J., Elliot, A. and Sargatal, J. (1992). *Hand book of the Birds of the World.* Vol.1: Barcelona: Lynx edicions. pp. 205.

Döpfner, M., Quillfeldt, P. and Bauer, H. G. (2009). Changes in behavioral time allocation of water birds in wing-molt at Lake Constance. *Waterbirds* **32:** 559-571.

Dorst, J. (1971). *The Life of Birds*, Vol. II. Columbia University Press, New York. EWCA (Ethiopian Wildlife Conservation Authority) (2011). http://www.ewca.gov.et/node/17, Accessed on 12 December/ 2014.

Dugan, P. J. (Eds). (1990). *Wetland conservation: A review of current issues and required action*. IUCN, Gland, Switzerland. pp. 94.

Eberhardt, L. E., Anthony, R. G. and Rickard, W. H. (1989). Movement and habitat use by Great Basin Canada goose broods. *J. Wildl.Manag.* **53:**740-748.

Eberhardt, L. E., Books, G. G., Anthony, R. G. and Rickard, W. H. (1989). Activity budgets of Canada Geese during brood rearing. *The Auk* **106:** 218-224.

Edroma, E. L. and Jumbe, J. (1983). The number and daily activity of the Egyptian goose in Queen Elizabeth National Park, Uganda. *Wildfowl* **34:** 99-104.

Edwards, S., Sebsebe Demissew and Hedberg, I. (eds.) (1997). *Flora of Ethiopia and Eritrea*. *Vol. 6: Hydrocharitaceae* to *Arecaceae*. EMPDA. The National Herbarium, Addis Ababa.

EFAP (Ethiopian Forestry Action Programme) (1989). *The Challenges for Development*. EFAP, Addis Ababa, Ethiopia. Vol. II, pp. 315.

Eisenhauer, D. I. and Kirkpatrick, C. M. (1977). Ecology of the emperor goose in Alaska. *Wildl. Monog*. **57:** 3-62.

Eltringham, S. K. (1974). The survival of broods of the Egyptian Goose in Uganda. *Wildfowl* **25:** 41-48.

EWNHS (1996). *Important Bird Areas of Ethiopia: A First Inventory*. Ethiopian Wildlife and Natural History Society. Addis Ababa. pp. 300.

Ghasemi, A. and Zahediasl, S. (2012). Normality tests for statistical analysis: A guide for non-statisticians. *I. J. Endocrinol. Metabol.* **10:** 486-489.

Gill, J. A. (1996). Habitat choice in pink-footed geese: quantifying the constraints determining winter site use. *J. Appl. Ecol.* **33:** 884-892.

Gyimesi, A. and Lensink, R. (2010). *Risk analysis of the Egyptian goose in the Netherlands*. Culemborg: Bureau Waardenburg. pp.10-29.

Gyimesi, A. and Lensink, R. (2012). Egyptian Goose (*Alopochen aegyptiacus)*: an introduced species spreading in and from the Netherlands. *Wildfowl* **62:** 128-145.

Hadis Tadele (2018). Ecological Study of Wattled Crane (Bugeranus Carunculatus, Gmelin 1789) in the Boyo Wetland and Bale Mountains National Park, Ethiopia. PhD thesis, Addis Ababa University, Ethiopia.

Halse, S. A. (1984). Diet, body condition, and gut size of Egyptian geese. *J. Wildl. Manag.* **48:** 569-573.

Halse, S. A. (1985). Activity budgets of Spur-winged and Egyptian Geese at Barberspan during winter. *Ostrich* **56:** 104-110.

Halse, S. A. (1985). Diet and size of the digestive organs of Spur-winged Geese. *Wildfowl* **36:** 129-134.

Hamilton, A. J., Taylor, I. R. and Hepworth, G. (2002). Activity budgets of waterfowl (Anatidae) on a waste-stabilization pond. *Emu* **102:** 171-179.

Hanson, W. C. and Eberhardt, L. L. (1971). A Columbia River Canada goose population, 1950-1970. *Wildl. Monog.* **28:** 3-61.

Harris, J. (2010). Introduction: Cranes, agriculture and climate change. **In:** *Proceedings of International Workshop on "Cranes, Agriculture and Climate Change*", pp. 1-14 (Harris, J. ed.). Baraboo, Wisconsin.

Harrison, C. J. O. (1978). *Bird families of the world*. Harry N. Abrams Publishing, New York.

Hedberg, I. and Edwards, S. (eds.) (1989). *Flora of Ethiopia. Vol. 3*: *Pitosporaceae to Araliaceae*. EMPDA. The National Herbarium, Addis Ababa. pp. 659.

Hedberg, I., Edwards, S. and Nemomissa, S. (2003). *Flora of Ethiopia and Eritrea. Volume 4, Part 1. Apiaceae to Dipsacaceae.* Addis Ababa: The National Herbarium, Biology Department, Science Faculty, Addis Ababa University.

Hepworth, G. and Hamilton, A. (2001). Scan sampling and waterfowl activity budget studies: design and analysis considerations. *Behaviour* **138:** 1391-1405.

Hilaluddin, J. N. S. and Tahir, A. S. (2003). Nest site selection and breeding success by Cattle Egret and Little Egret in Amroha, Uttar Pradesh, India. *Waterbirds* **26:** 444 - 448.

Hillman, J. C. (1993). Ethiopia: Compendium of Wildlife Conservation Information. *Wildlife Conservation Area. New York Zoological Society and Ethiopian Wildlife Conservation Organization, Addis Ababa*. Vol. 2: pp.786.

Hockey, P. A. R., Dean, W. R. J., Ryan, P. G. and Maree, S. (2005). *Roberts' Birds of Southern Africa*–John Voelcker Bird Book Fund. *Cape Town*. pp. 91-93.

Hohman, W. L. and Rave, D. P. (1990). Diurnal time-activity budgets of Wintering Canvasbacks in Louisiana. *The Wilson Bulletin* **102:** 645-654.

Holderby, Z., Simper, W., Geary, B. and Green, M. C. (2012). Potential factors affecting nest initiation date, clutch size and nest success in the plumage dimorphic Reddish Egret. *Waterbirds* **35:** 437-442.

Infield, M. and Namara, A. (2001). Community attitudes and behaviour towards conservation: an assessment of a community conservation programme around Lake Mburo National Park, Uganda. *Oryx* **35:** 48-60.

Jancikova, K. (1996). Crop and pasture damage by Egyptian Geese *(Alopochen aegyptiaca)* in the Overberg, Western Cape. Unpublished Nature Conservation Report, Cape Technikon.

Jansen, H., Hengsdijk, H., Legesse, D., Ayenew, T., Hellegers, P. and Spliethoff, P. (2007). Land and water resources assessment in the Ethiopian Central Rift Valley. Alterra, Wageningen.

Jarvinen, O. and Vaisanen, A.R. (1979). Changes in bird populations as a criterion of environmental changes. *Holark. Ecol.* **2:** 75- 80.

Johnsgard, P. A. (1978). *Ducks, geese, and swans of the World*. University of Nebraska Press. pp.115-116.

Johnsgard, P. A. (2010). *Ducks, Geese, and Swans of the World*: Tribe Tadornini (Sheldgeese and Shelducks). University of Nebraska-Lincoln. pp.115-116.

Jónsson, J. E. and Afton, A. D. (2006). Different time and energy budgets of Lesser Snow Geese in rice-prairies and coastal marshes in southwest Louisiana. *Waterbirds* **29:** 451-458.

Kelley, K, Clark B, Brown, V. Sitzia, J. (2003). Good practice in the conduct and reporting of survey research. *International Journal for Quality in health care* **15:** 261-266.

Kleinheinz, G. T., McDermott, C. M. and Chomeau, V. (2006). Evaluation of avian waste and bird counts as predictors of *Escherichia coli* contamination at Door County, Wisconsin beaches. *J. Great Lakes Resear*. **32:** 117- 123.

Laing, K. K. and Raveling, D. G. (1993). Habitat and food selection by emperor goose goslings. *The Condor* **95:** 879-888.

Lensink, R. (1998). Temporal and spatial expansion of the Egyptian goose (*Alopochen aegyptiacus*) in the Netherlands, 1967–94. *J. biogeog.* **5:** 251-263.

Lensink, R. (1999). Aspects of the biology of Egyptian Goose (*Alopochen aegyptiacus*) colonizing The Netherlands. *Bird Study* **46:** 195-204.

Lepage, D. (2006). Avibase-Bird Checklists of the World-Ethiopia. http://www.bsc-eoc.org. Accessed on 31/07/2006.

Linnaeus, C. (1766). Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus *I*. Editio duodecima, reformata. Holmiae. (Laurentii Salvii).pp.1-532.

Little, R. M. and Sutton, J. L. (2013). Perceptions towards Egyptian Geese at the Steenberg Golf Estate, Cape Town, South Africa. *Ostrich* **84:** 85-87.

Little, R. M., Vester, K. C. and Crowe, T. M. (1995). Temporal and spatial patterns of breeding activity of 12 duck species (Anatidae) in the Cape Provinces, South Africa, and their implications for hunting seasons. South African. *J. Wildl. Resear.* **25:** 17-22.

Londoño, G. A., Chappell, M. A., Castañeda, M. D. R., Jankowski, J. E. and Robinson, S. K. (2015). Basal metabolism in tropical birds: latitude, altitude, and the 'pace of life'. *Func. Ecol.* **29:** 338-346.

Mackay, B., Little, R. M., Amar, A. and Hockey, P. A. (2014). Incorporating environmental considerations in managing Egyptian geese on golf courses in South Africa. *J. wildl. manag.***78:** 671-678.

Mackworth-Praed, C. W. and Grant, C. H. B. (1980). *African handbook of birds*: *Vol. 1*. Longman Group Limited, London.

Maclean, G. L. (1993). *Robert's birds of southern Africa*.7th edition. Cape Town: John Voelcker Birds Book Fund.

Maclean, G. L. (1997). *Atlas of southern African birds*. Volume 1. BirdLife South Africa, Johannesburg, South Africa. pp. 122-123.

Maclean, L. (1988). *Robert's birds of southern Africa*. New Holland Publishers, London.

MacMillan, D., Hanley, N. and Daw, M. (2004). Costs and benefits of wild goose conservation in Scotland. *Biol. Conserv.* **119:** 475-485.

Mafabi, P. (1995). Wetlands and their Wildlife. *Swara* **18:** 36.

Makram, A. (2018). Goose World. Poultry Production Department, Faculty of Agriculture, Fayoum University, Egypt. *The 10th International Poultry Conference-Proceeding from 26-29 November*. pp. 1-12.

Mangnall, M. J. (2001). The demography of the Egyptian Goose, its impacts on cereal crop agriculture on the Agulhas Plain, Western Cape, South Africa and the measures to mitigate damage to crops by geese. PhD thesis, University of Cape Town, Cape town.

Mangnall, M. J. and Crowe, T. M. (2002). Population dynamics and the physical and financial impacts to cereal crops of the Egyptian Goose (*Alopochen aegyptiacus*) on the Agulhas Plain, Western Cape, South Africa. *Agri. Ecosys. Environ.* **90:** 231-246.

Mangnall, M. J. and Crowe.T. M. (2001). Managing Egyptian geese on the croplands of the Agulhas Plain, Western Cape, South Africa. South African. *J. Wildl. Resear.***31:** 25-34.

McDowell, C. (1988). Factors Affecting the Conservation of Renosterveld by Private Landholders. PhD thesis, University of Cape Town, Cape town.

McNeill, P. and Chapman, S. (1985). *Research Methods* (3rd ed.). Tavistock Publications Ltd, London.

Mengistu Wondafrash (2003). Wetlands, birds and important bird areas in Ethiopia. **In:** *Wetlands of Ethiopia: Proceedings of a Seminar on the Resource and Status of*

Ethiopia's Wetlands, pp. 25-30, (Yilma Delelegn and Geheb, K. (eds). International Union for Conservation of Nature and Natural Resources, Gland.

Mitsch, W. J. and Gosselink, J. G. (1993). *Wetlands*. 2nd Edition. Van Nostrand Reinhold, New York, U.S.A. pp. 537.

Mitsch, W. J. and Hernandez, M. E. (2013). Landscape and climate change threats to wetlands of North and Central America. *Aquatic Sci*.**75:** 133-149.

Mukherjee, A., Soni, V., Borad, C. and Parasharya, B. (2000). Nest and eggs of Sarus Crane (*Grus antigone antigone Linn*.). *Zoos' Print Journal* **15:** 375-385.

Mullarney, K. Svensson, L. Zetterstrom, D. and Grant, P. J. (1999). *Birds of Europe*. Princeton University Press, Princeton.

Muzaffar, S. B. (2004). Diurnal time-activity budgets in wintering Ferruginous Pochard (*Aythya nyroca*) in Tanguar Haor, Bangladesh. *Forktail* **20:** 25-27.

Nilsson, L., Bunnefeld, N., Persson, J. and Månsson, J. (2016). Large grazing birds and agriculture; Predicting field use of common cranes and implications for crop damage prevention. *Agri. Ecosys. Environ.***219:** 163-170.

Nowald, G. (2012). Cranes and people: Agriculture and tourism. **In:** *Proceedings of International Workshop on "Cranes, Agriculture and Climate Change*", pp. 60-64 (Harris, J. ed). Baraboo, Wisconsin.

Oatley, T. O. and Prys-Jones, R. P. (1985). A comparative analysis of movements of southern African waterfowl (Anatidae), based on ringing recoveries. *S. Afri. J. Wildl. Resear.* **16:** 1-6.

Owen, M. (1975). An assessment of fecal analysis technique in waterfowl feeding studies. *J. Wildl. Manag.* **39:** 271-279.

Owen, M. (1980). *Wild geese of the World: their life history and ecology*. Batsford.

Patterson, I. J. (1991). Conflict between geese and agriculture: does goose grazing cause damage to crops? *Ardea* **79:** 179-186.

Peakall, D. B. and Boyd, H. (1987). Birds as bio-indicators of environmental conditions. **In:** *The Value of Birds*, pp. 113-118, (Diamond, A.W. and Filion, F. L., eds). ICBP Technical Publication, Kingston.

Petersen, M. R. (1992). Reproductive ecology of emperor geese: annual and individual variation in nesting. *The Condor* **94:** 383-397.

Phillips, S. (1995). *Flora of Ethiopia and Eritrea*: *Volume 7. Poaceae (Gramineae).* Addis Ababa, Uppsala: The National Herbarium, Biology Department, Science Faculty, Addis Ababa University.

Pitman, C. C. (1965). The nesting and some other habits of *Alopochen*, *Nettapus*, *Plectropterus* and *Sarkidiornis*. *Wildfowl* **16:** 7.

Pranty, B. I. L. L. and Ponzo, V. A. L. E. R. I. (2014). Status and distribution of Egyptian geese (*Alopochen aegyptiaca*) in Southeastern Florida. *Florida Field Naturalist* **42:** 91-107.

Prins, H. T., Ydenberg, R. C. and Drent, R. H. (1980). The interaction of brent geese (*Branta bernicla*) and sea plantain (*Plantago maritima*) during spring staging: field observations and experiments. *Acta Botanica Neerlandica* **29:** 585-596.

Ralph, C. P., Nagata, S. E. and Ralph, C. J. (1985). Analysis of droppings to describe diets of small birds. *J. Field Ecol.* **56:** 165 - 174.

Read, J. L. (1999). A strategy for minimizing waterfowl death on toxic water bodies. *J. Appl. Ecol.* **36:** 345 - 350.

Redman, N., Stevenson, T. and Fanashawe, J. (2009). *Birds of the Horn of Africa*. Princeton University Press. Princeton and Oxford. pp. 496.

Rehfisch, M. M., Allan, J. R. and Austin, G. E. (2010). The effect on the environment of Great Britain's naturalized Greater Canada (*Branta canadensis*) and Egyptian Geese (*Alopochen aegyptiacus). BOU Proceedings–The Impacts of Non-native Species* **2:** 1-9.

Riddington, R., Hassall, M., Lane, S. J., Turner, P. A. and Walters, R. (1996). The impact of disturbance on the behaviour and energy budgets of Brent Geese (*Branta b. bernicla*). *Bird study* **43:** 269-279.

Rounds, R. A., Erwin, R. M. and Porter, J. H. (2004). Nest-site selection and hatching success of waterbirds in coastal Virginia: some results of habitat manipulation. *J. Field Ornithol.* **75:** 317-329.

Ryder, J. P. (1971). Distribution and breeding biology of the Lesser Snow Goose in central Arctic Canada. *Wildfowl* **22:** 18-28.

Scott, D. A. and Rose, P. M. (1996). Atlas of Anatidae populations in Africa and western Eurasia.

Shibru Tedela (1995). Protected area management crisis in Ethiopia. *Walia* **16:**17-30.

Shimada, T. (2002). Daily activity pattern and habitat use of Greater White-fronted Geese wintering in Japan: factors for the population increase. *Waterbirds* **25:** 371-377.

Shimelis Aynalem (2017). Birds of Lake Tana Sub-Basin. **In:** *Social and Ecological System Dynamics: Characteristics, Trends, and Integration in the Lake Tana Basin, Ethiopia*, pp. 179-206 (Stave, K., Goraw. Goshu and Shimelis Aynalem eds.). Springer.

Shimelis Aynalem (2017). The Ecology of Black Crowned Crane (*Balearica Pavonina ceciliae*) in Relation to Changes of Land use at Lake Tana, Ethiopia. PhD thesis, Addis Ababa University, Ethiopia.

Shimelis Aynalem and Afework Bekele (2008). Species composition, relative abundance and distribution of bird fauna of riverine and wetland habitats of

Infranz and Yiganda at southern tip of Lake Tana, Ethiopia. *Tropic. Ecol.* **49:** 199-209.

Simonsen, C. E., Madsen, J., Tombre, I. M. and Nabe-Nielsen, J. (2016). Is it worthwhile scaring geese to alleviate damage to crops? An experimental study. *J. Appl. Ecol.* **53:** 916-924.

Smith, K. G. and Fames, D. A. (2012). History and current status of Egyptian goose (*Alopochen aegyptiacus*) in Northwestern Arkansas. *J. Arkansas Academy Sci.* **66:** 200-204.

Stephen, V. (2008). A review of mitigation measures and their effectiveness in reducing the nuisance of geese on golf courses. *Unpublished MSc thesis, University of Cape Town.*

Sutherland, W. J. (1996). *Ecological Census Techniques: A Hand book*. Cambridge University Press, Cambridge, pp.332-336.

Sutherland, W. J. (2000). *The Conservation Hand book Research Management and Policy*, Cambridge University Press, Cambridge, UK.

Sutherland, W. J. (2004). Diet and Foraging Behavior. **In:** *Bird Ecology and Conservation; A Handbook of Techniques*, Pp. 233-250 (Sutherland, W. J., Newton, I. and Green, R. E., eds). Oxford University Press, Oxford.

Sutherland, W. J. and Allport, G. (1991). The distribution and ecology of naturalized Egyptian Geese (*Alopochen aegyptiaca*) in Britain. *Bird Study* **38:** 128-134.

Swanson, G. A., Meyer, M. I. and Serie, J. R. (1974). Feeding ecology of breeding Blue-Winged Teals. *J. Wildl. Manag.* **38:** 396-407.

Tattan, A. (2004). *Alopochen aegyptiaca*, Egyptian Goose. Animal Diversity website <animal diversity. ummz.umich.edu/accounts/Alopochen_aegyptiaca>. Accessed 31 October 2013.

Tesfaye Hundessa (1990). *The Conservation Status of Wetlands and Waterfowl in Ethiopia*. Paper Presented to IWRP Workshop. 3 - 12 March, 1990, Uganda. pp. 18.

Thirgood, S., Woodroffe, R. and Rabinowitz, A. (2005). The impact of human-wildlife conflict on human lives and livelihoods. **In:** *People and Wildlife, Conflict or Co-existence* pp. 13-26 (Woodroffe, R., Thirgood, S. and Rabinowitz, A., eds). Cambridge University Press, Cambridge.

Todd, F. S. (1979). *Waterfowl: ducks, geese and swans of the World*. Sea World Press.

Tombre, I. M., Eythórsson, E. and Madsen, J. (2013). Towards a solution to the goose-agriculture conflict in North Norway, 1988-2012: the interplay between policy, stakeholder influence and goose population dynamics. *PLOS ONE* **8:** e71912.

Tombre, I. M., Madsen, J., Tømmervik, H., Haugen, K.-P. and Eythórsson, E. (2005). Influence of organized scaring on distribution and habitat choice of geese on pastures in Northern Norway. *Agric. Ecosys. Environ.* **111:** 311-320.

Towery, B. N. (2015). The distribution and nest survival of giant Canada geese breeding in Iowa.

Van der Sar, L. (1992). Alleviation of the crop damage conflict from the agricultural point of view. **In:** Van Roomen, M and Madsen, J. (Eds), Review and future perspective of the crop damage conflict in Europe. Slimbridge, U.K.

van Kleef, H., H.Willems, F., E. Volkov, A., J. H. R. Smeets, J., Nowak, D. and Nowak, A. (2007). Dark-bellied brent geese (*Branta b. bernicla*) breeding near snowy owl (*Nyctea scandiaca*) nests lay more and larger eggs. *J. Avian Biol.* **38:** 1-6.

Vickery, J. and Gill, J. (1999). Managing grassland for wild geese in Britain: a review. *Biol. Conser.* **89:** 93-106.

Viveropol, J. L. (2001). *A guide to Endemic birds of Ethiopia and Eritrea.* Shama Books, Addis Ababa, Ethiopia, Pp.78. Volume 1: Lynx Edicions, Barcelona.

Wang, S. W., Curtis, P. D. and Lassoie, J. P. (2006). Farmer perceptions of crop damage by wildlife in Jigme Singye Wangchuck National Park, Bhutan. *Wildl. Soc. Bull.* **34:** 359-365.

Webb, E. B., Smith, L. M., Vrtiska, M. P. and Lagrange, T. G. (2011). Factors influencing behavior of wetland birds in the Rainwater Basin during spring migration. *Waterbirds* **34:** 457-467.

Wilson, E.O. (1992). *The Diversity of Life*. Harvard University Press, Cambridge. pp. 56.

Yalden, D.W. (1983). The extent of high ground in Ethiopia compared to the rest of Africa. *SINET: Ethiop. J. Sci.* **6:** 35-39.

Yilma, Delelegn (1998). The Wattled Cranes (*Burgeranus carunculatus*) of Boyo Wetlands, Ethiopia: Presence, Activities and Interactions with Human Communities. IUCN, Eastern African program.

Zhang, J. (1991). To devote major efforts to developing herbivorous animal production in China. *World review of animal production* **26:** 61-65.

Zheng, R., Smith, L. M., Prosser, D. J., Takekawa, J. Y., Newman, S. H., Sullivan, J. D. and Yan, B. (2018). Investigating Home Range, Movement Pattern, and Habitat Selection of Bar-headed Geese during Breeding Season at Qinghai Lake, China. *Animals* **8:** 182.

APPENDICES

Appedix I: **Questionnaire**

Purpose: The purpose of this study is to "Assess how Egyptian geese and local communities coexist or interact with local farmers in Boyo wetland". It is hoped that the information you will give to design appropriate ways of identifying the main challenges that occur with birds of Egyptian geese and design appropriate conservation measures for the species and the wetland as well as the local communities' in the near future.

1. Back ground characteristics of the respondent and family members

a.Sex____________ b.Age____________ c. Religion ____________________

d.Marital status__________________e.Education status ____________________

f.Current occupation__________________g.Direction to the wetland_______________h. Family size______________i.Kebele_________________

2. Land and livestock property

a. What is the size of your farmland in hectare______________________

b. **Livestock holding and utilization in (January 2017 – January 2018)**

Livestock	**Before two years**	**At present**
Ox		

Cow		
Donkey		
Sheep		
Goat		

3. Knowledge and perception towards birds in general and Egyptian geese in particular

a. Do you feel happy when you see birds or hear their songs in the wetland or nearby areas? Yes/No

b. Do you know Egyptian geese? Yes/No

c. Since when do you know Egyptian goose?

d. Do you think Egyptian geese are harmful? Yes/No If yes/ how?

i) In farm to damage crop ii) In breeding season to affect human being house iii) Others

e. At what season do Egyptian geese visit your farm?

i) During wet season ii) Dry season iii) All year round

f. How often do they visit your farm in a day?

i) Once a day ii) Two times iii) Three times iv) More than three times a day

g. In what number and when did you see the maximum number of Egyptian goose in the wetland?

h. Have you noticed any change in the population status of Egyptian geese in this area since long time ago?

i) Increasing ii) Decreasing iii) No difference iv) Indeterminate

i. Have you seen any kind of illegal hunting or killing of Egyptian geese by the local people before? Yes/No

If yes for what purpose do they kill Egyptian geese?

i) For food ii) Being as a pest iii) Just for recreation iv) Not known

j. What type of crop do you plant mainly?

i) Teff ii) Wheat iii) Soybean iv) Corn v) Others

k. Which type of crop do they prefer more?

i) Teff ii) Wheat iii) Soybean iv) Corn v) Others

i. At what stage do they preference to feed?

i) Just before germination ii) During first stage of germination iii) Planting iv) During harvesting v) After harvesting

m. Do you use any mechanism to deter Egyptian goose from damaging your crop? Yes/No If yes, what kind of deterring mechanisms do you use?

i) ________________________________

ii) ________________________________

iii) ________________________________

4. Perception and knowledge towards the wetland

a. Do you think that this wetland has a potential benefit for your survival? i) Yes ii) No

If yes/ how________________________________

b. Level of benefits, If yes to the above question i) High ii) Medium iii) Moderate

c. For what purpose do you use the wetland

i) Grazing ii) Irrigation iii) To access drinking iv) Grass

d. Do you believe that livelihood improvements can be possible by conserving this wetland

i) Yes ii) No

If NO/// Reasons________________________________

If Yes/// Indicate the means of doing it ________________________________

e. Do you think this wetland is at risk due to human induced factors? i) Yes ii) No

If yes /Give rank (1-12) to the following major human factors which may cause the wetland at risk:

1. Deforestation and Soil erosion________________________________
2. Irrigation________________________________

3. Absence of strong abiding common rules and regulations to the wetland________________

4. Overgrazing______________________________

5. Expansion of cultivated land______________________________

6. The area is very exposed to marginalized poor ______________________________

7. Absence of well structured property right system (if so, specify) _______________

8. Investment______________________________

9. Intra-resource use conflict ______________________________

10. Absence of trust among the community members _________________________

11. Free riding problems ______________________________

12. Other specify ______________________________

f. Do you know the existence of sustainable NR utilization and wetland conservation methods?

i) Yes ii) No

If Yes______________________________

g. Would you be willing and able to use community-based conservation measures without the subsidies or support from government or NGOs? i) Yes ii) No

h. What do you suggest to improve the perception of local communities towards biodiversity (birds in the area) conservation?

i. Are there opportunities that promote the community based birds and wetland conservation activities in your study area?

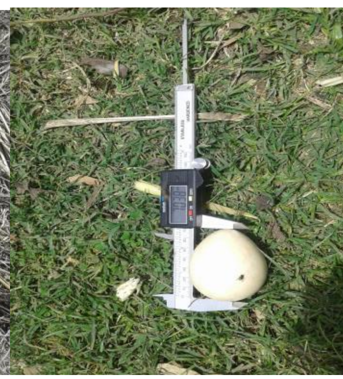
i) Yes ii) No iii) Unknown

j. If yes, what are they? --

PLATES



A B C


D E F

G H I



J K L

Plate description: A. Egyptian goose incubating on house roof nest, B and C: Nest with eggs, D: Nest without eggs, E and F: Egg length and width measurement at nesting area, G and H: Egg weight measurement, I: Goose feces sample prepared for lab analysis, J and K: Fecal sample analysis in the lab. L. Boyo wetland during flooding.