Sudan University of Science and Technology

College of Graduate Studies

Wildlife and Fisheries Department

The Status, diversity and some aspects of breeding behaviour of avian species in Khartoum State with emphasis on the Laughing Dove *Streptopelia senegalensis* (2013-2014)

وضعية وتنوع وبعض جوانب سلوكيات التوالد لأنواع الطيور في

ولاية الخرطوم مع التركيز علي طائر القمري (2013 -2014)

A thesis submitted in fulfillment of the degree of Ph.D in Wildlife science

By

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DEDICATION

I dedicate my research to soul of my father Nugud Margani and to my great mother Fatma Mohammed. Who gave me their love and always asking Allah to save and guard me through my hard work in research

To my husband, and my friends for helping me.

To my children Anan, Amro and Abed.

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ABSTRACT

The Laughing Dove (*Streptopelia senegalensis*) is the most widespread species of Columbidae in Africa. There is no research done on this species in Sudan. Therefore, the present study aims to describe the breeding habits of the Laughing Dove in order to provide field data on breeding and breeding sites locations.Field observations were conducted on the breeding habits of the Laughing Dove (*Streptopelia senegalensis*) at Khartoum State, Sudan, from 2013 to 2014. Observations were made under natural conditions. Observation were made using binoculars and field camera . A ladder of 4meter height was used to reach the nests. Morphometrics measurements were taken of eggs using vernier caliper. Digital scale professional balance was used to weight eggs.Descriptions were also given of the nest sites , nest building, nesting materials , nest measurements , nest height and preference for nesting trees included Tamrhindi *Pterolobium exosum*,Tundub, *Capparis deciduas*, Sedir,*Ziziphaus spinachristi*, Heglieg, *Balanites aegyptiaca*. Breeding activities were all shared by both sexes. Egg laying,incubation, hatching and fledgling were observed. The mineralogical contents for egg shells were not significant in two different habitats .The differences in mean of the numbers of nests between three towns (Khartoum, Bahari and Omdurman) was statistically significant difference ($p<0.05$).Also there were significant difference between the seasons(dry season, winter and wet season). The ANOVA revealed significant variation in number of nests in different seasons (P=0.011) and in the three towns(P=0.0001) in 2013. In 2014 there was significant difference in number of nests in seasons (P=0.05),and in the three towns(P=0.005). The maximum numbers of the investigated nests were 36 in the first season and 45nests in the second breeding season. The Laughing Dove (*Streptopelia*

senegalensis) breeds throught the year with the highest number of nests in rainy season and winter . That indicate there would be abundant food, when young were hatched.Birds bred solitary, males and females built the nest together.The average number of eggs per nests were two(n=76). The breeding success of the Laughing dove (*Streptopelia Senegalensis)*was found to be moderate. The percentage of nesting success in the first breeding season(2013) was 42.1 % in Khartoum based on 8 nests, the percentage of nesting success in the first breeding season (2013) was 37.9 % in Bahari based on 6 nests. In the second breeding season (2014) the percentage of nesting success was47.8% in Khartoum based on 11nests, and the percentage of nesting success in Bahary was 48.3% based on 8 nests, in Omdurman the percentage of nesting success was 40% based on 3nests.Breeding success was calculated from nests that were followed from egg laying to fledgling . Also the present study describes bird fauna in Khartoum State (Khartoum, Bahari, and Omdurman).To the best of my knowledge since (Macleay,1960)there was not any recent study,so the studies of the area become basic necessity.The objective of this study were to document avifauna of Khartoum State. Identification of birds was executed using bird guides (Williams 1991 and Sinclair and Ryan 2010).The result was analysed in order to see the abundance and status of each species, it was tabulated and also presented as graphs.Data was provided on birds species, A total of 84 bird species were recorded in the area of which36species were Palearctic Migrants and 26 species were resident throughout the study period. A total of 6599 individual birds were found in the area, in 2013 and 8776 in 2014.Birds showed influx both in species and number of individual and this is attributed to habitat changes in rainy season. Also they were difference in bird species diversity and number of individuals between the sites in Khartoum State for the different habitats.

المستخلص

طائر القمرى (*Streptopelia senegalensis*) Laughing Doveمن

اكثر انواع القمارى انتشارا فى معظم افريقيا. لا توجد دراسات علمية على هذا النوع فى السودان. الدراسة الحالية تهدف لوصف عادات التناسل لهذا النوع من الطيور و مواقع التعشيش.

تمت الدراسات الميدانية لسلوك التناسل لطائر القمارى فى ولاية الخرطزم – السودان فى الفترة من 2013الى 2014م حيث تمت الدراسة على الطبيعة . تمت هذه الدراسة باستخدام منظار و كاميرا للملاحظة سلم طوله حوالى 4 امتار للوصول الى الاعشاش. وتم اخذ القياسات الفيزيائية للبيبض باستخدام ممسا ك للقياسات و ميزان رقمى لقراءة اوزان البيض..وتم وصف مواقع الاعشاش وهيكلها ومعمار بناءها والمواد المستخدمة فى ذلك وقياسها وقياس ارتفاعها عن سطح الارض كما وجد ان الطائر يبنى اعشاشه على اشجار التمر هندى والطندبة و السدر والهجليج وتم ملاحظة الادوار التى يقوم بها الذكور والاناث خلال فترة التعشيش ووضع البيض والاحتضان والفقس.اثبتت الدراسة ان ليس هنالك فرق معنوى بين محتويات قشرة البيض من العناصر فى منطقة الدراسة .كما اثبتت ان هنالك فرق معنوى فى عدد الاعشاش فى المدن الثلاث (الخرطوم وبحرى وام درمان) كما ان هناك فرق معنوى بين فصول السنة(الصيف و االشتاء والصيف الممطر). وقداظهر تحليل البيانات ان هناك اختلاف معنوي في عدد الاعشاش في الفصول المختلفة (P=0.011) ,وفي المدن الثلاث(P=0.0001)في 2013 وفي 2014 كان الاختلاف المعنوي في عدد الاعشاش في الفصول (P=0.05) وفي المدن الثلاث(P=0.005). العدد الاقصى من الاعشاش التى وجدت فى الموسم التزاوج الاول كانت 36عشا اما فى موسم التزاوج الثانى كانت 45عش.التوالد

في طائر القمري طوال العام واعلي نسبة في موسم الامطار والشتاء نسبة لتوفر الغذاء للصغار عند الفقس . يتوالد هذا النوع مفردا حيث يقوم الذكر والانثى ببناء عشا واحدا.متوسط عدد البيض فى كل عش اثنان(n=76). وجد ان نسبة نجاح التكاثر كانت وسطية عند طائر القمرى حيث نجد ان نسبة نجاح التفريخ فى موسم التكاثر الاول كانت 42.1% فى الخرطوم بناء على 8 اعشاش وفى بحرى كانت نسبة نجاح التفريخ فى موسم التكاثر الاول كانت 37.9% بناء على 6 اعشاش. حيث نجد ان نسبة نجاح التفريخ فى موسم التكاثر الثانى كانت 47.8% فى الخرطوم بناء على 11 عشا وفى بحرى كانت نسبة نجاح التفريخ فى موسم التكاثر الثانى كانت 48.3% بناء على 8 اعشاش درست بدقة.وفى امدرمان كانت نسبة نجاح التفريخ 40% اعتمادا على 3 اعشاش . نسبة نجاح التكاثر حسبت من الاعشاش التى تمت مراقبتها بعناية من وضع البيض الى التفريخ

هذه الا طروحة تصف الطيور فى ولاية الخرطوم (الخرطوم وبحرى وام درمان) حيث انه لاتوجد دراسة حالية منذ (ماكلي1960) .تهدف الدراسة الى تسجيل وتحديد انواع الطيور في ولاية الخرطوم. تم تحليل البيانات لمعرفة وفرة ووضع كل الانواع وتم جدولتها وعرضها فى شكل رسومات بيانية .وقدمت بيانات عن انواع الطيور فى ولاية الخرطوم. 84نوعا من الطيور تم تسجيلها فى المنطقة منها 36نوعا منها مهاجرا و 26نوعا مستقر فى المنطقة. مجموع6599طائرا تم تسجيلها فى 2013و 8776 طائرا تم تسجيلها فى 2014.كما وجد ان هنالك اختلاف فى التنوع والاعداد فى الطيور بين مناطق فى ولاية الخرطوم نسبة لتغير البيئات في موسم الامطار. كما ان هنالك اختلاف في تنوع الطيور واعدادها في مناطق ولاية الخرطوم نسبة لاختلاف البيئات.

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CHAPTER ONE

1-INTRODUCTION

Sudan is a large country with different habitats including rivers, plain,valleys,Plateau, and Mountains, all are of importance to birds. Sudan is considered one of the richest African countries in wildlife. Sudan, geographically, is located on the main routes used by migratory birds from three continents (Europe, Asia,and Africa). Sudan is a place for migratory bird in providing food, water and aresting sites after a long journey (Hamed, 1998). Change in species composition occur because resident and migrant species contribute in varying proportion in different periods of the year (Avery&Van Ribber, 1989). Some resident African birds also migrate from one part of the continent to another. The large number of African birds have regular seasonal movement within the continent always coinciding with the rainy season (Hamed, and Evan,1982; Dodman and Diagana,2007).

Khartoum is ideally situated for the study of birds. It is considered as a transitional zone between the extreme desert to the north and dry wood savannah to the south. Therefore representive of bird of both desert and and savannah species are found(Happold, 1967). Khartoum is located on the great migration route of most of the summer visitors to Europe and the rest of Palaearctic region.It is also an important centre for many African migrants which spend their summer and more especially the rainy season in the north part of their range, and returning south to central and southern Africa during October after their breeding has finished.Moreover, during the winter months of the north temperate region, the Sudan is invaded by large number of species which spend their non-breeding season in Africa. Many remain in the Sudan while other pass through to the south and stop over, rest, feed and drink(Cave and Macdonald, 1955).

The avifauna of Sudan includes 938 species before separation of south Sudan Nikolaus, (1987).And according to Huyam,et al., 2012) over all 87 bird species were recorded in Al-Sunut Forest in Khartoum State. Among the recorded species, 50 were palearctic migrants, 8were local migrants and 29 species were resident. (Lado 1994; Abd-Alrahman,1998) recorded that; Al – Sunut forest contains at least 70 species (among which 26 are migrants).

Al-Sunut Forest is a natural forest which borders the White Nile at the Mogran area, Khartoum. Sunut forest is a unique biotope; a poor savannah habitat impeded in the semi desert background of Northern Sudan (Shawki & Musnad, 1964). As a consequence, the forest is characterized by high density of plant cover, mainly composed of *Acacia nilotica* trees (Ahmed, 1998). Moreover, it represents a hot spot of bird and invertebrate diversity. The Sunut Forest is a national protected area. It is regarded as a forest reserve since 1932 and declared as a bird sanctuary since 1945. The forest attracted considerable attention at the international level as well. The management category of the International Union for the Conservation of Nature (IUCN) has listed the site as a bird sanctuary. In addition, it has been proposed as a Ramsar site (i.e. wetland of international importance) based on Ramsar convention (Altayeb & Hamed, 2003). The avifauna at Sunut forest was found to show considerable temporal fluctuations with respect to both abundance and species diversity. These variations can be attributed to two main factors (Mac Nally, 1996; Yahner, 1997): first, the seasonal change in water availability that is associated with the Nile flood, this change influences both vegetation cover and insect density at the forest, and thus affects the attractiveness of the site for birds. The second factor which underlies the temporal variations is bird migrational patterns.

Additional to the Sunnt Forest there are another type of wetland in Khartoum, it is Jabal Awlia dam, it was built in 1937 to augment the storge

of water for summer irrigation. It is worth mentioning that it is the only dam in the Sudan with a fish passage way and a navigation lock. Monakov (1968) made a survey of 1500km of the White Nile and emphasized the impact of Jabal Awlia dam on the ecology of the river. It is of interest to mention that whereas that the maximum biomass of zooplankton was close to the dam, the maximum (Nile Basin Initiative, 2001).Also there are Al Sunut Forest surrounded the area near the dam. Also there are temporal variation in birds migration pattern. And the recorded information about artificial wetland (Dam of Jabal Awlia) are very rare

Nikolaus (1987) recorded 23 species of Columbidae(Doves and Pigeons) in Sudan, although some of these were rare records.The more common dove spieces are laughing Dove *Streptopelia Senegalensis*, Namaqua Dove, *Oena capensis*, Ring necked dove,*Streptopelia capicola*, Mourning Dove, *Streptopelia decipiens*, Turtle Dove,*Streptopelia turtur*, Lemon Dove, *Aplopelia larvata*, Pink breasted Dove, *Streptopelia lugens*, Red eyed Dove, *Streptopelia semitorquata*, Black billed wood Dove *Turtur abyssinicus*, , Speckled Pigeon, *Columba guinea guinea*, Rock Pigeon, *Columba livia*, , Green Pigeon, *Teron australis uellensis*, Tambourine Dove, *Turtur tympanistria*.

Distribution of Laughing Dove in Sudan: common and widely distributed in all habitat in Sudan (Figure 1)

This research is intended to give information on seasonal breeding behaviour of the laughing dove *Streptopelia senegalensis* in Khartoum State (urban area),this is the main objective of the study .On the other hand, the other objectives is to record the species of the columbidae and the number of it and the species of others bird in six sites in Khartoum State. Sudan. The main reasons for selecting this species for research were as follows:

1-There is a need for field data on columbidae in sudan. No study was made on this species.

2-The species is common in sudan and some breeding sites were located in Khartoum State (Hamed, personal communication,1999)

3-If need arises for laboratory studies it can easily be caught.

The main objectives were:

1-To study breeding behavior of Laughing dove throughout the year (nest site and building,eggs,and nestling).

2-To determine morphometric measures which will include measurement of eggs dimensions length,width and thickness, and egg shell minerals contents of Laughing dove.

3-To detect nest site location of Laughing dove and measurement were taken of the length, width and depth of nests using a tape meter.

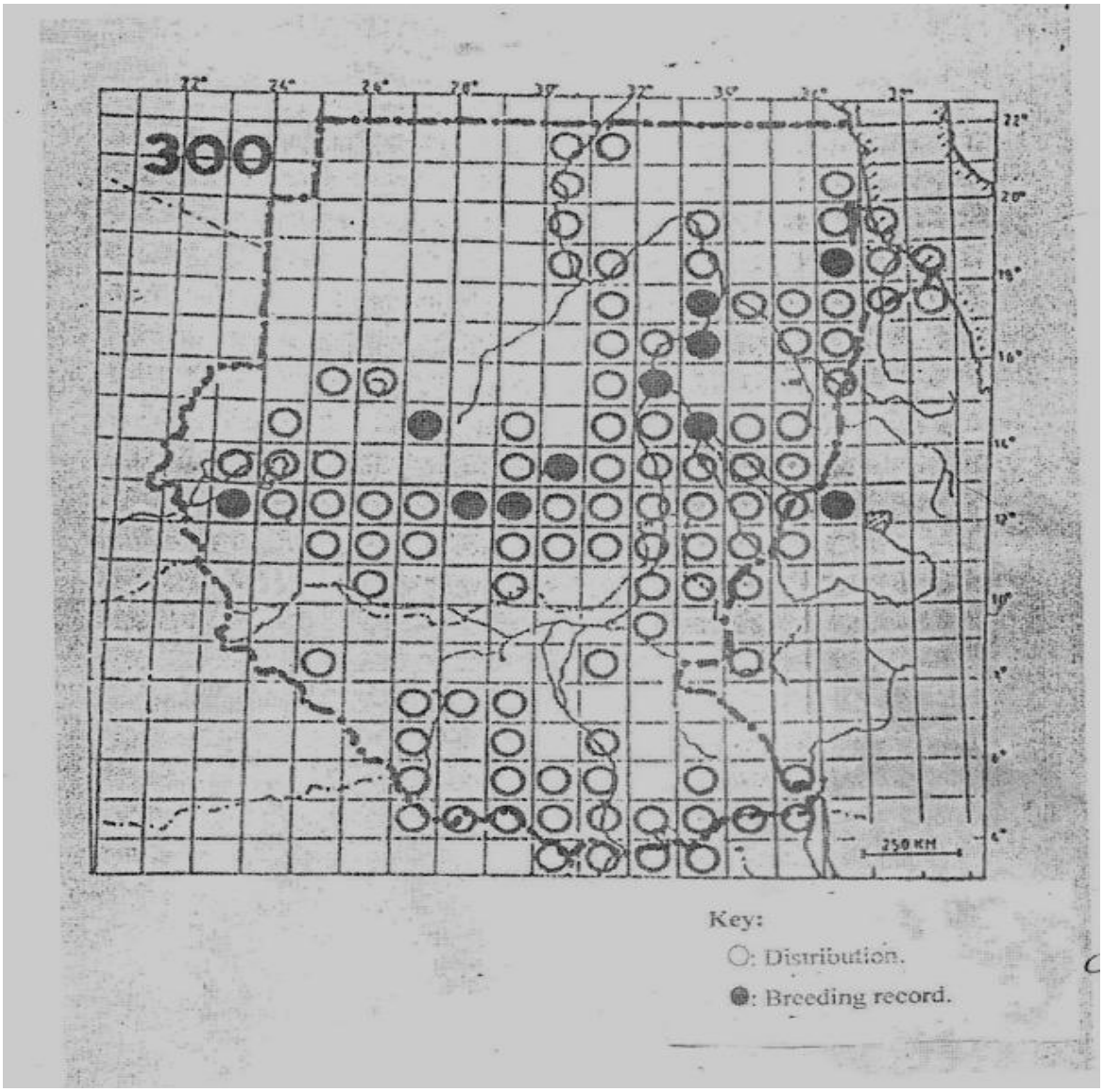
4-To study the effect of seasons on nest success as apercentage.

5-Identify and quantify birds species in the Khartoum State

The other objectives of the study were

1-To identify tree species used by Laughing dove the identification based on submission of fruit, seeds and leaves,and study the characteristics of utilization of trees for nesting in three zone.

2-To study incubation period and pattern of incubation.



Figure(1): Distribution of the laughing dove Streptopelia senegalensis in Sudan,redrawn from (Nikolaus,1987)

Chapter Two

LITERATURE REVIEW

2-1Taxonomic classification

Pigeons and doves are in the order Columbiformes and family Columbidae. There are five subfamilies within Columbidae, 50 genera and 351 species.(Baptista, *et al., 2016*).They are easily recognizable and have a world-wide distribution. They live in almost all types of terrestrial habitats from desert to dense forest and large urban areas. Many of the seed-eating columbids are buff, grey and brown in color, while the fruit-eaters are often more brightly colored. Many have ornamentation and iridescent feathers on the neck, breast, back, wings and face. *(*Lack, 2003; Baptista, *et al*., 1992; Dickinson, 2003; Wells and Wells, 2001*).*

Pigeons and doves exhibit considerable variation in size. The largest species are the crowned pigeons of New Guinea, which can weigh up to 2000 g, the smallest species is the new World Common Ground-dove, which is the same size as a House Sparrow . Smaller species are known as doves, and larger species as Pigeons, but there is no taxonomic basis for distinguishing between the two.(Johnson *et al.,2001*)

Family Columbidae is divided into five sub families (Baptista, *et al*.,1997), (a) Columinae (typical pigeons and doves) which include 29 genera,(b) Otidiphabinae (pheasant pigeon), (c) Gourinte (crowned pigeons), (d) Treroninae (greenand fruit dove), (e) Didunculinae (tooth-billed pigeon).

Genus Streptopelia by Bonaparte (1855). has recently been placed into the genus Stigmatopelia by some authorities following the studies of Johnson, *et al*.(2001).

2-2 Food and feeding

Pigeons and doves have often been seen feeding in flocks. They are primarily grainivorous and frugivorous, but occasionally they eat insects, snails, worms, lizards, leaves, buds and flowers. Seeds are picked up off the ground and eaten. They are fairly terrestrial, foraging on the ground in grasslands and cultivation. Pigeons and doves drink by submerging their beaks into the water and sucking the water up, they do not scoop water in their beaks and lift their heads to swallow like most birds.(Baptista, et al., 1992; Gibbs, et al., 2001; Lack, 2003; Wells and Wells, 2001*)*.The palm dove eats a variety of food grains and cooked food (Patil and Shende 2015).

2-3 Habitat

Doves and pigeons are found in almost all terrestrial habitats from temperate areas to the tropics including: lowland rainforest, highland forest, tropical forest, savanna, desert, cliff, mangroves, woodland edge, agricultural areas, suburban and urban areas. The highest diversity of pigeons and doves occurs in tropical rainforests *(*Baptista, et al., 1992; Gibbs, et al., 2001; Lack, 2003; Wells and Wells, 2001*).* The palm dove is found in dry scrub and semi-desert habitats where pairs can often be seen feeding on the ground. A rufous and black chequered necklace gives it a distinctive pattern and is also easily distinguished from other doves by its call. Other names include palm dove and Senegal dove while in India the name of the little brown dove is often used.

2-4 Social Behaviour

Pigeons and doves range from solitary to extremely social and can be found in flocks of several thousand. A flock of the now extinct passenger pigeons (*Ectopistes migratorius*) seen in 1740 which were so dense that they blocked out the sun. Dominance hierarchies occur in flocks. Many species roost communally at night (pigeons and doves are diurnal) and some are colonial breeders. To stay warm, Inca doves (*Columbina inca*) form groups of up to

12 each other's backs. They shift positions so that each bird takes a turn on the outside. *(*Baptista, *et a*l., 1992; Lack, 2003; Wells and Wells, 2001).Species in hot areas rest during the hottest part of the day. In cold weather, pigeons and doves fluff up their feathers to conserve their body heat. If they are hot, they raise their feathers even more so that the tips do not touch (a behavior called piloerection); this allows heat to escape and helps the bird cool down. Columbids spend a lot of time preening and bathing in the sun. *(*Baptista, *et al.*, 1992; Lack, 2003; Wells and Wells, 2001).

2-5 Distribution in Africa

The Laughing Dove has an extremely large range in Africa.The African range includes the major part of the continent except the Sahara and some Western regions (Heim de Balsac and Mayaud 1962;Cramp and Perrins 1994; Isenmann and Moali 2000;BirdLife International 2014). In North Africa, the status of the species is poorly documented and aspects of its life history are little known (Boukhriss and Selmi 2009; Hanane, andThévenot 2011), with no published study documenting its breeding ecology in Algeria. It has been reported to breed in scattered locations in southeastern oases of Algeria. Description of its distribution and habitat associations is available in literature (Heim de Balsac and Mayaud 1962; Isenmann and Moali 2000),but information on its breeding, phenology, nest placement, or nesting success is scarce. The competition with the Turtle Dove or other species is also poorly known and requires further studies.

2-6 Communication and Perception

Pigeons and doves have a variety of songs and calls that they use to find mates, signal danger, and defend territories. Males have special vocalizations that are only used in courtship and advertising. Both males and females sing; most songs are flute-like cooing noises that differ in the length of each note and in the interval between notes. Small columbidae species have higher-

pitched calls than larger species. They will sometimes call in duets. Some species make quiet purring sounds that function in mate-bonding. Young birds have begging calls and the results of cross-fostering experiments show that songs are innate and are not learned from their parents. King,(1978) reported that Laughing dove sings in early morning; an hour before dawn and late afternoon until an hour after sun set.Ahollow rolling laughing ' ha-ha-hoo-hoo hoo-hoo-hoo' or 'ha-hahoo-ha' with variants calling from high poles or dead tree top branches. The advertising call given up to pair – formation but also during nest-building and incubation.

2-7 The timing of breeding season

In periodically changing environments animals organise their major life history events to match the regular changes in food availability. Proper timing is very important because the costs and benefits of performing a given action (e.g. migration, molt) vary over the year (Lack 1968; Perrins 1970; Houston and McNamara 1999; Barta, *et al*., 2006, 2008). in particular, reproductive success often depends on appropriate timing of breeding (e.g. Brinkhof *et al*., 1993; Visser and Verboven.1999).In Birds which cannot respond immediately to changes in the environment (because physiological development takes considerable time.In such environments there is a trade-off between (1) reactivating reproductive organs earlier, which incurs the cost of maintaining the gonads during unfavorable periods and (2) delaying reactivation, which increases the chance that periods with high food availability will be missed. The consequences of missing the peak of suitable food are especially serious in birds whose offspring require specialized, protein-rich food, because these species cannot easily buffer the effect of environmental variability e.g. by providing milk (Zann *et al*., 1995; Barea and Watson.2007)

According to Elsheikh (2007). in birds each reproductive attempt being divided into the three distinct stages of egg laying , incubation and

chick rearing , However ,the demand of each reproductive stages can be manipulated independently, and the consequence for other stages within both current and future reproductive attempts can be measured. Food availability is the a principal ultimate factor that has shaped the timing of breeding season in birds. Theory postulated, that timing of breeding behaviour has genetic basis.

Also Perrins and Birkhead (1983) recorded that the seasonal variation in food supply selected genotypes. The onset of egg laying, the length of the breeding season, and the density of breeding pairs are life history traits that strongly depend on the habitat condition..Therefore, the short egg laying period and reduced density of Laughing Dove breeding pairs (Hanane, and Thévenot 2011) indicate that the study site might not be an optimum habitat for this Dove despite the fact that olive orchards are intensively used by the species for breeding throughout North Africa.(Isenmann and Moali 2000; Boukhriss and Selmi 2009; Hanane, and Thévenot 2011).

2-9 Home Range

The analysis of home range provides fundamental information on the land use and resource requirements of a species, simultaneously indicating the suitablility of the habitat (Perry 2000). Home range can be defined as the area used by an animal or bird in which all normal day to day activities occur, while the core area is found within a home range and is the area where the individuals spend the majority of their time (Kenward *et al*.,2001; Olsen *et al*., 2011).During the breeding season, individuals use the core area of the home range intensely as they spend most time within the vicinity of the nest (Olsen *et al*., 2011). Home range is determined in terms of size,shape and structure(Kenward *et al*., 2001). The shape of a home range can indicate the land use strategy of the species as well as the degrees of territoriality (Kenward *et al*., 2001).Behaviour can also be influenced by

additional food supplies as there is less competition for resources and therefore birds may be less territorial and or maintain smaller foraging home ranges(Robb *et al*.,2008). Home range analysis can also be used to indicate the landscape use by a particular species, as well as territoriality, both of which can be used in conser**v**ation management and rehabilitation and release programs (Kenward *et al*.,2001)

2-10 Territorial and Mating System

The term territories has been defined according to different criteria including defended area' "exclusive area" and a fixed exclusive area with the presence of defendant that keeps out rivals (Hassan,2001). Many species used territories for wide different activities such as feeding, roosting or nesting behaviour (Hassan, 2001& Elsheikh,2007).Whether territories are defended through violent border disputes or by more subtle signaling systems, defense is a cost on the owner. Much evidence suggests that territorial behaviour is linked with the spatial and or temporal distribution and availability of food (Horn, 1968 and Johnson and Boerlijst, 2002). The term mating system which is used to reflect the way in which individual obtain mates and includes description of how mates are acquired (forms of courtship,coercion and competition); how many mates ; the characteristics of the pair bond; pattern of parental care by each sex and mating resources defended and offered (Crook,1964;Wilmer *et al*., 1958). However, the species access to mates by many types of mating system, monogamous,polygamous,polygyny system (Reynod,1996,Hassan,2001and Elsheikh,2007).The breeding system in animal population depend on the ability of one sex to acquire mates by association with them directly or by defending territories and other resources of breeding (Elsheikh,2007).During breeding season territory is a characteristic of many species of birds.Thus many birds defend territories only during the breeding period, and these territories often include resources, such as food or nesting site,necessary for

successful reproduction incubation. In monogamous species there is rapid decline in plasma levels of the steroid hormone testosterone (T). (Wingfield 1980, 1983) accompanied by a reduction of territorial and sexual behavior, as soon as the female begins incubation

2-11 **Sexual Selection and Mate choice**

Mate choice is any pattern of behaviour by any individual that makes it more likely to mate with a particular pattern rather than another. Quader(2005)reported that mate choice have typically concentrated on detecting the patterns and adaptiveness of female preferences for male morphological or behavioural traits Such studies provide a detailed picture of the role that female choice can play in influencing the evolution and maintenance of elaborate and exaggerated male morphology and behaviour , including bright coloration (Houde, 1997). However, females may also pay attention to traits other than morphology and behaviour. These extended phenotypes range from nest and nest- like structures of several species of fishes (Taylor *et al*.,1998;Barber *et al*.,2001)and birds(Hoi *et al*., 1994). Nest-building may also be involved in post –mating sexual selection if female adjust their investment in offspring according to expected levels of male parental care (Soler *et al*., 1998). So,female choice may select for extended phenotypes of males, and therefore their associated motor and engineering skill. These skills like bird song, may in turn depend on underlying neural and learning mechanisms (Catchpole and Sltar 1995; Madden 2001).Also Barske *et al*., (2011) addressed that females choose their mates on the basis of subtle differences in motor performance during courtship. Elaborate, acrobatic courtship dances may have evolved because they reflect motor skills and cardiovascular function of male Golden-collared Manakins (*Manacus vitellinus*). Furthermore Ihle *et al*., (2015) studied that the mate choice and the evolution of traits that made individuals attractive to others. In some species, however, individuals can differ

substantially in who they find attractive, and this variation has typically been interpreted as “mate choice for compatibility". The benefits of such mate choice in a socially monogamous passerine bird, the Zebra Finch pairs that resulted from free mate choice achieved a 37% higher reproductive success than pairs that were forced to mate with a randomly assigned individual. Forced pairs suffered from increased failure to fertilize eggs and from increased mortality of hatched offspring in females while males that were force-paired showed reduced parental care and increased activity in courting extra-pair females. These findings support the hypothesis that Zebra Finches choose mates on the basis of behavioral compatibility . Female Zebra Finches *Taeniopygia guttata* prefer males with redder beaks and high song rate, which are both condition-dependent traits (Rutstein, 2004). In Zebra Doves *Geopelia striata*, males and females are not different in morphology (Lekagu and Round, 1991) but they are different in vocalization and display behaviour. Male zebra dove use acoustic display to court the female before pairing, the advertising calls is high in the initial phase of courting; it is increasing to the highest level in the second week of courtship. After pairing, nesting and copulation occur, the advertising calls decrease and be rarely found after the female laying egg s (Phromchan, 2004). The vocalization, therefore, of zebra dove may have the important role in sexual selection particularly for female mate choice. Advertising call of zebra dove is under the influence of testosterone which deals with sperm production and sex characteristics as well as reproductive behavior of the animal (Supasi *et al*.,2005). In song bird, song has been proposed to function in mate choice, and such a role has been demonstrated experimentally in a number of species.In House Finches *Carpodacus mexicanus*, females showed mate choice in male’s song characteristics which reflected a male’s energy reserves, and could be important sources of information for females choosing mate with display, plumage colours (Nolan & Hill, 2004). Bird

song has been shown to be subjected to female preferences for large repertoire size, high production rates or particular song variants (Secondi *et al*., 2002). Acoustic variation across cooing individuals may broadcast information about sex,age, and strength, but the message can only become available to the doves themselves if they are able to detect and recognize the variation (Slabbekoorn, 2004). Trainer *et al*., 2002 reported that in Long-tailed manakins (*Chiroxiphia linearis*) singing performance improved with age; variability in four song characteristics of males less than 3 years old was greater than that in their older partners. .There are many studies of female choice related to male plumage colouration. One of the fundamental predictions of sexual selection theory is that female mate preferences co-evolve with the degree of elaboration of male ornamental traits (Fisher, 1958; Lande, 1981; Hill, 1990; Hill and McGraw, 2002). Assortative mating based on absolute or relative genetic quality among monogamous species, depending on whether individuals look for good genes or genetic complementarity (Mays *et al*., 2008). Drickamer *et al.*, 2002 reported that females invest more than males, selection should act on females to be choosiness for mates that will invest in offspring and/or will give good genetic material to offspring (Drickamer *et al.*, 2002).

2-12 Courtship Display Behaviour and Forms of Display

Courtship display is a set of behaviours which some animals perform as part of courtship. It includes special calls, postures, and movement, and may involve special plumage, bright colours or other ornamentation. Moreover, mate choice sexual selection hypothesis would claim that pair displays evolved because they gave an advantage in mate attraction (Wachtmeister, 2001).Also with individual more elaborate display may be better mates (e.g. have better genetic quality). Manning and Dawkins (1992) argued that, birds defend the territories usually by songs and visual displays.For example Pigeons and doves are monogamous, they have the same mate from year to

year. They have numerous displays that are performed either on the ground or males also make display flight.Pre-mating courtship seems common among species The male in courtship display, follows the female with head bobbing displays while cooing. The male pecks its folded wings in "displacement-preening" to solicit copulation. The female accepts by crouching and begging for food. The male may indulge in courtship feeding before mounting and copulating. Pairs may preen each other(Gibbs *et al*, 200*1)*. In laughing dove during courtship, male groom the female and feed her with some insects and caterpillars (Patil& Shende.,2015).

2-13 Nest Site Selection and Habitat

Each bird species is likely to have particular habitat or climatic limitation.Among these can be elevation, ecosystem type, temperature, and precipitation (lahti,2003).Hanane (2015) studied the recent expansion of Laughing dove distribution throughout Morocco has raised concerns regarding its effects on species, particularly Turtle doves *S. turtur*. Observed in nest-niche partitioning may diminish the potential for competition between these species and enhance opportunities for their coexistence. And the behaviour of selecting high trees may be a response to the height of trees available for nesting, which is an important factor affecting nest height, as nest height increased with tree height in the case of many bird species (Browne and Aebischer, 2004; Boukhemza-Zemmouri *et al*., 2008; Taberner *et al*., 2012; Bensouilah *et al*.,2014). The vertical position of the Laughing and Turtle Doves' nests differed considerably, but their position on branches was quite similar. This pattern was also observed in Morocco (Hanane, and Thévenot 2011). On the other hand, it is known that the Laughing Dove preferred median part on branches (Boukhriss and Selmi 2009; Hanane, Bergier, and Thévenot, 2011) .Lindell (1996) reported that selection of suitable nest sites is a key component of the breeding cycle in many avian taxa and the nest site selection influencing avian natural history. Traits like

selection for plant community, community structural configuration, habitat selection at the landscape level or microhabitat, tree height, tree species, clutch size, nestling period, probability of renesting, within habitats and rate of nest predation all correlate with nesting niche (Lack, 1968; Martin, 1995). Species that nest in limiting microhabitats can have the availability of nesting sites regulate the productivity of populations (Robinson *et al*., 2000; Brightsmith, 2005). It would seem that a species' choice of nest site could directly influence where it lives and with which species it coexists (Brightsmith, 2005). Hence, investigation and explanation of patterns of nest-site use are central to understanding the population ecology and evolution of species, including how nest-site use affects a species' interactions with coexisting species. Studies of niche partitioning in doves have addressed food habits and foraging activities (Wolf *et al*., 2002; Sol *et al*., 2005; Hayslette, 2006) and vocal activities (de Kort *et al*., 2002; Kopij, 2003) in dove species. Nesting behaviors and partitioning of space among dove species (Columbidiae) using similar resources have not been thoroughly researched (Cunningham, 1997). A multitude of factors ranging from risk of predation to interspecific competition for available resources may influence nesting habitat selection by dove species. Nesting preferences are difficult to determine and may also vary by habitat. For many species of bird the nest site is of a great significance in the ecological niche. Consequently, the selection of nest location is considered the main adaptive response to nest predation pressure (Mezqida and Marone, 2002; Barrientos *et al*.,2009),to climate condition (Fergusson and Siegfried, 1989) or to human disturbances (Hanane and BaamL, 2011; Hanane, 2014b). Little is known about the relative effect of habitat characteristics and human factors on nest site selection of dove species (Ruiz,2012). Butler(1977) found a significant correlation between number of White Winged dove nests and high foliage densities. The high foliage density is important for several

reasons to reduce susceptibility to predation through better concealmen, better nest structurals support, and a favorable microclimate surrounding the nest . Since the number of branches increased as foliage density increased, it appears intuitive that nest structural support would also increase.

Walsberg and Voss-roberts(1983)found that desert nesting Mourning Dove cool their eggs during incubating doves turned off nests within honey mesquite habitat during afternoon hours caused nest abandonment due to egg mortality. Physiological microclimate is an important factor in nest site selection in many species (Walsberg,1985). High foliage densities should provide relatively cool microclimate for nesting because increased shade and relatively higher transpiration rates. Patil & Shende (2015) reported that Laughing Dove is adapted to habitat near human population. Nest site selection can greatly affect reproductive success and alter reproductive behaviour and trends depending on resource availability, competition, and disturbance (Cardador *et al*., 2012).

2-14 Site Fidelity and Re-nesting

Awide range of birds species usually return to occupy the nest site or territories where they have bred previously (Warkentin and Hernindez,1996).Fidelity to breeding, staging, and wintering areas is a wide spread phenomenon in birds (Elsheikh,2007) Based on large number of studies involving marked individuals, return rates to breeding sites by birds are now known to be highly variables and influenced by a variety of factors including previous reproductive success, age and sex of the returning individual, in addition to habitat stability(Warkentin and Hernindez, 1996 and Elsheikh, 2007). In tropical monogamous species. in the Zenaida dove, (*Zenaida aurita)* characterised by year-round breeding and multiple renesting attempts, with some pairs rising up to four broods per year (Wiley 1991).

2-15 Parental Care

An alternative definition of parental care is any parental traits that enhances the fitness of a parents offspring, and that is likely to have originated and\or currently maintained for this function (Royle *et al*., 2012). There are four possible patterns of parental care that might be favored by natural selection there are: no care, uni-parental by a male, uni-parental care by a female and biparental care (Elsheikh, 2007). In monogamous species with biparental care, both males and females are expected to exert mate choice (Johnstone *et al*.,1996). This is because reproductive success directly depends on the parent ability to feed their chicks. The bi-parental care by either the male or female exist-for example –in many monogamous, where male or female make roughly equal numbers of food deliveries to nestling. In polygymous species, the males parental role is reduced in both precocial and altricial birds(Greenberge and gradwohl,1983).In pigeon and doves squabs are altricial and are fed by both parents. The squab are usually fed crop-milk for three to four days and are then fed seeds and fruit. Crop-milk is made in the crop of the adult male and the female, milk is high in fat, protein,minerals and amino acid. Nestling pigeons and doves grow rapidly because the crop-milk reducing the most vulnerable period in the life cycle (Gibbs *et al.*, 2001). Chicks fledge in 10 to 36 days (earlier if disturbed) and may continue to receive food from their parents for 30 to 40 days. (Baptista, et al., 1992; Gibbs, et al., 2001; Lack, 2003; Wells and Wells, 2001). Earlier observations of a nesting pair of pink-necked green pigeons (*Treron vernans*) showed that the male took up the day duty while the female, the night shift (Wee, 2005).

As with incubation, both parents took turns brooding, changing shifts around the same times every morning and evening (Gibbs *et al.*, 2001).

Adult bird was not in the nest all the time but left for short periods when the chicks were a few days old but mostly stayed around the nesting tree, keeping a close watch. As the chicks grew, the adult spent less and less time

in the nest during the day. It is most likely that there would always be an adult in the nest at night. Feeding of the chicks was regular. The adult was constantly preening the chicks.Adult feeding the chick, with the chick's bill buried deep inside the adult's buccal cavity or both may be fed at the same time, with the bill of each chick inserted from either side. When they had fledged. They moved to a nearby tree where the adults continued to feed them. In Mourning Dove two white eggs hatched in about 14-16days . One egg is laid in the evening and the second on the next morning . The male usually incubates the egg during the day, and the female incubates at night. Nestlings, cared by both parents, fledge in about 12-14 days. The parents continue to care for the fledglings until they are 25 to 27 days old. (Hockey *et al*., 2005). In Laughing Dove the nestlings were naked, blind, helpless and wholly dependent on its parents .They have dark gray skin gray color blunt beak and body covered with patches of creamy white down filaments. Female regularly changing its orientation after every 1-2 hours. The eggs were incubated after the second egg was laid (Nene,1979; Ali and Ripley, 1981). Adult Mourning Doves will try to lure predators away from their nests by pretending to be injured. This is called the "broken-wing feign." They flutter about on the ground in front of the predator, as if they had a broken wing, and lure them away from the area of their nest. *(*Mirarchi and Baskett, 1994). This prolonged parental care in tropical birds may be a strategy against the high rate of egg and nestling mortality. Ricklefs, (1969). Ashmole & Tovar (1968) suggested that prolonged parental care is developed in species in which the young might require an extended amount of time in learning foraging skills.

2-16 Food as Limiting Factor on Breeding and Growth Rate

The most important ecological issue is food limitation, because it influences life history traits, population size and community structure, reproductive successes and survival of bird (Richner,1992 and Hassan, 2001).It is

commonly argued that food is superabundant during higher breeding seasons (Anderson *et al*.,1982).

Population growth rate of birds is defined as"ecological adaptation for breeding " this confirms that population growth rate has a direct influence on reproductive success. However, growth needs energy and rate affects the number of offspring that can be raised by birds which feed their young (Ricklefs, 1973). Another definition by Lack (1968) assumes growth rate as time of fledging or the attainment of flight,

2-17 Breeding Success

The critical stage for avian survival is the transition from dependent fledge to independent juvenile. However, food limitation during nestling stages can limit fitness by reducing number of offspring that fledge, the quality of fledging or both (Richner, 1992). Juvenile mortality rates during this period have been attributed to starvation; parents may not be able to provide enough food for the entire fledging –dependency period, and high mortality rates caused by starvation are expected (Styrsky *et al*., 2005 and Elsheikh, 2007). Breeding success was found to be due to the good hatchability of eggs, fledging survival and non- predation. Thus chick survival depends on many factors such as food availability, parental quality, clutch size, hatching order, predation rates, diseases and weather condition (Hassan, 2001; Monaghan *et al*., 1998 and Elsheikh, 2007).

In tropical monogamous. Individual quality can influence both access to a mate and mate quality, such as low-quality individuals would remain unpaired and high-quality ones would be paired between themselves. Positive assortative mating for various phenotypic traits potentially indicative of individual quality, such as body size (Helfenstein *et al*., 2004; Haggerty, 2006)and age (Fasola *et al*., 2001).

2-18 Identification of Birds

Ecosystem disturbance is one of the major phenomena in recent times, which alter the relationship of organisms and their habitat in time and space. Some species of the birds may adapt to the human habitation and mining environment as it provides easy food and habitat (Smith *et al*., 2005).

Identifying the habitat requirements of birds is essential for protecting habitat to maintain population of the species. Numerous studies have focused on the proximate habitat used by birds, describing features associated with, for example, the territories, song perches, or nest sites of breeding birds (Finch, 1989).Identify-ing the scales at which birds respond most strongly to landscape features would help clarify and explain effects of fragmentation on bird distribution. Scale information could also guide habitat management, ensuring that efforts are applied at appropriate scales. Identifying dominant scales of response also would be useful in predicting environmental response in contrasting areas, such as agricultural areas and wooded landscapes.Finding the major scales of response might also provide insight into the mechanisms by which birds respond to their surroundings. Much of the initial research on the influence of different scales on breeding birds has emphasized forest dwelling species (Maurer, 1993).In that context, landscape-scale habitat fragmentation has emerged as an important factor influencing population levels and reproductive success. Occurrence of bird species correlates with vegetation structure, in turn vegetation structure and several other factors, such as temperature and productivity, vary along the environmental gradient associated with elevation (Maurer,1993). Because elevation affect the condition of the physical environment and the kinds and amounts of resources available for breeding and foraging activities, the composition and structure of bird communities may change along

elevational gradients (Maurer, 1993), water- birds are among the most mobile of birds, many are dependent for their survival on a national and even an international network of wetland. Resident water-birds must move to take advantage of ever changing surface water(Demopoulos, 2004;Penny and Michaell, 2004).

2-19 Migratory behavioural types

Dodman and Diagana (2006) define several different (migratory behavioural types :

Local move/short-distance migrants; move relatively short distances between a network of key sites.Their migrations are fairly regular and predictable. Black Crowned Cranes(*Balearica pavonina*) breeding in marshy floodplains of Casamance of southern Senegal between August and November migrate to wetlands of Guinea-Bissau, Where numbers peak in January.

Rains migrants/arid migrant; include a large number of species for which rainfall or, conversely, dwindling water resources are the principal triggers for movement .

Nutrition migrant/post –roost dispersers; Some waterbirds share common night roosts and disperse widely by day in search of food. White pelicans (*Pelecans onocrotalus*)can cover a large distance during a single day;in some areas their roosts may be far from any water source. They are essentially day migrants, flying to distant wetland daily from secure roosts or breeding colonies. Some large White pelican roosts on breeding sites, however, are found very close to their main feeding areas, such as those in the lower Senegal Valley, so the need for undisturbed roosts may be the principal factors behind their migratory behaviour.

Post-breeding dispersers,many birds disperse after breeding and also fall into other (migration categories) such as rains migrants . Some, however,

disperse widely away from breeding sites in different direction; an example being Grey –headed Gull(*Larus cirrocephalus*). Ringing recoveries from birds ringed at colonies in South Africa on the eastern Witwatersrand show striking dispersal, with movement to Mozambique, Zimbabwe, Zambia, Botswana , Namibia and Angola and within South Africa to the south-western and eastern coasts (Underhill *et al*;1999). It is hard to determine if these constitute migratory movement, as it is not clear if the same birds are returning to breed in the area or colony where they were themselves born.

Nomads; True nomads are not migrants, as they do not move in a cyclical or predictable manner. However, some nomadic movements are predictable to a certain extent, in that they are usually in response to, often irregular, climatic or environmental conditions, for instance in semi-arid areas with irregular rainfall. In such areas, temporary wetlands may attract large numbers of waterbirds, even when they only appear every few years .Lesser Flamingo (*Phoenicopterus minor*)can be considered a nomad in East Africa moving frequently and unpredictably between a series of known key sites in the Rift Valley, as demonstrated by Childress *et al*.,(2006).

Altitudinal migrants, some waterbirds particularly in East Africa, are at least partial altitudinal migrants. One example is the Eastern African Snipe(*Gallinago nigripennis aequatorialis*), which breeds in highland bogs up to 4, 000m above sea level, from where altitudinal migration takes place to lower-lying and warmer areas during the non-breeding season(Gichuki *et al*., 2000)

Environmental response migrants ; some waterbirds move opportunistically as a result of , sometimes irregular, environmental conditions and local habitat changes . Apart from rainfall, other environmental conditions such as fire and locust eruptions can initiate movement. Movements of Lesser Black –winged Lapwing(*Vanellus lugubris*), for instance, may in part be dictated by brush fires in some areas, which cause new grass growth suitable for nesting (Urban *et al*., 1986).

Arctic and sub arctic marshlands as well as prairie potholes are the principal breeding grounds for waterfowl in the Northern Hemisphere. Since these wetlands freeze in winter, there is a vast southernward movements of ducks and geese to a more favourabl, environment for this reason. Most of the movements are from the Palearctic to central Africa. Because of climatic and alimental factors , many birds of Northern Europe and Northern Asia, like their North American counterparts are forced to move southwards in winter. The majority of northern European species, however, move to the vast African Continent, where favourable conditions for survival prevail. This involves flight over an extensive area of water, the Mediterranean Sea (Robert,1970).

The onset of rain is an important trigger for migration ; some waterbirds are harbingers of the rainy seasons, whilst other follow in the wake of rain. However, levels and timing of rains can be unpredictable and rain may not fall at all some years . When rain falls in arid and semi-arid areas, productive temporary wetlands can appear rapidly and attract large numbers of waterbirds, many of which are partially nomadic . This unpredictability present difficult management scenarios (Dodman and Diagana,2007).

2-20 Wetlands as habitats for birds

One of the best known functions of wetlands is to provide a habitat for birds, and birds use them for breeding, nesting, and rearing young. Birds also use wetland as a source of drinking water and for feeding, shelter, and social interactions. Some waterfowl, such as pelicans, have been adapted to wetlands to such an extent that their survival as individual species depends on the availability of certain types of wetlands within their geographical range. Other species like; Abdim's Stork *Ciconid abdimii*, Sacred Ibis *Threskiornis aethiopicus* and African spoon bill *Anastomus lamelligerus* use

wetlands only during some parts of their lives (Khalid,2004). The relation between wetlands and birds is shaped by many factors . These include the availability , depth , and width of water ;the availability of food and shelter , and presence or absence of predators (Bellrose and Trudeau,1988).Birds that use wetlands for breeding depend on the physical and biological attributes of the wetland. Birds have daily and seasonal dependencies on wetlands for food and other life support-system (Kroodsma, 1979). The availability or influence of water is a very important wetland featur to birds. It is not;however, the only feature that determines if birds will be present, how birds use the wetland, or how many kinds of numbers of birds may use the wetland. Other determining physical or biological factors include water depth, temperatures, presence or absence of vegetations , patchiness or openness of vegetation , type of vegetation, foods, water chemistry , type of soils, and geographic or topographic location. Any variation in any of these wetland features will cause subtle,but distinct , differences in bird use (Pulliam and Daneilason,1991).

Diverse species of mammals, plants, insects , amphibians , reptiles , birds fish rely on wetlands for food , habitat or shelter. Wetlands are some of the most biologically productiuve natural ecosystems in the world; compared to tropical rain forests or coral reefs in the number and variety of species they support(Esther, 2013and Ewel and White More, 1973).

Wetlands provide food for birds in the forms of plants, vertebrates , and invertebrates. Some feeders forage for food in the wetlands soils, some find food in the water column, and some feed on the vertebrates and invertebrates that live in submersed and emergent plant. Vegetarian birds eat the fruits, vegetables, tubers and leaves of wetlands plant. Water temperature influences food production .Invertebrates production in the water column may ultimately depend on water temperature and the ability of wetland to

produce algae. Cold water might not be a hospitable environment for small animals and plants that some wetland birds eat. However, water that is too warm might not produce foods that some birds prefer (Kroodsma,1979)

2-21 The Wetlands in Sudan

Wetlands cover 20% of the total area of the country and about 3% of the Nile Basin is covered by wetlands (Abdehameed ,2009). Based on the Ramsar (1971) definition there are about 13 wetlands types distinigusted in the country which include the following:-

1- Seasonal Streams (e.g. Gash, Barraka, Dinder & Rahad).
2- Nile & its tributaries.
3-Mountain Streams (e.g. Khor Arba'at, River Gilo & Ingassana Hills).
4- Lakes.
5- Man-made lake system.
6- Dams.
7- Hot springs.
8- Haffirs.
9- Mayas.
10- Coral reef.
11- Mangrove Swamps (Red Sea Coast).
12- Riparian forest.

CHAPTER THREE

MATERIAL AND METHODS

3.1. The study Area

The study sites in Khartoum State is geographically divided into three blocks .There are first Jabal Awliya Locality,Al-Kharṭoum Locality (This starts from the Mugran), the confluence of the Blue Nile and White Nile, and extends southward to the boundaries of Gezira State. Second block Al-Kharṭoum Baḥri Locality (Khartoum North)and Sharq El-Neil Locality (Blue Nile). This is the northern block, between the Blue Nile and the River Nile. The largest town in this block is Khartoum North. Third block Omdurman Locality Ombadda Locality (Um Badda) Karari Locality (Karari) this block is west of the White Nile and the River Nile. It contains the country's largest city, Omdurman. It is surrounded by River Nile State on the north and east, on the northwestern side by the Northern State, on the eastern and southern side by the states of Kassala, Gedaref and Gezira, and on the west by North Kurdufan.

The study was carried out at six sites in Khartoum State.There are two sites in Khartoum Jabal Awlia and Soba –El Bagair,(passes through different farms), in Omdurman there are two sites Omdurman(1) and Omdurman(2) (western side of the surveyed area which is generally adesert plain) and in Bahari also there are two point Khartoum Bahari and Sharq El Neil (passes through different farms) ,in Khartoum, the two sites in Khartoum include Jabal Awlia the geographical coordinates are (N15^{o}15´E 32^{o} 30´) within 45.9Km the other site is Soba –El Bagair the geographical coordinates are (N15^{o} 16´ E 32^{o} 44´) within 46.2 Km. In Bahri two point Khartoum Bahari, the geographical coordinates are (N 16^{o} 17´ E 32^{o} 39´) within72.8 Km, the second site is Sharq El Neil the geographical coordinates are (N15^{o} 17´E 33^{o} 04´) within 65.5Km.The last two sites in Omdurman, Omudrman(1) the

geographical coordinates (N 15^{o} 45´ E 32^{o} 4´) within 51.3 Km and Omdurman(2) the geographical coordinates (N15^{o} 31´ E 32^{o} 09´) within 42.9 Km,.The six sites were coordinate by using GARMIN/ GPS map (Geographical Positioning System) (Figure 2).

The nest site coordinate by using GARMIN/ GPS map (Geographical Positioning System. The study of nest site covered another site in Mohammed Ali Farm and the surrounded area . Another site in the College of Animal Production Science andTechnology at Hillat Kuku, Sudan Unversity of Science and Technology.

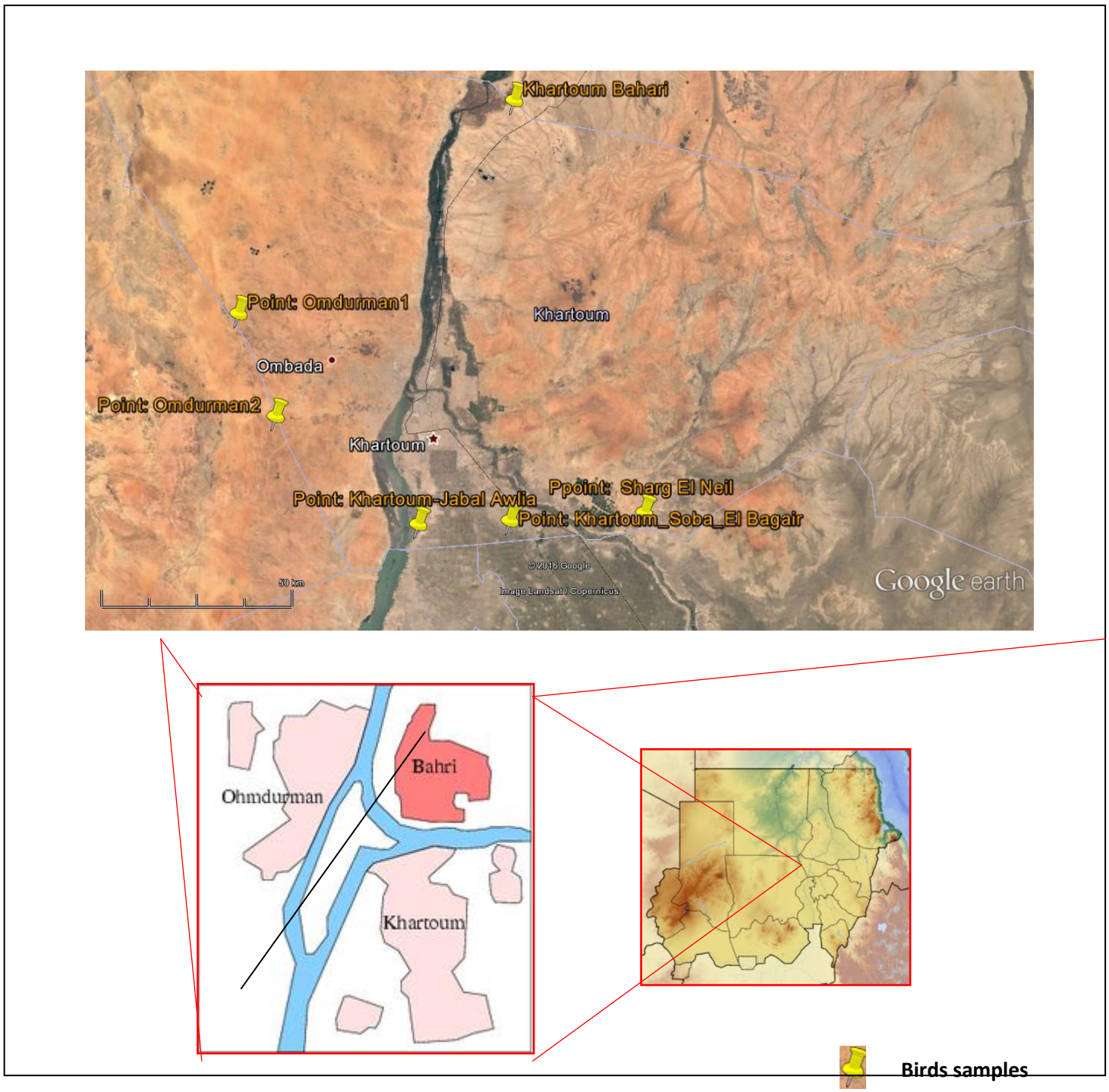


Figure (2): The six sites in the Study Area in Khartoum State *(produced from Google earth and http://krt-loc.gov.sd/*

3.1.1. Geology of Khartoum State

The western side of the surveyed area which lies west of the Main Nile (River Nile) and the White Nile is generally desert plain**.** The two sites which are situated in this part is (Omudrman1and Omudrman2). This is apart of the Nubian Sandstone country of the Sudan.

The Nubian sandstone formation is defined by Kheiralla 1966 to include all conglomerates, intraformational conglomerates, grits, sandstones, sandmudstones and mudstones which rest unconformably on the basement complex which is composed largely of Precambrian age (Plate1a&1b).

Three main lithological units are recognized

1-Merkhiyat sand stone

2-pebble conglomerates

3-Mudstones

The Merkhiyat sand stone. exhibit various colours ranging from buff to dark reddish brown. The desert plain bearing series of hills (jebel) : The Merkhiyat and other isolated Jebels . The shape and size of these Jebels differ and represent successive stage of the later part of an arid land erosion cycle.

Kassas(1956) studied the plant growth in the desert west of Omdurman. He showed that a close relationship existed between the plant growth and land forms .

The eastern side of the surveyed area which lies between the White Nile and the Blue Nile and that on the east of the Blue Nile and the Main Nile (part of Gezira plain) is almost flat except for sand drift.This area is drained by small water channels. Their water often overflow their sides, flood sheet, are

common causing, in the rainy season. Here the Nubian sandstone formation is covered with alluvial depposites called(Gezira clay). The Gezira clay formation consist of clay, sand and gravel. The clays are alkaline, dark coloured (Plate, 2) .The percentage clay reported by Yassin(1956.) commonly varies from 20%to 40%but in places it rises to 60% and fall as low as 10%. Shukri (1950) remarked that the clay change colour from brown to grey in depth. The Sand is mainly composed of angular and sub angular quartz grains which in size vary from fine to medium these sand grains are brown or grey due to contamination with clay.The gravel consist mainly of quartaz pebble which are usually white or yellowish in colours. The thickness of formation varies considerably from one location to the other. Yassin(1956) found that at Soba (South of Khartoum) the formation consist of 15m of clay resting on the Nubian Sand Stone .Gezira plain is also characterized by the presence of an under ground water reserve. The standing water level in bore holes varies from 7meter s near the bank of the Blue Nile to 14 meters away from the Blue Nile. At Soba the standing water level is 14 meters in the Gezira formation which has thickness of 18 meters

Plate (1a&1b): The extention of Nubian sandstone in OM1and OM2, the photo by the Author

Plate(2): The Gezira clay formation consist of clay, sand and gravel. The clays are alkaline, dark coloured,the photo by the Author

3.1.2.Topography and soil of the Khartoum

The Khartoum region is an open flat country (Halwagy,1961). The soil of Khartoum can be classified based on Worrall(1956) into the following .

1. Riverain Soils:these are associated with the present flood plain of the Nile River system and included; White Nile clay, Blue Nile, main Nile Silts and silt clay,miscellaneous soils ranging in texture from sand t o silt with admixture of finer materials. All these riverain soils are alkaline soil. They are fertile soil.

2. High Level Dark Clays: these occur above the present flood level of the river between the Blue Nile and White Nile and along the eastern side of the main Nile. The soils have high salt content and contain calcium carbonates and gypsum . These soils are generally grey in colour becoming browner southwards, and they have affinities with cotton soils of the Gezira

3. Nubian Sandstone Soils:on the west bank of the main Nile near Omdurman, the Nubian series abuts the river.

4.Goz Sands: these are extensive areas of stabilized sands found in the western part of Khartoum overlying high level dark clays and White Nile clays.(Plate 4)

5. Miscellaneous Soils : Conspicuous but rather minor areas of alluvial and colluvial soils of very mixed materials occurs adjacent to wadies which cross the Nubian landscape (Worrall,1956)

Description of the six sites Surveyed:

3.2. Omudrman1and Omudrman2

Part of the study area included part of the Al Sunut Forest in two point Omudrman 1(N15º 45´ E 32º 04´)and Omudrman2(N15º 31´E 32º 09´).The extention of these two sites passed through the new White Nile Bridge which was constructed as reclamation of the forest land for construction purposes: and about 15% of the forest area has been removed for the construction of the Bridge (Altayeb & Hamed, 2003).The area is surrounded by cultivated area.

3.2.1. Omudrman 1

This site contains desert area (Plate,3) and the Merkhiyat sand stone , Jebel Sger El wafied,and Goz abudlowa (Plate4) this site extends until State of North Kordofan. The natural vegetation in the area is sparse and not homogeneous The plant which covered this arid area Seyal(*Acacia tortilis*) Tundub(*Capparis decidua*),Usher(*calotropisprocer*) *Acacia ehrenberglanas,* Heglieg (*Balanites aegyptiaca*),*Panicum turgidum*, *Cassia senna* and *Cynodon dactylon*(Nagila). in rain season.

Plate (3): The extention of desert area in OM1, the phot by the Author

Plate(4): The study area in (OM1) which covered with Goz Sands: these are extensive areas of stabilized sands found in the western part of Khartoum, the photo by the Author

Omudrman2

The extention of the site passed through Abu seed untilt the selling point of cattles and selling point of Camels until jebel El Torriya and extends until Fetcha near State of North Kordofan. The natural vegetation in the area is sparse and not homogeneous.The plant which covered this area arid Seyal(*Acacia tortilis*)Tundub(*Capparis decidua*) Usher (*calotropis procer*), Kitir (*Acacia mellifera*), Heglieg (*Balanites aegyptiaca*),*Acacia ehrenberglanas*, *Panicum turgidum (*tmama), a lot of *Cassia senna* and *Cynodon dactylon*(Nagila) in rainer season.

3.3.1. Jabal A wlia

It situated south of Khartoum and it consisted of two parts (Jabal Awlia and the Sunt Forest). Also there is some agricultural point in this line . The dam was built in 1937 to augment the storage of water for summer irrigation. The tree species covering the study area are Acacia sp, Kitir (*Acacia mellifer*), and Sunt *Acacia nilotica* which is noteworthy , because it has several roles to play in the site. Acacia is nitrogen support and good habitat for birds ;they like to nest at the branches of this tree species . The natural vegetation in the area is sparse and not homogeneous because of erosion dominating. The plant which covered this site Meskeat *Prosopis glandulosa* and Usher(*calotropis procer*), Heglieg (*Balanitesa egyptiaca*), Sidir (*Zizphaus spinachristi*) and Talih (*Acacia Seyal*). The herbaceous plants in this locations were *Cassia senna,* also there are Nagila (*Cynodon dactylon*) in rainer season.

3.3.2. Soba –El Bagair

It is situated South of Khartoum this point consisted of many farms which are irrigated by small water runnels in some part and the other part by bore

holes. This point passed through farms and extends until Gezira State borders.The natural vegetation in the area is sparse and not homogeneous because of erosion dominating the area. Along this line plant species are Tundub (*Capparis decidua*) , Usher(*calotropis procer*), Heglieg (*Balanitesa egyptiaca*), Meskeat(*Prosopis glandulosa*), Kitir (*Acacia mellifer*) Sidir (*Zizphaus spinachristi*), Talih(*Acacia Seya)* (Plate,(5)andPlate,(6) *Acacia nubica* (laout). *Cassia senna* and *Cynodon dactylon*(Nagila).

3.3.3. Sharaq El Neil.

This site contains some villages and farms with drainage system.This villages are (Um Dom,Um Ashosh,Um soban , Debaba , wad sarrar, Tayba El Mahas, El Nabty.The natural vegetation in this location; *Acacia ehrenbergiana*, Seyal (*Acacia tortilis var. spirocarpa*) ,Talah (*Acacia Seyal*) and Heglig (*Balanites aegyptiaca*), Sidir (*Zizphaus spinachristi*). Tundub (*Capparis deciduas*). Meskeat **(***Prosopis glandulosa*), kiter (*Acacia rnellifera*). The herbaceous plants, were *Cassia senna*(Senna), *Panicum turgidum*(tamam), *Dactyloctenium aegyptium*(Koreib).

3.3.4 Khartoum Bahari

The surveyed part in this location passed through many towns(Hulfia almulweek, Kadroo, Al Faki Hashim, Al Sagai, Al Gaily,Wad Rmli). The last point in this line was The border of Sabaloke Game Reserve.There are a lot of number of farms in this point which irrigated by with drainage system. The natural vegetation covering this area were Acacia seyal, Sunt (*Acacia nilotica*) , Meskeat **(***Prosopis glandulosa* **),** kiter (*Acacia rnellifer*). Sidir (Zizphaus spinachristi). Tundub (*Capparis deciduas*), Ushar (*Calotropis procera*), kiter (*Acacia rnellifera*) the herbaceous plants, were *Cassia senna*(Senna)and *Dactyloctenium aegyptium*(Koreib) , *Panicum turgidum*(tmama)

Plate (5): the extention of semi desert area with different species Kiter, Usher and Meskeat in Soba- Elbagair, by the Author

Plate(6): the extention of semi desert area with Acacia seyal Talih ahmar in Soba-Elbagair, the photo by the Author

3.4. Climate

The general climate of the region is tropical continental characterized by warm dry winter and hot brief rainy summer (Irelanda, 1948). Climatic data for the areas were obtained from Meteorological Station at Khartoum which included the monthly mean temperature (Minimum and Maximum), rainfall, relative humidity and wind speed (Table,I).

The annual mean temperature and total rainfall in 2013and 2014 at Khartoum areas were 37.7o C and 97.1mm and 36.7^{o}Cand 166.4mm respectively . The rainy season start from July to the end of September with occasional showers in May and October . Rainful is usually accompanied by thunder storm and rains are often of short duration and sometimes of localized occurrence . The average amount of rainfall decreases from south to north and from east to west. Winter (November to Febuary) is rather mild, followed by a hot dry summer lasting from March to the beginning of the rainy season. Generally, the relative humidity in Khartoum area is low, especially during the dry season, but increases during the rainy season. Wind blows mainly from the north during November –May, bringing dry cool air

especially during winter months and then switches bringing warm humid air from the south during June –October.

Table(I):Mean annual climatic conditions (Meterological Station of Khartoum)2013-2014

Month	Maximum Temperature^{o}C		Minimum Temperature ^{o}C		Relative Humidity%		Rainfall mm		Wind speed Km/h	
Year	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
January	32.8	31.6	18.8	17.3	24	25	0	0	9	9
February	35.8	32.4	20.9	18.4	17	21	0	0	9	9
March	37.3	37.4	23.3	23.1	10	14	0	0.2	9	10
April	39.7	40.9	25.1	27.4	8	16	0	0	7	9
May	42.5	41.0	28.7	28.4	11	17	0	4.6	6	8
June	41.8	42.0	29.2	29.0	22	21	1.3	0.6	7	6
July	40.3	36.9	29.4	26.1	28	45	14.4	73.6	9	10
August	35.4	34.7	25.4	25.5	56	54	75.2	52.3	8	9
September	39.4	37.2	27.4	26.3	33	45	6.2	29.4	9	8
October	38.9	38.0	26.3	26.5	19	27	0	5.7	8	8
November	36.0	34.7	18.1	22.1	22	21	0	0	8	9
December	32.0	33.3	22.4	19.3	28	29	0	0	9	8

Source: Meterological Station of Khartoum,2013&2014

3.5. Breeding behaviour data

Nests were systematically searched for from early January to late December 2013(first season) and from early January to late December 2014(second season). Suitable nest sites were checked at least once a week and often daily. Using parental cues such as observation of males doves actively seeking mates was used to help locate new nests or finding the male taking the material of the nest. Some nests were found during nest building and most of them during egg laying period.To determine the laying date , clutch size and number of nestlings hatched and fledged each nest were visited until it failed or young fledged .Then classified as successful on the basis of

1-direct observation of fledged nestling

2-observation of nestling just before fledging (at least 10 days old, when they are able to escape from the nest)

3-nestlings were viewed in close proximity of the nest (Mathewson2002).

Nests were considered failed if adult were not seen on the nest during three consecutive visits (deserted/starved or predation) . When a nest fledged the site was checked for re nests during subsequent visit

3.6.Methodolog of breeding behaviour

Three periods of field works were carried out. Data were collected from the first week of January to the end of December during both the first and second breeding seasons 2013 – 2014. During 2015 short trips were made to check some aspects of breeding. The study covered nest site choice, nests building,number of nests and nests measurements,egg laying sequence, clutch size,incubation patterns,hatching dates and fledging .Disappearance of

eggs or chicks from the nests was considered as predation. Hatching success was defined as number of egg hatched / number of egg laid (Velarde, 1999). Fledging success was defined as the number of chicks fledge /number of chicks hatched (Velarde, 1999).

3.6.1.Incubation and Hatching:

Methods used for detecting nests followed Bertram,(1992). These included I.Questioning the elders and the school children about the flock of laughing dove and the nest site

II. Searching for target nesting trees and sexually active pairs .

3.6.2. Nest site

The nesting tree was identified to genera, and the height of the nest was recorded , the nest site including semi desert habitats, open land with scattering of trees and shrubs.Also adapted to nest near human habitation

3.6.3.Investigation of Nests

Precautions are taken not to disturb birds, eggs, chicks and nesting site**.** To prevent the effects of research activity on the breeding success, The nest checked only when the parents were absent **.**

a) Different egg colours, and shape

b) Egg dimensions length and width were measured using a vernier caliper to the nearest 0.1 mm (plate,7). Egg weight was taken using a digital scale professional(plate,8).Each egg shell thickness was measured by a micrometer(plate,9).

The birds were observed using binoculars Pentax of magnification ($10_{\times}50$) at approximately (4-12m) distance from tree or by simply naked eye. The

Ladder or mirror attached to a long pole were used to investigate the nest. Photograph were taken using digital camera Casio N835-Cool pix 4.00 Mega Pixel

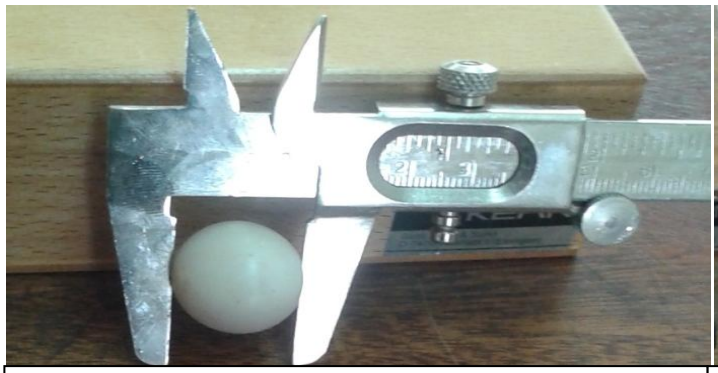


Plate (7a): Measurement of length of egg by vernier caliper

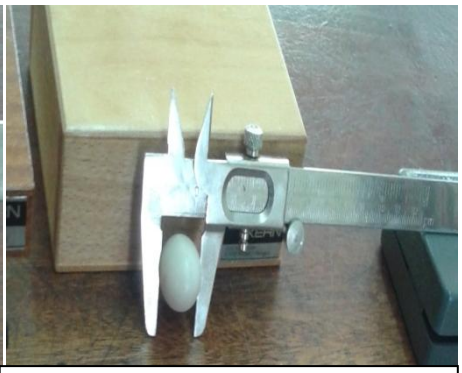


Plate (7b): Measurement of egg width by vernier caliper

Plate (8): Digital scale professional mini balance (model 1479u) used to weight egg

Plate (9): Measurement of the thickness of egg shell by micrometer

3.7. Calculation of K-value (egg weight coefficient for the species):

The method described by Furness and Furness (1981)was adopted to calculate the K-value for laughing dove as follows:In each nest length , breadth and weight of each egg was measured .

The K-value was calculated from the formula given by Hoyt(1976)as follows:

$$W=KL\mathbf{B}^{\mathbf{2}}$$

Where:

W=egg weight in gm

K=is a constant for species or family =0.510

L=egg length in mm

B=egg breadth in mm

3.7.1Assessment of Mineralogical contents of Laughing Dove –eggshells

The comparison of egg shell contents in two habitats, In man made structure and arid natural habitat. Also for the difference in degree of colour in two habitat.

3.7.2 Methodology of assessment of eggshell mineral

Egg shells were separated and carefully removed membrane from it, shell were rinsed with warm distilled water several times to remove adhered albumen,then the shells dried in conventional oven at 98°C and powdered.Ash,macro-element: Calcium (Ca), Magnesium(Mg), and micro-elements Iron(Fe), Zinc(Zn), Cobalt and Lead(pb) content in egg shells.Ash was determined by ashing samples using muffle furnace oven at600°C.All analyzed elements were done by weighing approximately 0.5 g of shells sample and digested in screw –cap bottles with concentrated high purity nitric acid, bottles were heated for 6hr then the digested sample were diluted to100ml using distilled water.Then the content of this solution and the blank solution(5ml high purity nitric acid diluted to 100ml using distilled water each content).Then the content of element in solutions were read by Atomic Absorption technique, using GCC-390 Flame Atomic Absorption .

3.8. Stastical analysis

Data were presented as means ± standard deviation and were analysed using the Statistical Package for Social Sciences (SPSS version 20) . Also used correlation coffecient between weight and breadth also between weight and length.One-wayANOVA test was carried out to investigate the differences between the number of nests in winter , dry season and wet season . Also one-wayANOVA test was carried out to investigate the different number of nests in Khartoum State.Correspondence analysis (CA), was applied in relation with the different seasons and also correspondence analysis applied in relation with the different areas, was represented on the Factorial and the Factorial test analysis highlighted the variation of number of nests in seasons and in study areas. Shannon-Wiener diversity index(H) were calculated for each sites in study area.Also data presented as percentage in nesting success and prefering trees.Relative abundance (RA) was calculated for families by the number of species included in that family divided by the total number of species recorded in the area.

3.9.Field Methods and Tools Used in Birds Survey:

The study areas were reached and patrolled by a land Rover car and patrolled on foot by two trained researchers in order to observe and identify all species of birds as far as possible.

3.9.1.Direct Observation

Bird species were identified and quantified. Discussion with local people were carried to determine avifauna species and their numbers, breeding activity, feeding location. The survey period covered two years from April to November 2013(first season –April to November 2014(second season). Observation started at 6.30am and ended at 5 pm and the species and the

number were recorded from the start point (my home) which was a fixed point for all these sites using line transect methods (Gaston, 1975and Girish &Pooja2015) and point count methods(Altman, 1974 and Girish &Pooja,2015). General observation were carried out twice a month at different sites. The count of birds was done at every 30 minute intervals, number of birds for each species sighted were recorded ,whether perching on trees, electricity wire, flying overhead for a session of two hours. using line transect methods (Gaston, 1975; Girish andPooja2015).in this method the plot are long , narrow, and strip, we assumes that all birds present in the plot just before the arrival of us. Counted all birds within afixed distance 50m of the line from right and left. and point count methods(Altman, 1974 and Girish and Pooja,2015).In this methods we went to anumber of points . These points randomly placed. All detected birds within afixed 100m radius plot are counted each count was conducted for 30min counts were divided into four equal intervals, number of birds for each species sighted were recorded

3.9.2.**Tools used**:

Three field guides (Williams 1991and Sinclair and Ryan 2003 and Sinclair and Ryan 2010) were used for identification of birds species. Examination of eggs and identification of birds sound and track were also used to supplement the direct field observation. Many local people in each area provided some information on birds species during the survey.

3.9.3.The Status Of Bird Spieces:

The status of each species was recorded as follow:

1-Resident (R): present throughout the study period

2-Winter Visitor (W): Present from end of Augusts to March

3-Summer Visitor (S):Present from April to late September

4-Palaearctic Migrant (PM) Palaearctic migrant (non-breeding visitors from the Palaearctic):Only present in spring period(March, April, May) and autumn migration(September, October November) periods.

5- local Migrant (LM). local migrant (undergoing distinct seasonal movements within its distribution .

3.9.4.Diversity of Bird species:

3.9.5.Species Richness and Evenness

The species richness (R) was determined as the total number of bird species at each site, Evenness is a measure of the relative abundance of different species making up the richness of an area (Hill,1973:Leinster and Cobbold,2012).

The diversity index was calculated using the Shannon – Wiener diversity index (1949). Shannon – Weiner Index assumes that individuals are randomly sampled from an independent large population and all the species are represented in the sample. Shannon diversity is avery widely used index for comparing diversity between various habitats (Girish and Pooja,2015and HCENR, 2001).It was calculated in order to know the species diversity at different habitats based on the abundance of the species by the following formula :

Diversity index $=H^{'}=-[\sum Pi \times InPi]$

Where Pi=S/N

S=number of individuals of one species

N=total number of all individuals in the sample

In=logarithm to base e

The presence of one individual of a species is not necessarily indicative of the species being present in a large number. The value of Shannon Weiner Diversity Index usually falls between 1.5and 3.5, only rarely it surpasses 4.5. A value near 4.6 would indicate that numbers of individuals are evenly distributed between all species.For calculation evenness of species, the Pielou's Evenness Index (e)was used (Mizrahi, *et al*.2007, Muhammad *et al*., 2006, Gregory, *et al*., 2004*)*.see the following formula:e= H/InS

Where:

H=Shannon-Wiener diversity index

S=Total number of species in the sample

Chapter Four

RESULTS

4.1 Nest & Nest Building Behaviour of Laughing Dove.

Nests building started in early January and until late December in the first and the second breeding seasons (2013-2014) in Khartoum (Jabal awlia, and Soba Elbagair) , Bahari (Khartoum Bahari and Sharq El Neil), In Omdurman the activity of nest building behaviour was recorded only in the second season and during wet season in Omdurman2.In general the maximum number of nests discovered in winter in January and February months and in wet season in Augusts and September months table (II) Figure (3)and Figure (4). The number of nests found in 2014 was 45 nests and in 2013 36 nests. What was believed to have been a site selection was observed on six occasion, in each case, birds sat close together at nest site(plate,10); alternatingly uttering soft cooing sound and nodding . Then the male left to collect material (mostly nearby) on the ground grass, or wire plastic, or twigs, they were highly selective. The male with its plumage slightly fluffed held a single twig in its beak (plate, 11), alighted on tree or building eaves, the female received twigs from male, and started building and arranging the material. Female may reject some material brought by male most building activites were in the mornings from 8.00 to 12.00 am , then continued in the evenings from 4.00 pm to 6.00 pm (n=15) and in the mid of the day the building behaviour was rare . The male brought about 9-11items per hour. Nest building behaviour and associated forages for materials tended to occur in bouts and the mean duration time for building a nest was 3days and the range time taken to build a nest was 3-5 days(n=20) . In some cases (n=7) the female wing – twitches and periodically gives soft call such call is louder if male is slow to return.

Table (II): Number of nests discovered in different months during the breeding season 2013and 2014 of Laughing Dove.

year	January	February	March	April	May	June	July	Augusts	Sept	Oct	Nov	December
2013	5	4	3	2	1	1	2	7	5	2	2	2
2014	6	5	3	1	1	2	4	8	5	4	3	3

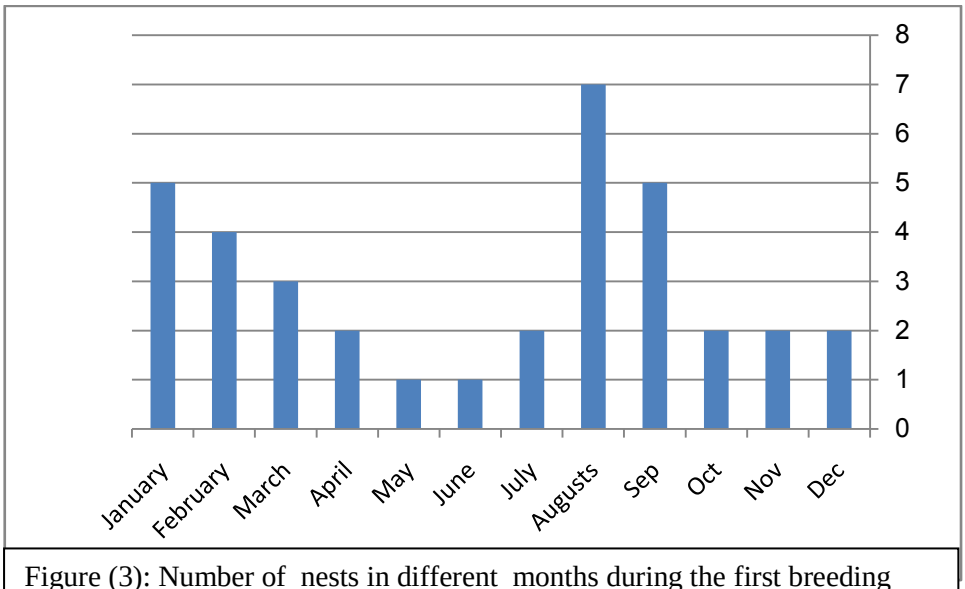


Figure (3): Number of nests in different months during the first breeding season (2013)

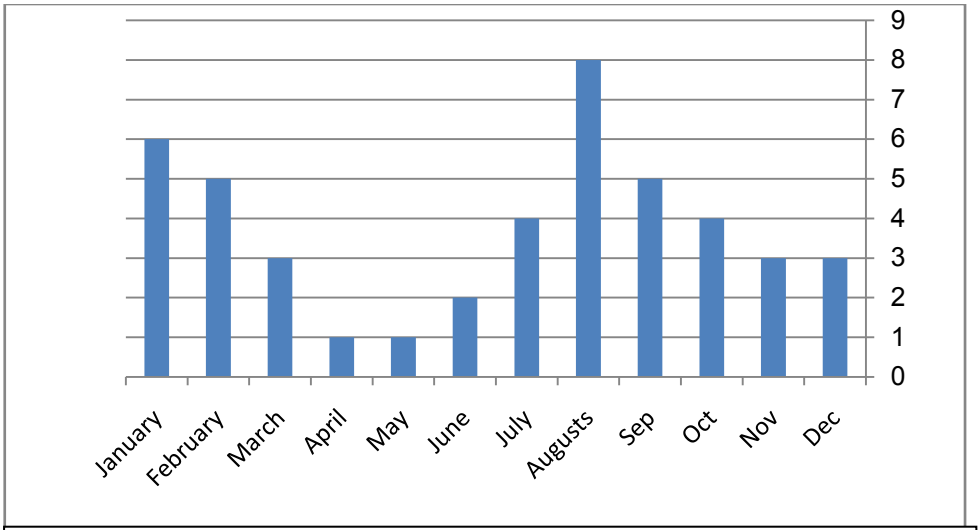


Figure (4): Number of nests in different months during the second breeding season (2014)

4.4. 1.The Nest building material & Nest Measurements:

Nest building materials were gathered from nearby areas surrounding nest sites. During incubation period no building materials were added to the nest. Nests were well stationed because no complete nest was seen collapsing due to storms.Stem of grass and plastic wire were probably used to fix together the different twigs and constitute the nest substrate. The nest which was platform made from thin and thick twigs,and lined with soft stems of grass like Najila (*Cynodon dactylon*) and plastic wire (plate12a &12b), or made from plastic wire with thin or thick twigs (plate,13a&13b), in man made structure. Nests built in semi arid area (plate,14a&14b).The maximum length for the nest was 18cm, and width was13cm in semi arid area(Plate,15) and the minimum length of nest 8cm and width 5cm in Nkheel (*Phoenix dactylifera*) tree in houses. In one case there were two nests together in the same site in the same branch in lime trees the discovered of these two nests in January in house around the farm in lime tree *Citrus paradise* (Plate,17a). The male used dry twigs of neem tree (*Azadirechta indica*), Mahogany(*Khaya senegalensis*) and in semi arid area used twigs of Kiter *Acacia mellifera* and tundab *(Capparis deciduas*). Meskeat*(Prosopis glandulosa*).Completed nests were plat –shaped with slight central depression.External measurements of nests were as followed: the nests were measured using a tape meter, the mean external measurement of seventy two nests were as follow: length 11.5±2.03 cm; width, 8.60±1.98 cm and depth 2.35±0.96 cm .Some nests were lined with soft grass before they were reused (n=16). Birds were using old nests after repairing. Females were seen (n=2) bringing nesting material to the old nests. The repair usually took 1-2days (n=8). The old nests became thick and littered with previous young feces(Plate, 16) .Birds nest solitarly , only in one case two nests close to each other (Plate,17a&17b)

Plate (10) : The nest site selection female Laughing dove sitting in the site and the male want to going to selection the nest building material,photo by the Author

Plate(11): The male Laughing dove held a single twig in its beak to start the nest buiding in Neem tree *Azadirechta indica*,photo by the Author

Plate:(12a&12b): The nest of the Laughing Dove, platform was made from thin and thick twigs,and lined with soft stems of grass like Naiila *(Cynodon dactylon*) and wire of plastic,photo by the Author

Plate:(13a&13b) Nest of Laughing Doves is open , with Platform was made from plastic wire with thin or thick twigs, with no soft stems of grass(*Cynodon dactylon),* photo by the Author

Plate(14a&14b): The nest of Laughing Dove Platform was made from thick twigs, or sticks in semi desert area, the photo by the Author

Plate:(15):the largest nest in study area in semi-desert area, the photo by the Author

Plate (16): The Female Laughing Dove was seen bringing nesting materials to the old nest and aranging the material in it the old nest. Though the old nest was littered with previous young feces after some uses.

Plate (17a&17b): two nests were built in the same branch in lime tree *(Citrus paradise* discovered in January 2014.

4.4.2.Variation in nest numbers during the breeding season in 2013

There was a difference in nest numbers between the three towns (Khartoum, Bahari and Omdurman), also there were a difference in numbers of nests in three seasons; winter, wet season and dry season. The highest number of nests were recorded in wet season(16 nests) and winter (13 nests), but in the dry summer the numbers of nests decreased(7 nests). In Omdruman no nest was found during the breeding season 2013(Table,III).

Table(III):Total numbers of nests of Laughing Dove in three towns during the breeding season 2013

Area	Season	Number of Nest
Khartoum	Winter	8
	Dry season	3
	Wet season	9
Bahari	Winter	5
	Dry season	4
	Wet season	7
Omudrman	Winter	-
	Dry season	-
	Wet season	-

The differences in The means between the three towns(Khartoum, Bahari and Omdurman), found to be statistically significant ($p<0.05$) at level 0.000 (P=0.001),the significant differences in this level between Khartoum and Omdurman,also between Bahari and Omdurman.

Also there were a significanct difference between the seasons (winter, dry season and wet season) was found to be statistically significant ($p<0.05$) at level 0.011(P=0.011) , the significant difference in this level between winter and dry season also between wet season and dry season table(IVa).

Table(IVa): Variation in nest numbers between the three towns and the three seasons during the breeding season 2013

Season / Area	Winter Mean± S.D	Dry Season Mean± S.D	Wet Season Mean± S.D	Significance
Khartoum	4±1.4	1.5±0.7	4.5±0.7	
Bahari	2.5± 0.7	2.0±0.0	3.5±0.7	
Omdurman	0.0±0.0	0.0±0.0	0.0±0.0	**0.000
significance	* 0.011			
Main effect				
Areas	Mean±S.E	Significance		
Khartoum	3.33±0.27a			
Bahari	2.67±0.27a			**0.000
Omdurman	0.00±0.27b			
Significance	*			
Seasons	Mean±S.E	Significance		
Winter	2.17±0.27a			
Dry season	1.17±0.27b			*0.011
Wet season	2.67±0.27a			
Significance	*			

4.4.3.Variation in nest numbers during the breeding season in 2014

The highest number of nests were recorded in wet Season (21 nests) and winter(17 nests) but in the dry summer the numbers of nest were decreased(7).In Omdurman there were no nests except in wet season, there were difference in nest numbers between the sites (Khartoum, Bahari and Omdurman) table (IVb).

Table(IVb). Total numbers of nests in three towns during the breeding season 2014.

Area	Season	Number of Nest
Khartoum	Winter	10
	Dry season	4
	Wet season	10
Bahari	Winter	7
	Dry season	3
	Wet season	8
Omudrman	Winter	0
	Dry season	0
	Wet season	3

The differences in The means between the three towns(Khartoum, Bahari and Omdurman), found to be statistically significant ($p<0.05$) at level 0.005 ($P=0.005$),the significant differences in this level between sites Khartoum and Omdurman,also between Bahari and Omdurman.

Also the significance difference between the seasons (winter, dry season and wet season) was found to be statistically significant ($p<0.05$) at level 0.05($P=0.05$) , the significant difference in this level between winter and dry season also winter and wet season, Also another significance differences between wet season and dry season table(IVc).

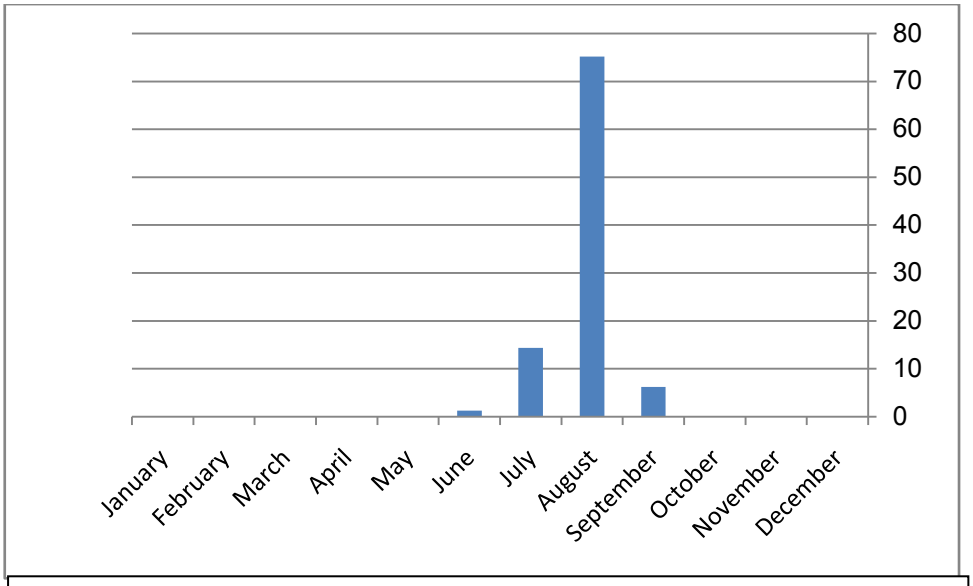
Table (IVc):Variation innest numbers between the three towns and the three seasons during the breeding season 2014

Season / Area	Winter Mean± S.D	Dry Season Mean± S.D	Wet Season Mean± S.D	Significance
Khartoum	5.0±0.0	2.0±1.4	5.0±2.8	**0.005
Bahari	3.5± 2.1	1.5±0.7	4.0±1.4	
Omdurman	0.0±0.0	0.0±0.0	1.5±0.7	
significance	* 0.05			

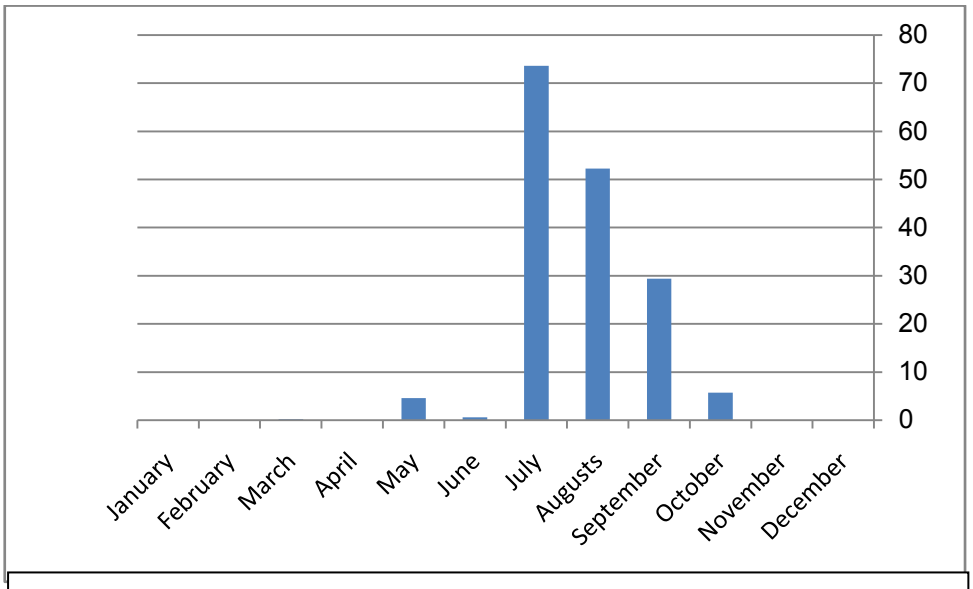
Main effect		
Areas	Mean±S.E	Significance
Khartoum	4.0±0.57 a	**0.005
Bahari	3.0±0.57 a	
Omdurman	0.5±0.57 b	
Significance	* *	
Seasons	Mean±S.E	Significance
Winter	2.83±0.57 a b	*0.05
Dry season	1.17±0.57 b	
Wet season	3.57±0.57 a	
Significance	*	

4.4.4. Breeding activities

The environmental changes e.g. rainfall probably increased stimulated breeding activities(Figure,5and Figure,6),the highest number of nests discovered in wet season in 2013 and 2014. Early and prolong rainy season seems to increased breeding activities and nests number in second season 2014(table, II).



Figure(5):Rainfall in mm during the first breeding season 2013
.Source: Meteorological Station of Khartoum.



Figure(6):Rainfall in mm during the second breeding season 2014
.Source: Meteorological Station of Khartoum.

4.5. Nesting habitats:

Nesting was recorded in the three following habitats.

1-Nesting in open semi arid area with presence of suitable nesting tree species like *Prosopis juliflora*, *Capparis deciduas*, *Acacia mellifera*, *Ziziphaus spinachristi* ,*Balanites aegyptiaca*, with proximity to permanent water source and agricultural field or near farm to avoid competition with Ring necked dove in nest site, also to avoid predation

2-Around human habitation, nest sites were in trees and building eaves; where foods and water available. (plate 18a&18b)

3-In thorny trees proximity to industrial block near the Blue Nile River bank. Association with human residential areas probably deter predators like snakes,thus may possibly ensure safety of eggs and nestlings.

Plate (18a): The nest on air cooler around human habitation

Plate (18b): The nest on building eaves around human habitation

4.5.1.Preference for nesting trees species

In the study area, a total of 75nests with eggs were found in 72trees belonging to seventeen species. The nesting trees with percentage use were Tamrhindi *Pterolobium exosum* constituted 12%(Plate,19), Tundub, *Capparis deciduas*10.7%(Plate, 20), Sedir,*Ziziphaus spinachristi* 10.7%(Plate, 21), Heglieg, *Balanites aegyptiaca* 9.3%, Nakheel ,*Phoenix dactylifera* 8%(Plate,22), Neem, *Azadiracht indica* 8%(Plate, 23), Meskeat, *Prosopis glandulosa* 6.7%(Plate, 24), Lime, *Citrus paradise* 6.6%(Plate, 25), Kiter, *Acacia mellifera* 5.3%(Plate, 26), talih, *Acacia Seyal* 4%, Damas, *Conocarpus lancifolius* 2.7%(Plate,27), Larenga, *Citrus larynge* 2.7%, Guava, *Pisidum guajava* 2.7%, Ushar, *Calotropis Procera* 2.7%(Plate,28) Lantana, *Lantana camara* ,1.3%, Indian Al Mond, *Terminalia oatappa* ,1.3%, Mahogany**,** *Khaya seneglensis*,1.3%.All trees with high percentage use are thorny which probably provide a mechanical barrier against predators. This is supported by the findings at semi arid area and industrial block near Blue Nile River where the species of nesting trees are thorny oneslike,Tamrhindi,*Pterolobiumexosum*,Tundub,*Capparisdeciduas*,Sedir,*Ziziphaus spinachristi* ,Heglieg, *Balanites aegyptiaca*, Meskeat, *Prosopis glandulosa*, and Kiter, *Acacia mellifera*.

Plate(19): The nes of Laughing dove with eggs on Tamrhindi, *Pterolobium exosum*

Plate (20)The nest of Laughing dove with eggs on Tundub *Capparis deciduas* tree ,

Plate (21): The nest of Laughing dove inside the Sedir,*Ziziphaus spinachristi*, tree, which was the biggest one in the study area

Plate(22): The nest of Laughing dove on Nakheel ,*Phoenix dactylifera* tree, the nest was the smallest one in the study area

Plate (23): The female Laughing dove sat on the nest in Neem, Azadiracht indica

Plate(24): The nest of Laughing dove with two eggs on Meskeat, *Prosopis alandulosa*

Plate (25): The nest of Laughing dove with one nestling on lime, *Citrus paradise*

Plate (26): The nest of Laughing dove with two eggs on Kiter, *Acacia mellifera*

Plate (27): The nest of Laughing dove on Damas, *Conocarpus lancifoliu*

Plate (28): The nest of Laughing dove with no eggs in semi desert area on Ushar, *Calotropis Procerai*

4.5.2.Measurement of tree heights

The mean height of nests above the ground level was 2.49±0.77m (n=75). The lowest recorded nest was one meter above the ground in Meskeat *Prosopis glandulosa*, Tundub *Capparis deciduas*, and the highest was 4m in Nakheel *Phoenix dactylifera* in Khartoum Bahari and Sharq El Neil. The different height of nests in different trees species in Khartoum (Jabal Awlia and Soba EL Bagair) in table (IVd), and Bahari(Khartoum Bahari and Sharq El Neil)in table(Va)and in Omdurman2 in table(Vb).

Table (IVd):Measurement of trees heights on which nests were built in 2013&2014in Khartoum (Jabal Awlia and Soba EL Bagair)

Site	Tree		Number of tree	Height of each tree (m)	Averge of height of trees (m)
	Scientific name	Local name			
Soba El Bagair and Jabal Awlia	*Citrus paradise*	Lime	3	2.30 2.50 2	2.27
	Pterolobium exosum	Tamrhindi	5	2.20 3 2.53 2.80 2.40	2.59
	Azadiracht indica	Neem	4	3.51 3 3.33 3.78	3.41
	Acacia mellifera	Kiter	3	2 1.60 2.38	1.99
	Ziziphaus spinachristi	Sedir	4	2.90 2.71 2.44 2.00	2.51
	Lantana camara	Lantana	1	2.50	
	Balanites aegyptiaca	Heglieg,	4	2.80 2.62 1.50 2.50	2.36
	Prosopis glandulosa	Meskeat	3	1 1.51 2	1.50
	Capparis deciduas	Tundub	4	1 2.25 2.50 2	1.94
	Calotropis Procera	Ushar	1	1.20	
	Phoenix dactylifera	Nakheel	3	3.90 3 3.45	3.45
	Khaya seneglensis	Mahogany	1	3.30	
	Conocarpus lancifolius	Damas	1	3	
	Citrus larynge	Larenga	2	3.50 3	3.30
		Building eaves	2	2.9o 3	3
		Water cooler	1	2.40	

Table (Va): Measurement of trees heights on which nests were built in 2013& 2014 in Bahari(Khartoum Bahari and Sharq El Neil)

Site	Tree		Number of tree	Hight of each tree (m)	Averge of hight of tree (m)
	Scientific name	Local name			
Khartoum North and Sharq El Nile	*Citrus paradise*	Lime	2	2.83 2.30	2.57
	Pterolobium exosum	Tamrhindi	4	2.90 2.51 2.60 3	2.75
	Azadiracht indica	Neem	2	3.36 2.90	2.90
	Acacia mellifera	Kiter	1	1.60	
	Ziziphaus spinachristi	Sedir	4	2 2.30 3.20 2.50	2.50
	Balanites aegyptiaca	Heglieg	3	2.50 2.10 2.30	2.30
	Prosopis juliflora	Meskeat	2	1.20 1.30	1.25
	Capparis deciduas	Tundub	2	2 1.80	1.90
	Phoenix dactylifera	Nakheel	3	4 3.30 3.55	3.62
	Terminalia oatappa	Indian Al Mond	1	3	
	Conocarpuslancifous	Damas	1	2.50	
	Pisidum guajava	Guava	2	1.90 2	1.95
	Acacia Seyal	talih	3	2.40 2.60 2.80	2.50

Table (Vb):Measurement of trees heights on which nests were built in 2014 in Omdurman2

Site	Tree		Number of tree	Hight of each tree (m)	Averge of hight of tree (m)
	Scientific name	Local name			
Omdurman2	*Capparis deciduas*	Tundub	2	1.60 1	1.30
	Calotropis Procera	Ushar	1	1.40	

4.6. Egg laying sequence and incubation

The first egg which was laid after finishing nest building. It was usually laid in the mornings at 6 am (n=4) the second egg was laid after one day. The mean intervals between the two eggs were 35.5 hours (n=17)(Plate 29). The third egg which was very rare(n=1)(plate,30) was laid two days after the second one.The clutch size which means the number of eggs laid in series without any interruption. Normally the upper limit of the clutch size is two(n=76) ,but in two cases there were only one egg in the nest. During egg laying period both sexes visited the nest together and sat on the egg for short periods 6-4 hours, but mostly stayed around the nesting area for a time (n=10).Continuous incubation, however , was not commenced until the last egg was laid (N=15). The incubation session beginning from the 6.45 ±20minutes in the mornings until 6.50 ±20 minutes in the evenings (N=13). The incubation was shared by both male and female in this time . Male sits during the day in morning and during the mid day,Mean duration of incubation session was 4.3±2.09 hours(n=12). The female sets during the night (Plate, 31) and contiguous light periods this was done by the female after 5 days from the beginning of incubation(N=9)(plate,32). In The change over more frequent in hot weather . In coming male perches on nest-rim, gives soft cooing sound , and allopreens female head and neck, gradually moves onto nest,gently pushing female off eggs, Female then flies off to

feed and loaf . In some cases the female gives soft cooing when the male was delayed then leave the nest for some minutes then came again (n=6). In one case when there were people around the nesting area , there would be delays of shift changing of parent up to half an hour until the people vanish away from the nesting area.The incubation period from egg laying to hatching was found to be before 12to 14 days with an average 13days based on thirty nests on which data records were kept. Eggs in each of them hatched more or less synchronously, within a period of less than a day (the mean14 hours) in (n=15). In the last days of incubation period, birds did not fly immediately on the approach of the observer but had to be flushed to examine the eggs.Generally parents sat tightly, and some times can be seized on nest (n=23), also they did the same thing if there were strongly wind they sat tightly and seized on nest (n=6) When alarmed usually crouched in nest, head lowered and feathers sleeked(n=23)(plate,33) . When flushed they rarely disappeared from view and returned to their nests after short time (n=20).

Plate (29): Anest of Laughing dove with two eggs

Plate (30): A nest of Laughing dove with three eggs

Plate (31):Showing an incubation, female sets on the nest during the night

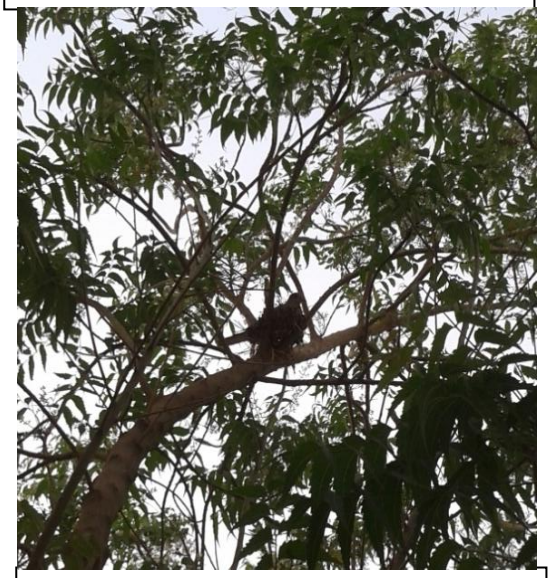


Plate (32):Showing an incubation, female sets on the nest until the first hours of the mourning

Plate (33): When female alarmed usually crouched in nest, head lowered and feathers sleeked

4.7. Hatching, Fledging

The mean time from hatching to fledging was found to be12-16 days with an average 14 days based on 34 nests on which detailed records were kept. The total investigated nests for fledgling in season one were14 nests, and the number of fledglings from these was 27.In the second breeding season the total number of nests in which detailed recorded were kept were 20 nests and the total number of fledglings was 38.

The egg cracked into two pieces of unequal sizes (plate,34). The bill and the legs were probably used to crack the egg shell(plate,35). Fragments of empty shells after hatching were removed from the nest. In one case one egg failed to hatch after four days from hatching the first egg (plate,36). The nestling was able to raise head after hatching probably induced by feeding behaviour(Plate,37).Soon after hatching, the adult was seen nodding its head and feeding the chicks with crop milk. Unlike incubation,the adult bird was not in the nest all the time but left for short period when the chicks were four

or five days old (N=24) but mostly stayed around the nesting tree keeping a close watch. As the chicks grew, the adult spent less and less time in the nest during the day. The young were fed by both parent, the chick's bill buried deep inside the adult's buccal cavity(plate,38a,38b). In some cases after feeding the nestling the female stayed for some minutes, maybe it was satisfied with herself and looking to their chicks kindely(N=8) (Plate,39a,plate,39b), The two nestling may be fed at the same time, with the bill of each chick inserted from either side. .Both parents may come to nest together or one may wait nearby while others feeds young. The young were fed by male only (N=7) in later period if subsequent brood started. Territorial behaviour among a male during breeding was observed (N=13), vigorous fights and aggressive chase noted between males; male quick to chase off any conspecific strangers approaching to the nest site. Female also defensed nest site from House Sparrow *Passer domesticus* and common bulbul *Pycnonotus barbatus* around the hatching time and for the first five days(N=6) .

Plate (34):The egg shell cracked into two pieces of unequal sizes in hatching

Plate (35): There were two marked in egg shell, in bill area and the legs area which were probably they were used to crack the egg shell

Plate (36): The egg failed to hatch after four days from hatched the first egg.

Plate (37):The nestling was able to raise head after hatching probably induced by feeding behaviour.

Plate (38a): The female feeding the chick in up situation, the chick's bill buried deep inside the adult's buccal cavity

Plate (38b): The female feeding the chick in down situation, the chick's bill buried deep inside the adult's buccal cavity

Plate (39a): After feeding female stayed for some minutes,her face expression, was satisfied for feeding nestling.

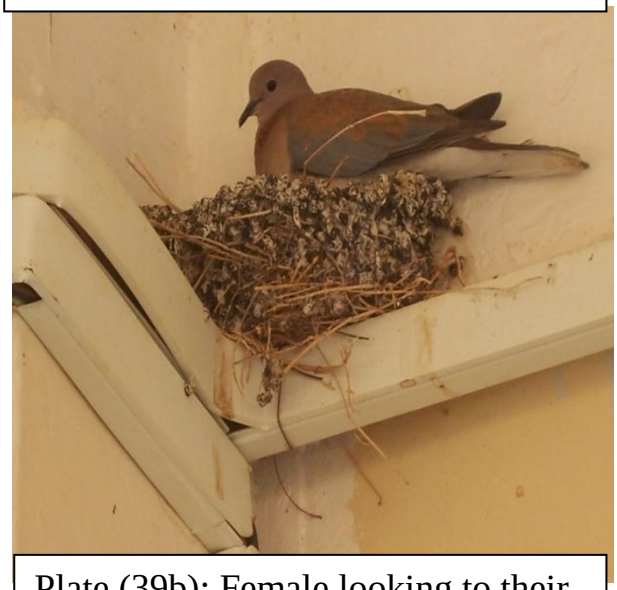


Plate (39b): Female looking to their nestling sensational pleasure after feeding them.

4.8.Development and care of nestling

Young on hatching had reddish pink skin with scattered yellowish downy feather(Plate, 40). As the young developed the skin became dark purplish grey, soon turning darker, covered with profuse yellow downy (Plate,41). On 4.0 ±0.7days young were able to see (N=10), Young in semi desert area were seen in 5days (N=3). Quills appeared on day four(plate, 42). Development rate varies within youngs (Plate,43). On five to six days young were able to crawl around in the nest. Feathers broke open on day seven(Plate,44),On day seven chick defended itself by bill snapping and wing flailing(plate,45), also the young may fluff the feathers, especially those of the breast, and "hiss"(Plate,46). Seven days after hatching young seen moving and stretching their wings . The young may shake its wings rapidly for a few seconds and repeat intermittently food begging movements. Walked well on day nine . Young nestling mostly slept head to tail in parallel. By day ten the young showed well developed feathers (Plate, 47). On leaving the nest young hanged around their nests for 3-5days (plate,48a &48b). Independent young may be sitting together (plate,49a &49b). Young were fed by both parents and they struggled to get their parents attention(Plate,50).Young begged food by gaping and this was stimulated by the light of parents on the nest . In the first days of fledging only males fed the young (N=12) (Plate,51). On three occasions female when flushed from nest (with young) showed a feigning behaviour, it dropped to the ground and performed a distraction lure display of disablement in which it trailed its wing . When the danger was over it returned to the nest.

Plate (40):Young of Laughing dove on hatching blind, had reddish pink skin with scattered yellowish downy feather

Plate (41): The young Laughing Dove three days old. Skin became darker, covered with profuse yellow downy

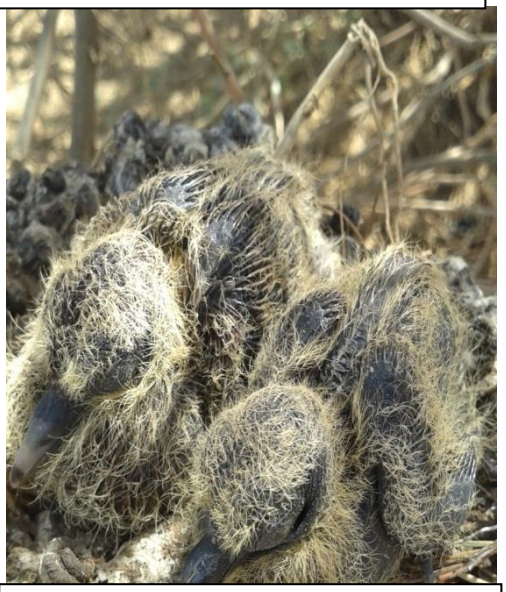


Plate (42): Nestling Laughing Dove g, with appeared of feathers on day four, but they were not able to see

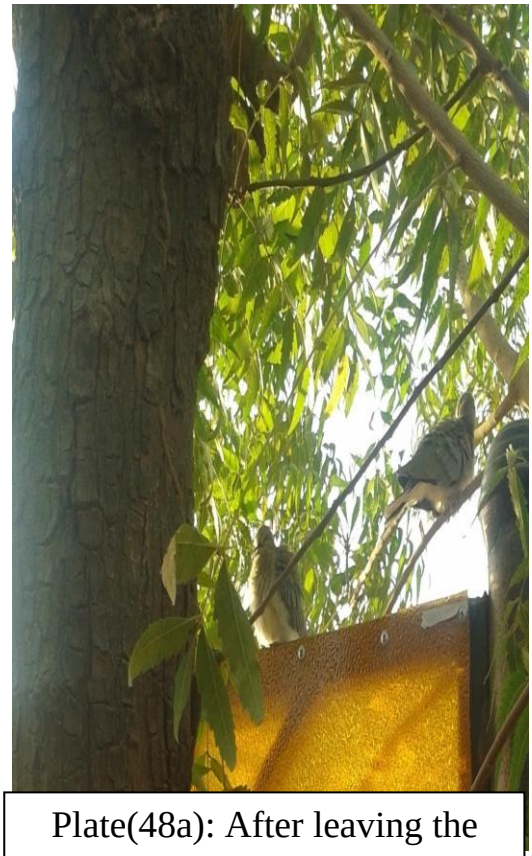
Plate(43): Development rate varies within youngs Laughing dove

Plate(44): Feathers broke open on day seven in the two nestling Laughing dove

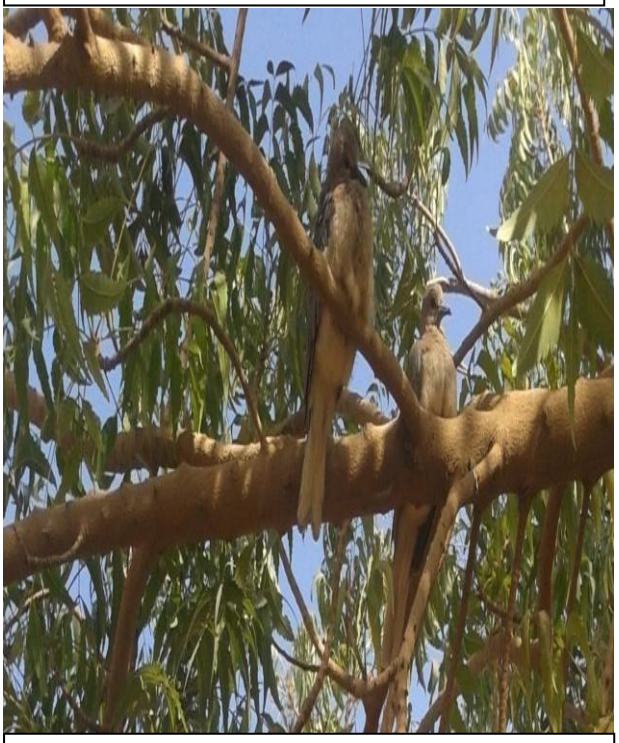
plate(45): On day seven chick defended itself by bill snapping And wing flailing

(Plate(46): The young may fluff the feathers, especially those of the breast, and "hiss"

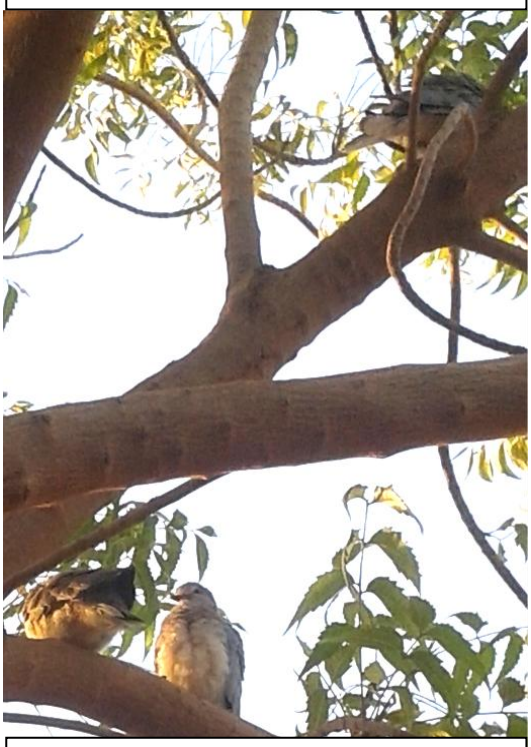
Plate(47): On day ten the young showed well developed feathers.



Plate(48a): After leaving the nest young hanged around their nest, they were nineteen days of age



Plate(48b): After leaving the nest young hanged around their nest, they were twenty two days old



Plate(49a): Independent young sitting together only three young

(Plate 49b): Independent young were fed together, then they disserted the area for unsuitable area (no food and no water)

Plate(50):Youngs were fed by female Laughing dove and they struggled to get her attention

Plate(51). In the first days of fledging only male fed the young, and they begged him to feed them.

4.9.Breeding Success

Breeding success is defined as "When one or more young from a clutch of eggs survives to fledging". During the study period of 24 months a total of 81 nests of *S. senegalensis* were studied.The percentage of the breeding success in Khartoum in the first season was 42.1% in (table, Vc)based on 8 nests which were carefully studied at (Soba – Elbagair and Jabal Awlia). And the percentage of breeding success in Bahari(Khartoum Bahari and Sharq ElNile) was 37.9% in (table VIb) based on 6 nests. They were two nests which were diserted with eggs in the study area one in Khartoum another in Bahari. The highest numbers of nests found in January and February(winter) and September and Augusts(wet season) table(II). In the second season fledgling success was 47.8% in (table, VIb) in Khartoum (Soba – Elbagair and Jabal Awlia) based on 11nests. And the percentage of breeding success in Bahari((Khartoum Bahari and Sharq ElNile)was 48.3% (table, VIc) based on 8 nests. The highest number of nests in January February(winter) Augusts September(wet season).In Omdurman 2 in the second season the fledgling success in was 40% in(table, VId) based on one nest The main cause of mortality was a wind velocity and wind stormy in (January, February) strongly wind

and heavy rain (Augusts September) which destroyed 9 nests(25%) in 2013 and 11nests(24.4%) in 2014. Any egg-bearing nest that was not protected from the wind was blown down and the eggs were lost (P late, 52a,52b) especially the nests on low height in trees of Kiter *Acacia mellifera* s and Meskeat *Prosopis juliflora* and Usher *Calotropis Procera*. in semi desert area, also the height trees in houses affected with the strongly wind and heavy rains, wind and heavy rains also destroyed uncompleted nests(n=2), but it never affected any offspring after they hatched. Throught –out of the study period many cases of predation were recorded 8 nests(22.2%) in 2013 and 9 nests(20%) in 2014. Predation was assumed taking place when broken eggs were seen or found in the ground,partially eaten,complete disappearance of clutches and nest demage or found on the ground. Predation were probably mammals; human (Plate,53) and semi-domestic cats (*Felis domesticus*). which were important predation in human habitation areas. It was always a round nest site area and in four cases it observed on the branches of trees, in one case it was observed swallow eggs from the nest. In semi desert area Snakes may arguably be the most important predators .The highest predation rate was associated with the activity of Snakes in the beginning of dry Summer months in end of February and March (n=9). All these Predation in lowest trees for example shrub of Kiter *Acacia mellifera* s and Meskeat *Prosopis juliflora* and Usher *Calotropis Procera*, and cutting dead tree. The probability of nest predation varies with the species of plant in study area the thorny and high trees for example Heglieg, *Balanites aegyptiaca* Sedir, *Ziziphaus spinachrist* Tundub, *Capparis deciduas*, which they were in semi desert area or farms the nest in it was not predated by snake although the shrub of Kiter *Acacia mellifera* s and Meskeat *Prosopis juliflora* and Usher *Calotropis*

Procera were predated by snakes (at that time people in farms surrounded this area kills three snakes). In the study area the nests which were built in highest dense foliage tree would be concealed from predation for example Damas, *Conocarpus lancifous*, Nakheel *Phoenix dactylifera*, Mahogany, *Khaya seneglensis* Larynge, *Citrus larynge*, and Neem,*Azadirachi indica*. the location of the nest in the central position inside the plant gaves provide from stormy wind and high velociety wind (n=7), which were main cause of broken eggs and reducing nesting success. Also in the study area there were different breeding cycles according to abundance of food and disappearance of predation

Table(Vc):Nesting Success of The laughing dove at Khartoum during the first season

Measurments	Total
Number of nest built	20
Number of completed nests	19
Number of nest in which eggs were laid	19
Number of egg laid	38
Mean clutch size	2
Mean number of eggs per nest	2
Number of egg hatched	26
Number of egg hatched per nest	1.37
Number of nests predated with eggs	0
Number of nests predated with young	5
Number of destroyed eggs	10
Mean number of eggs failing to hatch per nest	0.10
Number of nests carefully followed till fledging	8
Number of young fledged	16
Nesting success young/egg laid	42.1%

Table (VIa): Nesting Success of the laughing dove at Bahari during the first season

Measurments	Total
Number of nest built	16
Number of completed nests	14
Number of nest in which eggs were laid	14
Number of egg laid	29
Mean clutch size	2.07
Mean number of eggs per nest	2.07
Number of egg hatched	15
Number of egg hatched per nest	1.07
Number of nests predated with eggs	1
Number of nests predated with young	2
Number of destroyed eggs	8
Mean number of eggs failing to hatch per nest	0.14
Number of nests carefully followed till fledging	6
Number of young fledged	11
Nesting success young/egglaid	37.9%

Table (VIb): Nesting Success of the laughing dove at Khartoum in the second season

Measurments	Total
Number of nest built	24
Number of completed nests	23
Number of nest in which eggs were laid	23
Number of eggs laid	46
Mean clutch size	2
Mean number of eggs per nest	2
Number of egg hatched	30
Number of egg hatched per nest	1.30
Number of nests predated with eggs	2
Number of nests predated with young	4
Number of destroyed eggs	12
Mean number of eggs failing to hatch per nest	0
Number of nests carefully followed till fledging	11
Number of young fledged	22
Nesting success young/egglaid	47.8%

Table(VIc): Nesting Success of The laughing dove at Bahary in the second season

Measurments	Total
Number of nest built	18
Number of completed nests	16
Number of nest in which eggs were laid	16
Number of egg laid	31
Mean clutch size	1.93
Mean number of eggs per nest	1.93
Number of egg hatched	21
Number of egg hatched per nest	1.31
Number of nests predated with eggs	0
Number of nests predated with young	3
Number of destroyed eggs	10
Mean number of eggs failing to hatch per nest	0
Number of nests carefully followed till fledging	8
Number of young fledged	15
Nesting success young/egglaid	48.3%

Table (VId): Nesting Success of The of the laughing dove at Omdurman during the second season

Measurments	Total
Number of nest built	3
Number of completed nests	3
Number of nest in which eggs were laid	3
Number of egg laid	5
Mean clutch size	1.66
Mean number of eggs per nest	1.66
Number of egg hatched	2
Number of egg hatched per nest	0.66
Number of nests predated with eggs	0
Number of nests predated with young	0
Number of destroyed eggs	0
Mean number of eggs failing to hatch per nest	1
Number of nests carefully followed till fledging	1
Number of young fledged	2
Nesting success young/egglaid	40%

Plate (52a) Laughing Dove egg shells fall on the ground at semi desert area

Plate (52b): Laughing Dove egg shells fall on the ground at semi desert area,

Plate (53):Predation were probably by human(block was thrown to the nest of Laughing Dove) , the nest and the egg were destroyed

4.10.Food and feeding habitati.

Based on observation during the course of study period,The adult Laughing dove foraged around the study area at early mornings (soon after sunrise) and occasionally at late afternoons, and before sunset. The birds were often seen in pairs, or in small flocks, though larger aggregation may occur where food was plentiful. Also when watering and roosting(plate,54).Two common characteristic features in feeding habitats in Laughing Dove were recorded the first characteristic feature in man made structures the adults well adapted to respective food ,to the best of my knowledge, human being provided it with stuff and cooked food. However its dependence on these urban provisions. The second characteristic features has limited its spread into natural environments a bird of semi desert area which was almost open and sunny environmental with scattered trees but almost near a source of water and agricultural field .Birds were adapted to feed with seed and fruit of plant and shells of snail from the ground.

The competition with inter specific the Ring–necked Dove *Streptopelia capicola* in farms in food in the study area was recorded

Plate (54): flock of laughing dove occur where food is plentiful also when watering and roosting in urban area

4.11.Egg dimension and egg shape index

In the study area there were differences in egg sizes at different habitat (plate,55) . These may be due to food availability in different sites, age,and number of eggs laid. The smallest sizes collected from the sites with little of food for example in natural habitats in the study area (n =10) and the smallest one in this sites when female produced three eggs(Plate,55). The largest egg size found in those nesting in human habitation(n=20). For example in College of Science andTechnology of Animal Production at Hillat Kuku, Sudan Unversity of Science and Technology where food was abundance.

The mean length of 30 eggs was 25.6±1.42 mm;the mean breadth was 19.7±0.6mm; and the mean weight of 30 eggs was 5.02±0.68gram

The egg shape index varies from pointed to oval (plate,56a and 56b)

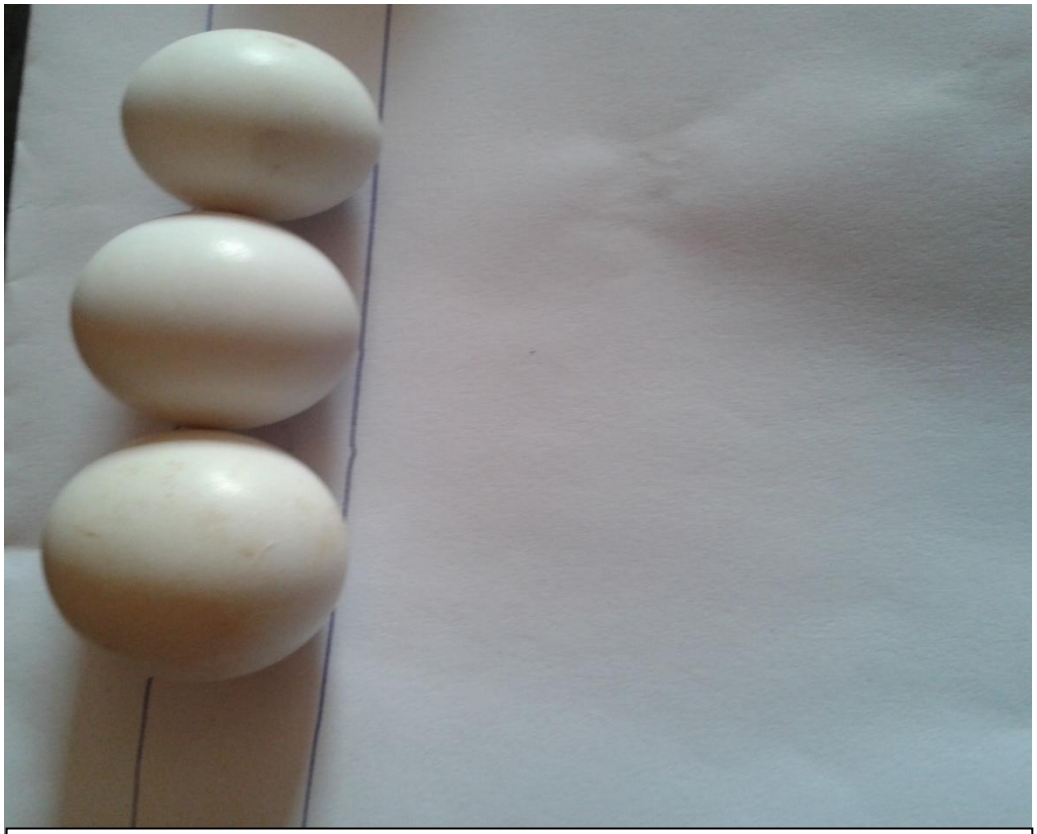
The laughing dove egg shape index was76.95% as calculated from Mills (1979) formula:

$$\text{Egg shape index} = \frac{\text{Mean Egg breadth}}{\text{Mean Egg Length}} \times 100$$

The correlation between egg length and egg weight and between egg breadth and egg weight was found to be statistically significant ($p<0.05$) and any of these parameters can be calculated from the equation. The regression equations derived were:

Length=18.8+1.35×weight (r=0.41)

Breadth=15.8+0.79×weight (r=0.65)



Plate(55): Variation of the laughing dove egg sizes at different habitats at the study sites

	
Plate(56a): Variation in egg shape diverge widely from oval to conical shape, with one end rounded and the other more pointed .	Plate(56b): eggs had two rounded end this eggs were collected from the semi desert area

4.12. Eggshell thicknes

The mean of shell thickness was 0.16±0.01µ and the correlation between egg weight and shell thickness was statistically insignificant ($p>0.05$). The minimum weight was3.3g with athickness of 0.16mm;the maximum weight 6.5g with athickness of 0.17mm; the highest thickness of 0.19mm; was recorded from 5.6g. Thus no clear relationship existed between the egg weight and the eggshell thickness and consequently no reliable predictive equation can be made from cracked egg shells with egg dimension.

4.13. Calculation of K-Value for the Laughing Dove

When applying the formula ($W=KLB^2$) given by Curry (1979),

Where;

W=egg weight in grams

K=is a constant for species or subspecies =0.510

L=egg length in mm

B=egg breadth in mm

The mean K-value for laughing dove was calculated to be 0.505(n=30 eggs) these was well in the range given by other researches of instance Curry (1979) who gave a value of 0.510 and Hoyt (1976), (1979)who gave a value 0.507.

4.14.The difference in colour in egg shells between two different habitats.

There were two different habitats in which eggs were collected for colour .The comparison here between natural habitat (semidesert area sunny condition and scattered trees), the parents did not sit on eggs continuosuly especially during midday (n=6) for example in Ushar tree or in dead trees or in trees with no dense leaves(plate,57a&57b) .The second habitat around human habitation in building eaves (man made structure)(Plate,58a) ,and shade trees (shading habitat) (Plate,58b) .Here incubation was continuously. The colour of egg shells are different between the two areas, white glossy in building eaves structure and shade tree and off white in semi desert area(Plate,59). The result showed there were no significant difference in the mean of minerals content in egg shells in two habitat.The concentrations of minerals in egg shells in man made structure, were higher in calcium,

Mganisum and Zinc but the difference was not significant between two habitat, but in natural habitat the concentration of iron in egg shells was higher but the difference was not significant. The concentration of various mineral in egg shells in the two different habitat were presented in table (VIe&VIIa).

Table(VIe):Assessment of mineralogical content of Laughing Dove egg shells (ppm) in two different habitat

Mineral (ppm)	Mean of mineral			
	Number of eggs	In natural habitat	Number of eggs	In man made habitat and shade tree
Calcium (Ca)	9	9.813±3.9471	5	12.396±5.4639
Magnesium (Mg)	9	0.298±0.1113	5	0.424±0.12190
Iron (Fe)	9	0.016±0.0137	5	0.0137±0.0872
Zinc (Zn)	9	0.001±0.0006	5	0.0014±0.0014

*PPm:means parts per million

Table (VIIa):Relation between two habitat in concentration of minerals in egg shells in Laughing Dove.

Mineral (ppm)	t	Df	p-value
Calcium (Ca)	1.027	12	0.325
Magnesium (Mg)	1.974	12	0.072
Iron (Fe)	0.289	12	0.777
Zinc (Zn)	0.583	12	0.571

The difference was not significance($p>0.05$) between the two habitat in concenteration of minerals in egg shells.The results can not explain the difference in colours between natural habitat and in man made habitat ,due to feeding habitat (essential nutrients are the essential nutrients required).

Also concentration of lead and cobalt was detected in semidesert habitat , the concentration of lead (Pb) was 0.00015 ppm in egg shells and concentration of cobalt (Co) was 0.00003.5 ppm in egg shells, that mean there was no pollution with this element in the semidesert habitat(pollution has no effect in egg shells colour in semidesert habitat).

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Plate (57a): the eggs of Laughing Dove in Ushar tree in semi desert area one was white colour and the other was off white, the white one was the last egg laying

Plate (57b): the eggs of Laughing Dove in dead tree the two eggs were off white in semidesert area

Plate (58a): The eggs of laughing dove had white colour around human habitation in building eaves

Plate (58b): The eggs of laughing dove had white colour around human habitation in the in shading tree

Plate (59): Variation in eggs colour between two habitat the semi desert habitat with off white colour , and glossy white colour in man made structure (building eaves and shading trees)

4.15. Monthly number of birds recorded:

A comparison of the total abundance of individuals between six sites in Khartoum (Jabal Awlia)(JA), Soba –El Bagair(S B) in Omdurman Omdurman1 (OM1) and Omdurman2(OM2) in Bahari Khartoum Bahari(Kh-B) and Sharq El Neil(Sh E) in Khartoum States was presented in .The six sites are important for 84 species and the number of individuals utilizing the sites, especially during the rainy season. The highest recorded number of individuals were 1518 in September in 2013and 1971in August 2014. The lowest number of individual birds recorded were in May 2013and 2014, 366 individuals in 2013 and 519individuals in 2014. Also there were decrease in numbers of birds in April and November, in April 518 individuals in 2013 and 813 individual in 2014 and in Novmber 728 individuals in 2013 and 869 individuals in 2014(TableVIIb) and (Figure, 7) . There were 84 species recorded in the study area 2013 and 82 species in 2014 in (table IXb, Xa).

Twenty- six species were recorded presents throughout the study period and fifty eight were present only in part of the study period . Some species were recorded as rare species in the study area. These were, Black-head plover and Golden pipit which were seen only during 2013 in (table, IXb,) , Pied Kingfisher which was seen only six times during study period in Sharaq El Nile, Speckled pigeon which was seen seven times during study period in OM2, Hoopoe lark which was seen seven times and white fronted Sparrow lark which were seen five times during study period in OM1

Table (VIIb): Monthly number of bird recorded in the Khartoum state during the period of April-November, 2013 and 2014

Months Study period	Study Site													
	Season 2013							Season 2014						
	J W	S B	OM1	OM 2	KH B	SH E	Total	J W	S B	OM1	OM2	KH B	SH E	Total
April	139	97	19	29	125	109	518	242	136	67	80	149	139	813
May	89	75	16	9	93	84	366	156	91	26	23	125	98	519
June	153	160	30	53	149	161	706	226	201	33	42	201	202	905
July	188	173	25	41	200	189	816	325	250	29	58	269	208	1139
Augusts	230	216	27	44	215	193	925	441	390	156	160	475	349	1971
September	330	282	129	171	334	272	1518	312	226	123	140	283	241	1325
October	180	136	132	157	182	235	1022	297	122	176	208	175	257	1235
November	114	107	127	144	108	128	728	143	88	155	191	117	175	869
Total	1423	1246	5o5	648	1406	1371	6599	2142	1504	765	902	1794	1669	8776

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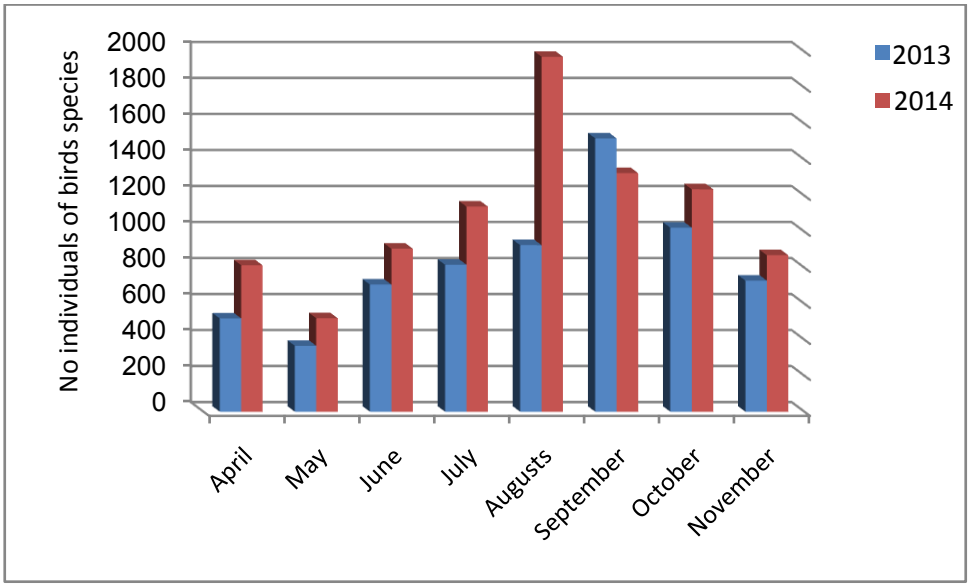


Figure 7: The monthly number of birds recorded in Khartoum study sites during 2013and 2014

4.15.1.The mean number of birds recorded in the study period

The mean observed avian fauna during the study period. Recorded that the value of means is higher in Augusts 2014, 3.91±12.6 these numbers means from any species which available in the study area could be seen four individuals from any of these species which recorded in study period(in Augusts). Also in September 2013, 3.01±9.16 that mean we were seen three individuals from each species recorded at that time in study area, The lowest value of mean in May 2013 in (table,VIIIa).

Table(VIIIa): The mean numbers of birds species, during the period of April to November, 2013and April to November 2014 in Khartoum state

Monthls study site	Mean of the total bird number in months	
	2013	2014
April	1.03±4.20	1.61±6.58
May	0.73±3.60	1.03±4.64
June	1.40±5.50	1.80±7.07
July	1.62±6.88	2.26±8.97
Augusts	1.84±7.75	3.91±12.6
September	3.01±9.16	2. 63±8.55
October	2.03±6.76	2.45±8.53
November	1.44±4.27	1.72±4.96

4.16.Seasonal variation at six study sites:

The variations in the species composition that were observed between the different study sites were shown in (tables VIIIb. All six sites have experienced considerable temporal variation in bird diversity and abundance. Acomparison of the total abundance of individuals between the six sites

during the 2013and2014 of study period was presented in (table,VIIIb) and (figure,8) ten species were recoded showing preference for two sites Omdurman1and Omdurman2 (two season)in (table IXa, IXb). White stork which was seen only at two sites Sharq El Neil and Jabal Awlia in 2013 and 2014.Turtle dove was seen at Jabal Awlia and Omdurman2 (in two season)in (table IXa, IXb). Glossy ibis , Sand Martin, Little weaver, and Ethiopian Swallow were seen at Jabal Awlia. Lesser Grey Shrike and Drongo were seen in two sites at Sharq El Neil and Khartoum Bahari. Chestnut bellid sand grouse was seen in two sites Sharq El Neil and Omdurman2. Black winged Stilt, African Spoonbill , Eurasian Spoonbill, Northen Shoveler yellow billed Egret, Common Sandpiper,Wood Sandpiper, Marsh Sandpiper and GreenSandpiper, Sacred ibis, which were seen only in two sites Omdurman1 and Omdurman2, Speckled pigeon which was seen at Omdurman2, Long tailed Nightjar was seen at Soba-El Bagair and Khartoum Bahari. Eurasian Roller which was seen at Jabal Awlia in 2013 and Jabal Awlia and Khartoum Bahari.in 2014.White fronted Sparrow Lark, Hoope Lark which were seen at Omdurman2,White head babler which was seen at Soba El Bagair only, Turtle Dove White Stork, Rufous BushChat which were seen at two sites at Jabal Awlia and Omdurman1 in 2013,but in 2014 at Jabal Awlia only. Grey Heron which were seen at Jabal Awlia and Omdurman2in (table IXa and IXb).

Table(VIIIb): Seasonal variations in birds abundance at the Six Study Sites in Khartoum state during 2013and 2014

Study site	years	
	2013	2014
J W	1423	2142
S B	1246	1504
OM1	505	765
OM2	648	902
KH B	1406	1794
SH E	1371	1669

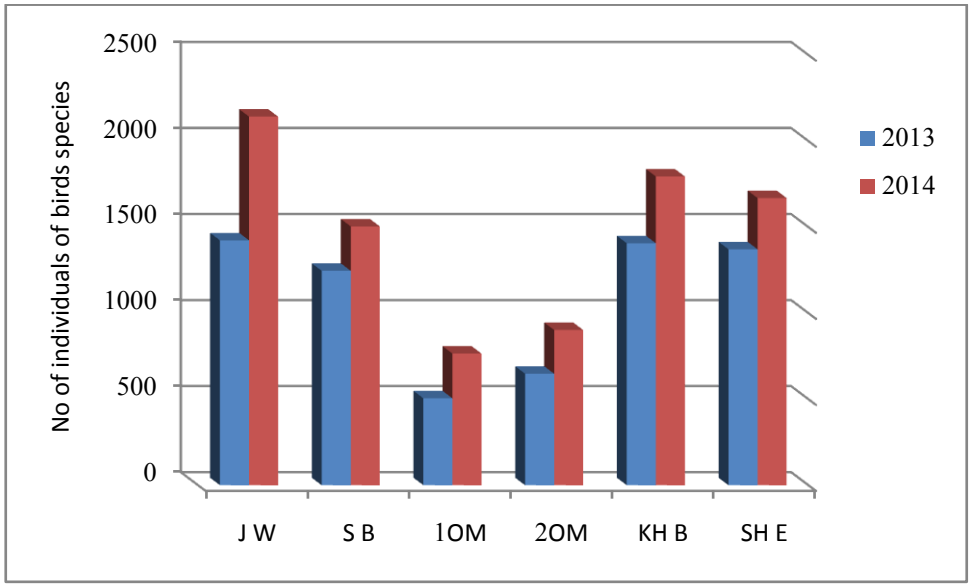


Figure 8:Seasonal variation in bird abundance at the six study sites in Khartoum study area during 2013 and 2014.

4.16.1.The mean number of birds recorded in the study period

The mean number of birds were higher in Jabal Awlia , Khartoum Bahari, Sharaq El Neil and Soba El Bagair and the lowest numbers in Omdurman1and Omdurman2. The mean value(2.12±7.32) at Jabal Awlia denoted that from any species which were recorded at Jabal Awlia in 2013 2 individuals were seen . The mean value (3.19±10.3) in 2014 denoted that 3individuals from each species recorded at Jabal Awlia were seen.The lowest value of means (0.86±2.26) in Omdurman1 and(0.9±2.74) at Omdurman2, these denoted that there were probability to seen one individual from all species recorded at Omdurman1 and at Omdurman2 in study period. And the mean value (1.14±3.37) at Omdurman1and (1.34±3.31) at Omdurman2 denoted that surely we were seen one individuals from all species recorded in 2014 table(IXa).

Table(IXa):Mean number of seasonal variation in birds aspecies, recorded at six sites in Khartoum state (2013-2014)

Study site	Mean number of bird species	
	2013	2014
J W	2.12±7.32	3.19±10.3
S B	1.85±6.07	2.24±8.08
OM1	0.86±2.26	1.14±3.37
OM2	0.91±2.74	1.34±3.31
KH B	2.12±7.77	2.76±10.0
SH E	2.11±9.16	2.54±10.6

Table (IXb): The mean number of individuals seen in the six sites in Khartoum State during 2013

Common English name	Mean number of individual seen in the six study sites in 2013					
	W J	S B	OM1	OM2	KH B	SH E
White Pelican	0.63	0.00	0.63	0.38	0.00	0.00
Long tailed cormorant	0.38	0.00	1.00	1.13	0.00	0.00
Grey Heron	0.63	0.00	1.00	0.00	0.00	0.00
Cattle Egret	8.75	1.38	3.50	4.13	2.88	1.00
Little Egret	10.5	0.87	1.62	2.25	1.37	0.25
Great White Egret	4.37	0.13	1.13	1.00	0.63	0.00
Yellow Billed Egret	0.00	0.00	0.50	0.13	0.00	0.00
African Open –bill Stork	1.50	0.00	1.62	1.75	0.00	0.00
Abdim's Stork	1.37	0.75	1.25	0.63	0.88	0.63
White Stork	0.25	0.00	0.00	0.00	0.00	0.50
Glossy Ibis*	1.13	0.00	0.00	000	0.00	0.00
Sacred Ibis	0.00	0.00	1.50	1.00	0.00	0.00
African Spoon bill	0.00	0.00	0.38	0.63	0.00	0.00
Eurasian Spoonbill	0.00	0.00	1.23	1.87	0.00	0.00
Northern Shoveler	0.00	0.00	5.38	4.50	0.00	0.00
Black Kite	5.63	5.13	3.38	3.38	4.25	1.88
Spur-winged Plover	2.60	2.13	2.50	1.8	1.63	1.13
Black –headed Plover	0.00	1.50	0.00	0.00	0.50	0.00
Common Sandpiper	0.00	0.00	0.88	0.63	0.00	0.00
Wood sandpiper	0.00	0.00	0.50	1.13	0.00	0.00
Marsh Sand piper	0.00	0.00	0.63	1.00	0.00	0.00
Green Sandpiper	0.00	0.00	1.25	0.625	0.00	0.00
Common Snipe	0.00	0.125	0.05	0.00	0.25	0.00
Little Stint	0.00	0.00	2.50	2.25	0.00	6.37
Black winged Stilt	0.00	0.00	3.00	3.25	0.00	0.00
Whiskered Tern	0.75	0.00	1.37	0.74	0.00	0.00
Chestnut-bellied Sandgrouse	0.00	0.00	0.00	0.750	0.00	1.10
Speckled Pigeon*	0.00	0.00	0.00	4.37	0.00	0.00

Namaqua Dove	2.00	2.25	0.00	0.82	0.37	1.50
Mourning Dove	1.00	1.25	0.63	0.75	0.87	0.87
Ring–necked Dove	0.25	2.87	0.00	0.00	2.50	2.37
Laughing Dove	7.50	11.75	2.62	4.63	7.75	10.50
Pink-headed Dove	1.12	0.00	0.00	0.00	1.12	0.00
Turtle Dove	0.37	0.00	0.00	0.50	0.00	0.00
Rose-ring Parakeet	0.77	1.25	0.00	0.00	0.87	1.50
Common Cuckoo	0.00	1.25	0.00	0.00	0.50	0.00
long-tailed Nightjar	0.00	1.75	0.00	0.00	1.12	0.00
Eurasian Swift	5.37	4.87	0.63	2.62	4.62	2.75
Alpine Swift	2.63	0.00	0.00	0.00	1.12	0.00
Blue-napped Mouse bird	1.25	3.87	2.12	1.75	1.37	1.25
Pied Kingfisher*	00.0	0.00	0.00	0.00	0.00	0.37
European Bee-eater	6.87	0.00	0.00	0.00	5.25	3.62
Little Green Bee-eater	0.75	1.12	0.37	0.00	0.87	1.12
Little Bee-eater	0.87	1.37	0.00	0.00	0.87	1.12
Abyssinian Roller	1.37	0.37	0.25	0.00	0.62	0.00
Eurasian Roller*	0.87	0.00	0.00	0.00	0.00	0.00
Common Hoopoe	0.88	2.00	0.00	0.00	0.75	0.50
Red-billed Hornbill	0.37	0.75	0.00	0.00	0.00	0.00
Hoopoe lark*	0.00	0.00	0.88	0.00	0.00	0.00
Short –toed Lark	2.50	0.00	0.00	2.37	3.25	6.75
Chestnut- back Sparrow Lark	1.87	0.75	0.00	0.87	1.87	0.00
White- fronted Sparrow Lark*	0.00	0.00	1.00	0.00	0.00	0.00
Crested Lark	0.50	1.25	0.75	0.00	0.37	0.75
Eurassian Swallow	0.75	0.12	0.37	1.25	0.00	0.00
Ethiopian Swallow*	0.37	0.00	0.00	0.00	0.00	0.00
Sand Martin*	0.500	0.00	0.00	0.00	0.00	0.00
Drongo	0.00	0.00	0.00	0.00	1.37	0.25
White headed babbler*	0.00	2.87	0.00	0.00	0.00	0.00
Common Bulbul	1.62	3.37	1.12	0.63	1.63	1.37
Rufous Bush Chat*	0.500	0.00	0.10	0.00	0.00	0.00

Black Bush Robin	0.00	0.75	0.00	0.00	0.50	0.00
Desert Wheatear	0.25	0.50	0.37	0.62	0.00	0.00
Black-eared Wheatear	0.12	0.00	0.13	0.00	0.25	0.12
Northern Wheatear	0.12	0.00	0.25	0.25	0.37	0.25
Tawny Pipt	0.62	0.50	0.25	0.50	0.50	0.37
White wagtail	2.00	2.00	0.75	1.50	1.63	1.25
Yellow Wagtail	1.00	0.75	2.00	2.37	1.87	3.75
Golden pipit	0.37	0.37	0.00	0.00	0.00	0.00
Lesser Grey Shrike	0.00	0.00	0.00	0.00	1.75	1.25
Blue -eared Glossy Starling	3.13	7.37	0.00	0.37	3.50	7.00
Ruppells-longtailed Glossy Starling	1.75	3.37	0.00	0.13	1.13	3.00
Beautiful Sunbird	0.625	1.125	0.00	0.00	0.500	1.25
Northern Red Bishop	0.00	0.00	2.87	2.00	0.00	0.00
Little Weaver*	0.75	0.00	0.00	0.00	0.00	0.00
Black headed Weaver	13.5	21.8	0.00	2.62	27.8	23.7
Northern MaskedWeaver	9.38	13.13	0.00	0.00	15.7	1.25
House Sparrow	55.6	37.8	4.13	6.87	54.75	66.6
Sudan golden Sparrow	2.13	1.75	0.00	0.75	1.13	1.37
Village Indigo Bird	0.00	0.87	0.25	0.00	4.75	0.00
Pin-tailed Whydah	0.00	0.50	0.00	0.00	1.50	0.87
Crimson-rumped Waxbill	1.50	0.00	1.37	2.63	0.00	0.00
Red-cheecked Cordon-bleu	0.25	1.00	0.25	0.50	0.87	0.87
Red billed Fire finch	1.00	1.75	0.87	1.12	2.25	2.25
African Silverbill	2.87	3.25	1.50	2.75	3.37	3.37

*species found one site only

Table(Xa): The mean number of individuals seen in the study area in the Khartoum State during 2014

Common English name	The mean number of individuals seen in the study area in Khartoum State during 2014					
	JW	SB	OM1	OM2	KH B	SH E
White Pelican	2.00	0.00	1.37	1.25	0.00	0.00
Long tailed cormorant	1.13	0.00	1.38	1.13	0.00	0.00
Grey Heron	1.50	0.00	0.50	0.00	0.00	0.00
Cattle Egree	17.6	1.13	5.63	7.63	2.25	0.63
Little Egret	19.4	1.38	2.50	2.88	1.50	0.00
Great White Egret	5.87	0.25	1.75	1.76	0.37	0.00
Yellow Billed Egret	0.00	0.00	1.00	0.37	0.00	0.00
African Open –bill Stork	1.63	0.00	2.00	1.25	0.00	0.00
Abdims Stork	2.13	1.38	1.38	1.50	2.37	1.37
White Stork	0.25	0.00	0.00	0.00	0.00	1.13
Glossy Ibis*	1.25	0.00	0.00	0.0	0.0	0.00
Sacred Ibis	0.00	0.00	2.00	1.87	0.00	0.00
African Spoon bill	0.00	0.00	0.75	0.50	0.00	0.00
Eurasian Spoonbill	0.00	0.00	1.75	1.63	0.00	0.00
Northern Shoveler	0.00	0.00	9.25	9.25	0.00	0.00
Black Kite	7.37	7.37	4.13	4.75	6.75	3.75
Spur-winged Plover	2.37	2.37	3.13	3.13	2.75	1.13
Black –headed Plover	0.00	0.00	0.00	0.00	0.00	0.00
Common Sandpiper	0.00	0.00	1.13	1.38	0.00	0.00
Wood sandpiper	0.00	0.00	1.63	1.25	0.00	0.00
Marsh Sand piper	0.00	0.00	1.25	1.00	0.00	0.00
Green Sandpiper	0.00	0.00	1.75	1.63	0.00	0.00
Common Snipe	0.00	0.123	0.625	0.38	0.00	0.00
Little Stint	0.00	0.00	2.75	3.38	0.00	6.00
Black winged Stilt	0.00	0.00	3.63	3.88	0.00	0.00
Whiskered Tern	0.50	0.00	1.63	1.00	0.00	0.00
Chestnut-bellied Sandgrouse	0.00	0.00	0.00	1.38	0.00	1.25

Speckled Pigeon*	0.00	0.00	0.00	4.25	0.00	0.00
Namaqua Dove	5.13	3.38	0.25	1.00	1.38	2.13
Mourning Dove	1.25	1.63	1.00	0.88	1.50	0.88
Ring–necked Dove	0.25	4.50	0.00	0.00	2.38	3.13
Laughing Dove	9.88	12.00	3.75	5.38	10.25	12.88
Pink-headed Dove	2.50	0.00	0.00	0.00	1.13	0.00
Turtle Dove	0.50	0.00	0.00	0.63	0.00	0.00
Rose-ring Parakeet	1.00	1.63	0.00	0.50	0.63	1.50
Common Cuckoo	0.00	0.00	0.00	0.00	0.50	0.75
long-tailed Nightjar	0.00	2.25	0.00	0.00	1.63	1.50
Eurasian Swift	8.50	4.75	2.63	3.38	4.50	2.50
Alpine Swift	3.88	0.00	0.00	0.00	0.88	0.00
Blue-napped Mouse bird	1.75	3.38	1.13	2.25	2.50	1.75
Pied Kingfisher	0.00	0.00	0.00	0.00	0.00	0.50*
European Bee-eater	11.9	0.00	0.00	0.00	5.38	2.13
Little Green Bee-eater	0.00	0.63	0.00	0.00	1.25	1.13
Little Bee-eater	1.13	1.25	0.00	0.00	0.75	1.38
Abyssinian Roller	2.00	0.00	0.63	0.00	1.38	0.00
Eurasian Roller	1.50	0.00	0.00	0.00	0.50	0.00
Common Hoopoe	1.25	1.38	0.00	0.00	0.75	1.00
Red-billed Hornbill	0.00	0.38	0.00	0.00	0.00	0.00
Hoopoe lark*	0.00	0.00	1.00	0.00	0.00	0.00
Short –toed Lark	1.88	0.00	0.00	1.50	0.00	6.75
Chestnut- back Sparrow Lark	1.75	1.13	0.88	1.13	1.75	0.87
White- fronted Sparrow Lark*	0.00	0.00	1.75	0.00	0.00	0.00
Crested Lark	1.13	1.13	1.88	0.00	1.00	1.00
Eurassian Swallow	1.50	0.13	1.00	1.37	0.00	0.25
Ethiopian Swallow*	0.88	0.00	0.00	0.00	0.00	0.00
Sand Martin*	0.75	0.00	0.00	0.00	0.00	0.00
Drongo	0.00	0.00	0.00	0.00	1.63	1.13
White headed babbler*	0.00	3.50	0.00	0.00	0.00	0.00
Common Bulbul	3.38	3.88	1.56	1.38	2.38	2.25
Rufous Bush Chat*	0.50	0.00	0.00	0.00	0.00	0.00
Black Bush Robin	0.00	1.13	0.0	0.00	0.75	0.00
Desert Wheatear	0.88	0.63	0.88	0.75	0.38	0.50
Black-eared Wheatear	0.00	0.00	0.00	0.13	0.13	0.25
Northern Wheatear	0.63	0.00	0.00	0.25	1.00	0.38

Tawny Pipt	0.63	1.00	0.37	0.50	0.50	1.25
White wagtail	2.13	1.63	1.25	1.88	2.75	2.00
Yellow Wagtail	1.88	0.75	1.88	2.25	2.25	4.75
Golden pipit	0.00	0.00	0.00	0.00	0.00	0.00
Lesser Grey Shrike	0.00	0.00	0.00	0.00	3.13	2.38
Blue -eared Glossy .Starling	7 7.25	8.88	0.378	0.00	6.00	8.88
Ruppells-longtailedGlossy Starling	2.88	3.88	0.00	0.500	2.63	4.00
Beautiful Sunbird	0.50	1.38	0.00	0.50	1.13	1.75
Northern Red Bishop	0.00	0.00	2.63	2.13	0.00	0.00
Little Weaver*	0.75	0.00	0.00	0.00	0.00	0.00
Black headed Weaver	20.6	35.6	0.00	2.38	37.3	29.8
Northern Masked Weaver	9.75	18.38	0.00	0.00	22.8	0.00
House Sparrow	78.00	43.4	9.38	11.6	63.4	78.1
Sudan golden Sparrow	4.50	2.00	0.00	1.50	2.25	1.63
Village Indigo Bird	0.00	0.25	0.75	0.75	8.00	0.75
Pin-tailed Whydah	0.00	0.50	0.00	0.00	2.00	2.25
Crimson-rumped Waxbill	3.75	0.00	2.13	3.25	0.00	0.00
Red-cheecked Cordon-bleu	0.00	2.13	0.63	1.00	1.00	1.25
Red billed Fire finch	1.88	1.50	1.63	1.38	2.25	2.50
African Silverbill	4.63	4.13	3.50	4.25	4.63	5.63

*species found one site only

4.17.The Relative abundance in Famillies and species

Total of 84species (in 2013), and 82 species (in 2014) belong to36 families were identified. Atotal of 84species in 2013 28.25% belong to Passeridae28.3 followed by Ploceidae 16.34%, Columbidae 8.9%,Ardeidae 5.8%, Estrildidae 5.38%, Sturnidae 3.72%, Alaudidae 3.36% Apodidae 3% Motacillidae 3%, Meropidae 2.94%,Accipitridae 2.92%, Scolopacidae 2.4%, Charadiidae 1.6%, Coliidae 1.4%, Ciconidae 1.3%, Anatidae 1.2%, Pycnontidae 1.2%,Threskiornithidae 0.9%, Recurvirostridae 0.8%, Turdidae 0.7%,Psittacidae 0.5%, Upupidae 0.5%, Coraciidae 0.4%, phalacrocoracidae 0.3%, Laridae 0.3%, Petroclidae 0.3%, Caprimulgidae 0.3%, Timaliidae 0.3%, Laniidae 0.3%, Pelecanidae 0.2%, Cuculidae 0.2%, Dicruridae 0.2%, Alcedinidae 0.05%, Bucerotidae 0.1%, Alcedinidae 0.05% in table(Xb). The number of families and species recorded in the Khartoum State during study period in 2013 and 2014 table(XIa).

Table(Xb):The percentage of bird families and species number during study period in April to November 2013 in Khartoum State

Family	Number of Species	Total Number of Species in study area	Percentage of number of Families/total number of birds %
Pelecanidae	1	13	0.2
phalacrocoracidae	1	20	0.3
Ardeidae	5	384	5.8
Ciconidae	3	89	1.3
Threskiornithidae	4	62	0.9
Anatidae	1	79	1.2
Accipitridae	1	189	2.9
Charadiidae	2	105	1.6
Scolopacidae	6	157	2.4
Recurvirostridae	1	50	0.8
Laridae	1	23	0.3
Petroclidae	1	17	0.3
Columbidae	7	585	8.9
Psittacidae	1	36	0.5
Cuculidae	1	13	0.2
Caprimulgidae	1	23	0.3
Apodidae	2	197	3
Coliidae	1	93	1.4
Alcedinidae	1	3	0.05
Meropidae	3	194	2.9
Coraciidae	2	28	0.4
Upupidae	1	33	0.5
Bucerotidae	1	9	0.1
Alaudidae	5	222	3.4
Hirundinidae	3	27	0.4
Dicruridae	1	13	0.2
Timaliidae	1	23	0.3
Pycnontidae	1	78	1.2

Turdidae	5	44	0.7
Motacillidae	4	195	3
Laniidae	1	24	0.3
Sturnidae	2	246	3.7
Nectariniidae	1	28	0.4
Ploceidae	4	1078	16.3
Passeridae	2	1864	28.3
Estrildidae	6	355	5.38

Table(XIa): Number of families and species recorded in the Khartoum State during April to November 2013 and April to November 2014

Family	Species	
	Scientific common name	English name
Pelecanidae	*Pelican onocrotalus*	White pelican
phalacrocoracidae	*Phalacrocorax africanus*	Long tail cormorant
Ardeidae	*Ardea cinerea*	Grey heron
	Egretta garzetta	Little Egret
	Mesophoyx intermedia	Yellow Billed Egret
	Bubulcus ibis	Cattle Egret
	Egretta alba	Great white Egret
Ciconidae	*Anastomus lamelligerus*	African Open –bill Stork
	Ciconid abdimii	Abdims Stork
	Ciconia ciconia	White Stork
Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis
	Threskiornis aethiopicus	Sacred Ibis
	Platalea alba	African Spoon bill
	Platalea leucorodia	Eurasian Spoonbill
Anatidae	*Spatula clypeata*	Northern Shoveler
Accipitridae	*Milvus migrans*	Black Kite
Charadiidae	Vanellus spinosus	Spur winged Plover
	Vanellus tectus	Black-headed Plover
Scolopacidae	*Actitis hypoleucos*	Common Sandpiper
	Tringa ochropus	Green Sandpiper
	Triinga stagnatilis	Marsh Sand piper
	Tringa glareola	Wood sandpiper
	Gallingo gallingo	Common Snipe
	Calidris minuta	Little Stint
Recurvirostridae	*Himantopus himantopus*	Black winged Stilt

Laridae	*Chlidonias hybrida*	Whiskered tern
Petroclidae	*Pterocles exustus*	Chestnut bellied Sandgrouse
Columbidae	*Columba guinea*	Speckled Pigeon
	Oena capensis	Namaqua Dove
	Streptopelia capicola	Ring –necked Dove
	Streptopelia decipiens	Mourning Dove
	Streptopelia roseogrisea	Pink-headed Dove
	Streptopelia sengalensis	Laughing Dove
	Streptopelia turtur	Turtle Dove
Psittacidae	*Psittacula krameri*	Rose ring parakeet
Cuculidae	*Cuculus canorus*	Common cuckoo
Caprimulgidae	*Caprimulgus climacurus*	Long –tailed Nghtjar
Apodidae	*Apus apus*	Eurasian Swift
	Apus melba	Alpine Swift
Coliidae	*Urocolius macrourus*	Blue- naped Mouse bird
Alcedinidae	*Ceryle rudis*	Pied Kingfisher
Meropidae	*Merops apiaster*	European Bee-eater
	Merops orientalis	Little Green Bee-eater
	Merops pusillus	Little Bee-eater
Coraciidae	*Coracias abyssinicus*	Abyssinian Roller
	Coracias garrulus	Eurasian Roller
Upupidae	*Upupa epops*	Common Hoopoe
Bucerotidae	*Tockus erythrorhynchus*	Red –billed Horn bill
Alaudidae	*Alaemon alaudipes*	Hoopoe lark
	Calandrella brachydactyla	Short –toed Lark
	Eremopterix leucotis	Chestnut- back Sparrow Lark
	Eremopterix nigriceps	White- fronted Sparrow Lark
	Galerida cristata	Crested Lark
Hirundinidae	*Hirundo aethiopica*	Ethiopian Swallow
	Hirundo rustica	Eurassian Swallow
	Riparia riparia	Sand Martin
Dicruridae	*Dicrurus adsimilis*	Drongo
Timaliidae	*Turdoides leucocephalus*	White-headed Babbler
Pycnontidae	*Pycnonotus barbatus*	Common Bulbul
Turdidae	*Cercotrichas galactotes*	Rufous Bush Chat
	Cercotrichas podobe	Black Bush Robin
	Oenanthe deserti	Desert Wheatear
	Oenanthe hispanica	Black-eared Wheatear
	Oenanthe oenanthe	Northern Wheatear
Motacillidae	*Anthus campestris*	Tawny Pipt
	Motacilla alba alba	White wagtail
	Motacilla flava	Yellow Wagtail
	Tmetothylacus tenellus	Golden pipit

Laniidae	*Lanius minor*	Lesser Grey Shrike
Sturnidae	*Lamprotornis chalybaeus* *Lamp rotornis purpuropterus*	Blue -eared Glossy Starling Ruppells Long- tailed Glossy Starling
Nectariniidae	*Nectarinia pulchella*	Beautiful Sun bird
Ploceidae	*Euplectes franciscanus* *Ploceus cucullatus* *Ploceus luteolus* *Ploceus taeniopterus*	Northern Red Bishop Black headed Weaver Little Weaver Northern Masked Weaver
Passeridae	*Passer domesticus* *Passer luteus*	House Sparrow Sudan golden Sparrow
Estrildidae	*Lagonosticta Senegala* *Estrilda rhodopyga* *Uraeginthus bengalis* *Lonchura malabarica* *Vidua chalybeate* *Vidua macroura*	Red billed Fire finch Crimson-rumped Waxbill Red-cheecked Cordon-bleu African Silverbill Village Indigo Bird Pin-tailed Whydah

4.18. Status:

The rare species in the area are Golden pipit, Black head plover,Crimson rumped waxbill, Rufous Bush Chat, Little Weaver, Northern Red Bishop, Ethiopian Swallow,Pied King Fisher, 32species(38.1%) were Palaearctic migrant, 26species(31%) out of 84 species that recorded in study area were resident throughout the study period, 8 species (9.5%) were summer visitor. 8 species (9.5%) vagrant , (7.1%) local migratory and (3.5%) were both palearctic migrant and Resident in table (XIb), and Bird species observed in the study area in table(XIIa).

Table (XIb):Showed the percentage status of birds species in the Khartoum State area during 2013 and 2014

NO	Status	No of species	%
1	Palearctic Migrant(PM)	36	42.9%
2	Resident throughout the study period(R)	26	31%
3	Summer Visitor(SV)	8	9.5%
4	Vagrant(V)	8	9.5%
5	Local Migratory (LM)	6	7.1%
Total		84	100

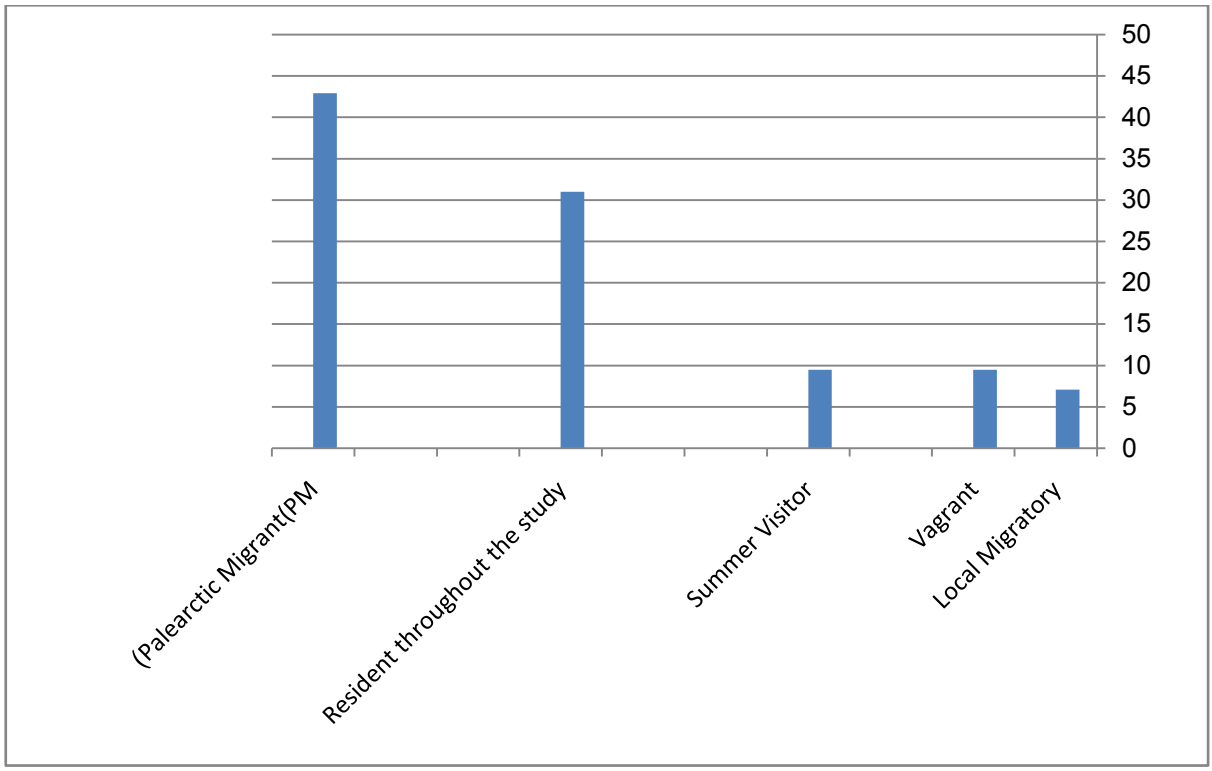


Figure 9:Status of the bird's species in Khartoum study area during the study period 2013 and 2014

Table (XIIa): Bird species observed in the study area: where R = resident (present throughout theyear), LM = local migrant (undergoing distinct seasonal movements within itsdistribution), PM = Palaearctic migrant (non-breeding visitors from the Palaearctic) SV=Summer visitor, V=Vagrant (stray records), Note B+ = Breeding, N=Nest

Common name	Scientific name	status	Note
White Pelican	*Pelican onocrotalus*	PM	
Long tailed cormorant	*Phalacrocorax africanus*	LM	
Grey Heron	*Ardea cinerea*	PM	
Cattle Egreet	*Bubulcus ibis*	PM	NB+
Little Egret	*Egretta garzetta*	PM	NB+
Great White Egret	*Egretta alba*	PM	
Yellow Billed Egret	*Egretta intermedia*	PM	
African Open –bill Stork	*Anastomus lamelligerus*	PM	
Abdims Stork	*Ciconid abdimii*	SV	
White Stork	Ciconia ciconia	PM	
Glossy Ibis	*Plegadis falcinellus*	PM	
Sacred Ibis	*Threskiornis aethiopicus*	LM	
African Spoon bill	*Platalea alba*	LM	
Eurasian Spoonbill	*Platalea leucorodia*	PM	
Northern Shoveler	*Spatula clypeata*	PM	
Black Kite	*Milvus migrans*	R	N
Spur-winged Plover	Vanellus spinosus	PM	NB+
Black –headed Plover	*Vanellus tectus*	V	
Common Sandpiper	*Actitis hypoleucos*	PM	
Wood sandpiper	*Tringa glareola*	PM	
Marsh Sand piper	*Triinga stagnatilis*	PM	
Green Sandpiper	*Tringa ochropus*	PM	
Common Snipe	*Gallingo gallingo*	PM	
Little Stint	*Calidris minuta*	PM	
Black winged Stilt	*Himantopus himantopus*	PM	

Whiskered Tern	*Chlidonias hybrida*	PM	
Chestnut-bellied Sandgrouse	*Pterocles exustus*	R	
Speckled Pigeon	*Columba guinea*	R	
Namaqua Dove	*Oena capensis*	R	N
Mourning Dove	*Streptopelia decipiens*	R	
Ring–necked Dove	*Streptopelia capicola*	R	NB+
Laughing Dove	*Streptopelia sengalensis*	R	NB+
Pink-headed Dove	*Streptopelia roseogrisea*	R	
Turtle Dove	Streptopelia turtur	PM	
Rose-ring Parakeet	*Psittacula krameri*	R	
Common Cuckoo	*Cuculus canorus*	V	
long-tailed Nightjar	*Caprimulgus climacurus*	R	N
Eurasian Swift	*Apus apus*	PM	
Alpine Swift	*Apus melba*	PM	
Blue-napped Mouse bird	*Urocolius macrourus*	R	
Pied Kingfisher	*Ceryle rudis*	V	
European Bee-eater	*Merops apiaster*	PM	
Little Green Bee-eater	*Merops orientalis*	LM	
Little Bee-eater	*Merops pusillus*	R	
Abyssinian Roller	*Coracias abyssinicus*	PM	
Eurasian Roller	*Coracias garrulus*	PM	
Common Hoopoe	*Upupa epops*	R	
Red-billed Hornbill	*Tockus erythrorhynchus*	R	
Hoopoe lark	*Alaemon alaudipes*	R	
Short –toed Lark	*Calandrella brachydactyla*	PM	
Chestnut- back Sparrow Lark	*Eremopterix leucotis*	SV	
White- fronted Sparrow Lark	*Eremopterix nigriceps*	V	
Crested Lark	*Galerida cristata*	R	
Eurassian Swallow	*Hirundo rustica*	PM	
Ethiopian Swallow	*Hirundo aethiopica*	V	
Sand Martin	*Riparia riparia*	PM	
Drongo	*Dicrurus adsimilis*	R	

White headed babbler	*Turdoides leucocephalus*	R	
Common Bulbul	*Pycnonotus barbatus*	R	
Rufous Bush Chat	*Cercotrichas galactotes*	V	
Black Bush Robin	*Cercotrichas podobe*	R	
Desert Wheatear	*Oenanthe deserti*	PM	
Black-eared Wheatear	*Oenanthe hispanica*	PM	
Northern Wheatear	*Oenanthe oenanthe*	PM	
Tawny Pipt	*Anthus campestris*	PM	
White wagtail	*Motacilla alba alba*	PM	
Yellow Wagtail	*Motacilla flava*	PM	
Golden pipit	*Tmetothylacus tenellus*	V	
Lesser Grey Shrike	*Lanius minor*	PM	
Blue -eared Glossy Starling	*La mprotornis chalybaeus*	L LM	
Ruppells-longtailedGlossy Starling	*Lamprotornis purpuropterus*	LM	
Beautiful Sunbird	*Nectarinia pulchella*	R	
Northern Red Bishop	*Euplectes franciscanus*	SV	
Little Weaver	*Ploceus luteolus*	V	
Black headed Weaver	*Ploceus cucullatus*	R	NB+
Northern Masked Weaver	*Ploceus taeniopterus*	SV	NB+
House Sparrow	*Passer domesticus*	R	NB+
Sudan golden Sparrow	*Passer luteus*	SV	
Village Indigo Bird	*Vidua chalybeate*	SV	
Pin-tailed Whydah	*Vidua macroura*	R	
Crimson-rumped Waxbill	*Estrilda rhodopyga*	R	
Red-cheecked Cordon-bleu	*Uraeginthus bengalis*	SV	
Red billed Fire finch	*Lagonosticta Senegala*	SV	
African Silverbill	*Lonchura malabarica*	R	

The nest of Spur-wing Plover with egg in the Soba –ElBagair area

The nest of Spur-wing Plover with young in Soba –ElBagair are

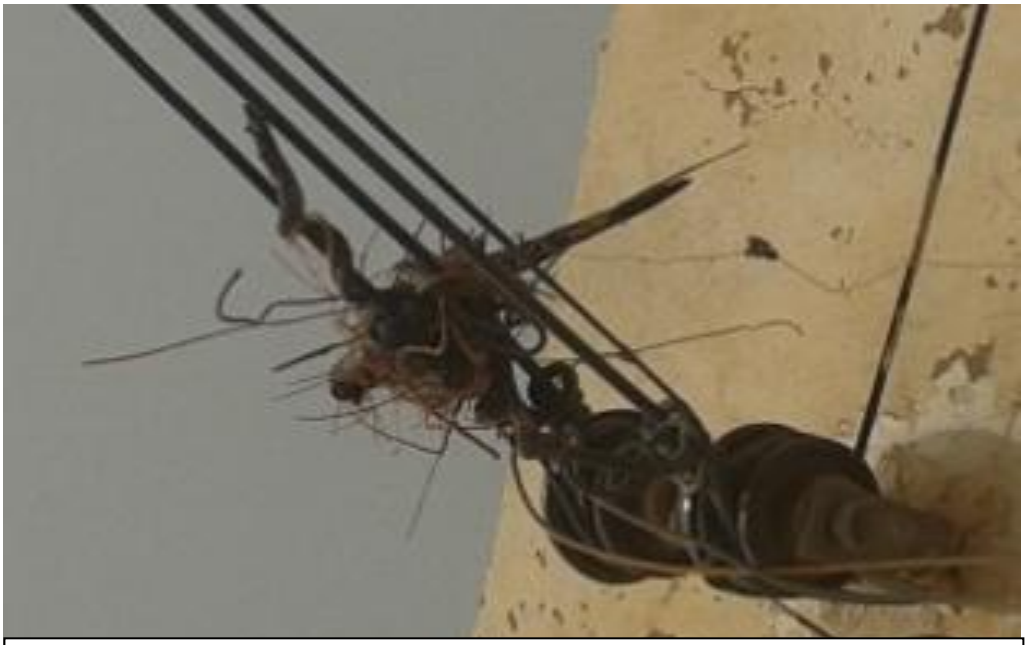
Complete nest of the Village Weavers at a palm tree, *Phoenix dactylifera*

Dead fledgling of the Village Weavers by rainy storm

The nest of White fronted Bulbul *Pycnonotus barbatus* in farm

The nest of the Ring neck dove *Streptopelia capicola* in Farm

The nest of Little Egreet *Egretta garzetta* in the Sunt Forest in Jabal Awlia.



The nest of Namaqua Dove *Oena capensis* with sitting male, the nest was in house in urban area (electricity wire)

The nest of Namaqua Dove *Oena capensis* with sitting female, the nest in house in urban area (electricity wire)

4.19.The avian diversity

Table(XIIb): showed that the species richness(R value) for 2013and 2014are 84 &82, respectively. The value of Shannon index (H') was the same in two years 2013and 2014 (3.27&3.26).The species evenness (E value)for 2013 and 2014were the same (0.738&0.735respectively)

Table(XIIb):Diversity degree for birds species and number seen in Khartoum study area during 2013 and 2014

Seasons	Richness(R)	Shannon index H'=-(∑pi×Ln pi)	Evenness E=(H' /LnR)
2013	84	3.27	0.73815
2014	82	3.26	0.73589

4.20.The avian diversity at sites

The avian diversity at each site was calculated according to Shannon diversity index (Table,XIII and XVa). The species richness (R value) in 2013 was higherthan that of 2014 (i.e. 84 & 82, respectively). The value of Shannon index (*H'*) was highest at two sites Omdurman1 & Omdurman2 in 2013 (3.55 in OM1 and 3.56 in OM2) and in 2014(3.54 in OM1and 3.56in OM2), the lowest value of Shannon index was in Sharq El Neil in 2013and 2014(2.50 and 2.62 respectively).The species evenness (E- value) was highest in OM1& OM2 in 2013 and 2014(OM10.800 and 0.799&OM2 0.804 and 0.805respectively).The lowest species evenness (E value) in Sharq E l Neil was o.564 in 2013 and 0.592 in 2014.

Table (XIII):Location variation in species diversity in study area in Khartoum State in 2013

Study area	Richness(R)	Shannon index H'=-(∑pi×Ln pi)	Evenness E=(H' /LnR)
J W	84	2.98	0.671
S B	84	2.93	0.661
OM1	84	3.55	0.800
OM2	84	3.56	0.804
KH B	84	2.76	0.623
SH E	84	2.50	0.564

Table (XVa): Location variation in species diversity in study area in Khartoum State in 2014

Study area	Richness(R)	Shannon index H'=-(∑pi×Ln pi)	Evenness E=(H' /LnR
J W	82	2.98	0.673
S B	82	2.78	0.628
OM1	82	3.54	0.799
OM2	82	3.57	0.805
KH B	82	2.79	0.630
SH E	82	2.62	0.592

Discussion

The Laughing Dove (Palm dove), *(Streptopelia senegalensis)*, breeds throughout the year (January until late December). There were three breeding attempts throught out the study period ; winter(November, December,January, February), dry season (March, April, May, June), wet season(July, Augusts, September, October).They bred throughout the year because their habitats have microclimate due to presence of river and vegetable farming. With a peak number of nests in wet season(Augusts, September) in(table, II)and (figure, 3and figure,4) due to availability of nesting material,the cultivated land(Sorghum) and a lot of insects bred there,and half ripe grass seeds provided young with food at the time of hatching.

There was another peak in number of nests during winter season(January and February) associated with the abundance and diversity of vegetables especially Tomatoes. But in dry, season the weather conditions has an influence on the reproductive process, e.g intense radiation, the lower vegetations and water in the area.In Africa there some differences in breeding time of the Laughing Dove.In Malawi, breeding occurs in all seasons; in Zimbabwe mainly May-November, with sporading breeding at other times . In South Africa, breeding takes place during August-April and in Egypt between February-June (Etchécopar & Hüe, 1967). In North Africa Hanane *et al*.,(2011) reported the breeding season of approximately six months in Morocco, Boukhriss and Selmi (2009) also reported that the breeding season in Tunisia lasted from February until August.The onset of egg laying, the length of the breeding season, depend on the habitat condition(Perrins and Birkhead 1983). Therefore, the short egg laying period and reduced density of Laughing Dove breeding pairs (Hanane *et al*.,2011) indicate that their study site might not be an optimum habitat for Laughing

dove despite the fact that olive orchards are intensively used by the species for breeding throughout North Africa (Boukhriss and Selmi 2009; Hanane, *et al.*,2011). In India(Sikar) Laughing Doves laid eggs throughout the year(Maha,2014) . Within Australia, breeding of *Streptopelia senegalensis*, is variable according to Desiree (2013).All found extend breeding of Laughing Dove.

Desiree(2013) in Australia hypothesised that whilst the gonadal cycles of Laughing Dove were significantly impacted by "fixed annual factors, including photoperiodic there were effects by environmental factors such as food. Also Frith *et al.*,(1975) recorded that the nutrition levels of urban populations was often above the threshold and that triggers breeding of Laughing Dove.

In the study area a peak of egg laying was delayed some weeks after the commence of the rains(Figure,5 and Figure,6). The rainfall and low temperature significantly affected breeding. Despite the fact that changes in photoperiod are not sufficiently large to be used as breeding signal in the tropics. Generally , breeding of birds depends on synchronizing reproduction with the period of minimum stress on adult and maximum survival of nestlings. In 2013 There was significant difference in the numbers of nests between winter and dry season ($p<0.05$) at level 0.01($P=0.01$), also between wet season and dry season($p<0.05$) at level 0.01 ($p=0.01$), in 2014 there was a significant difference in the number of the nests between winter and dry season also between winter and wet season ($p<0.05$) at level 0.05 ($p=0.05$), also there were significant difference between wet season and dry season ($p<0.05$) at level $P=0.05$.There was significant difference in the numbers of nests between Khartoum and Omdurman ($p<0.05$) at level $P=0.000$, also between Bahari and Omdruman($p<0.05$) at level $P=0.000$.

In 2014 also there was significance difference between Khartoum and Omdurman($p<0.05$) at level P=0.005, also between Bahari and Omdruman ($p<0.05$) at level P=0.005. This was associated with the different types of habitats in Omdurman.The study area in Omdurman1is desert and arid in Omdurman 2 for these reasons there were no nests in(2013) found in the 2014 the highest rate of rains fall (table,(I) and Figure,(6))which were reflected in abundance of half ripe grass seeds and insects which form the diet for young in time of hatching for that reason there were three nests recorded in Omdurman2 near human habitation in the selling point of cattles . Frith *et al.,* (1975) found that Laughing Dove can maintain supply of sufficient food and water to nourish the young in harsh environmental conditions. Klomp (1970) found that the variation of food abundance have been often correlated with the reproductive behaviour of altricial birds.

In Khartoum and Bahari the study areas were semi desert habitat with some vegetation e.g permanent trees and temporary vegetation during the rainy season.

Laughing Dove breeding around human habitation area, is highly adaptively due to present of nest building materials, e.g plastic wire, Najila(*Cynodon dactylon*). In Semidesert area the nest is built only by the dry twigs and wood stick of Kiter *(Acacia mellifera)* ,Tundub *(Capparis deciduas),* and Meskeat *(Prosopis glandulosa)*.This difference in nest materials in the study area is adaptation.Walsh *et al*., (2009) mentioned that birds built nests according to a genetic 'template' with little influenced by learning or memory . In India, patil and Shende (2015) found that Laughing Dove collected soft and semi dried materials like thin grass ,few wood sticks and plastic wires for nest building. The nest contributes to nestling development by holding both the eggs and youngs, conserving the warmth

of eggs and nestling ,concealing egg and nestlings, protecting them from rain and hot sunshine , restraining predator attack. In this study nest building takes 3days, but the environmental conditions e.g., wind velocity , or stormy wind,increased the days takes in building. The nest building takes 2days during the wet season this may be associated with abundance of materials, which was near by to save time and energy . Male and female shared nest building.The same result was reported by Mirzobokhodurov,1974 and Maha,2014 in India.

In study area Laughing Dove bred in some instance in human building and this provide the bird with some protection from predators and supported with sufficient foods.Breeding in some thorny trees also provide protection from predators . Kleindorfer *et al*., (2009) recorded that some species may be able to maintain relatively high nest success by adjusting breeding habitat selection or breeding territory or nest site selection(within patch scale)to avoid area with more predation.This result is consistent with a previous study conducted in the Tadla region (Hanane and Baamal, 2011), as well as with several studies on Columbid species that have examined the relationship between nest location and nesting success [e.g. Laughing Dove (*Streptopelia senegalensis*) (Hanane *et al*. 2011), Mourning Dove (Yahner 1983; Miller and Otis 2010), Zenaida Dove (*Zenaida aurita*) (Rivera-Milán 1996), Common Ground-dove (*Columbina passerine*) (Rivera-Milán 1996), Plain Pigeon (*Patagioenas inornata*) (Rivera-Milán et al. 2003), and Wood Pigeon (*Columba palumbus*) (Hanane and Besnard 2013)].

Also Desiree(2013) found that the ability of the Laughing dove to adapt to human modified habitats has made it a successful urban. It has been adapted by utilising built structures or trees to shelter and nest, and foraging for food stuffs or foods scrap left by people. However its dependence on these urban provisions has limited its spread into natural environments.The same

conclusions reached, because the large number of nests discovered in human modified habitats(table, VIb).

Also the study showed that Laughing Dove preferred thorn tree to nest on it ,Tamrhindi *Pterolobium exosum(*12%*)*Tundub*Capparis deciduas*(10.7%),Sedir *Ziziphaus spinachristi* (10.7%), and Heglieg *Balanites aegyptiaca*(9.3%). Woolfenden and Rohwer(1969) reported that the probability of eggs or entire nests falling to the ground as aresult of wind, rain storms were less in thorn tree. It has been found in some species that the probability of nest predation varies with the species of plant that supports the nest and location of the nest inside the plant or with the features of the immediate area around the nest. Thus, it is widely believed that nest site selection in birds may have evolved mainly as an adaptive response against nest predation(Kelly, 1993). Nevertheless to strengthen the evidence supporting the action of the process of natural selection in shaping nest site preferences it is also necessary to show that some measure of fitness is higher in preferred nest sites (i.e.,that there is an adaptive response). However, this prediction is seldom tested in studies of nest site selection (Clark andShutler, 1999). Most studies of nest site selection have assessed whether there are differences between the general habitat and the portion of the habitat used for nesting, and whether habitat characteristics of successful and unsuccessful nest sites differ (Kelly, 1993). In many species of birds, reproductive success is heavily affected by nest-site choice (Martin and Roper 1988; Lomáscolo et al. 2010; Hanane and Besnard 2013).

According to O'Connor 1984 , the Long Tailed Tit Parus spp breeding success was improved by 12 to 47times by nesting in thorny vegetation which offer protection against predator. Also Runde and Capen (1987) mentioned that quality of nest site can be affected by micro-climate, food availability, and nest predation. However, density of snags and live trees

could also affect risk of nest predation. Probability of predation may decrease with increasing abundance of potential nest sites,because predators must search more empty sites to find an occupied site (Colin *et al*., 1998).

The mean height of nests above the ground level in this present study was 2.49±0.77m. Boukhriss and Selmi, (2009) recorded that nests in Laghing Dove were built at an average height of 2.58 ± 0.09 m.

The lowest recorded nest was one meter above the ground in Meskeat *Prosopis glandulosa*, Tundub *Capparis deciduas*, and highest one was 4m in Nakheel *Phoenix dactylifera* . That mean the habitat condition is the major factors and Laughing Dove will adaptable with the different height of trees which cover the areas.This behaviour may be a response to the height of trees available for nesting which is an important factors affecting nest height in the case of many bird species(Taberner *et al*.,2012; Bensouilah *et al.*,2014). . On the other hand, the Laughing Dove in the study area preferred median part on branches to build the nests to escape inclement weather and avian predators, because this part of the canopy had dense foliage, the same result was found by (Hanane *et al*.,2011).

The clutch size of Laughing Dove in this study were two which was well within the range reported from Africa. Brahmia, *et al*., (2015) in Algeria reported that the clutch size of Laughing Dove was two. Desiree(2013) in Australia recorded that the upper limit of the clutch size is two in Laughing Dove , also Maha (2014) and Patil &Shende(2015) in India they reported that the clutch size in Laughing Dove were two.

Also the same results are reported from another species which belonged to the family columbidae. Robertson, (1990) recorded that the clutch size of the Collared dove in England are two, Seyed Masoud Hosseini *et al*., (2013) in Iran recorded the same result. Brahmia,*et al*., (2015) in

Algeria recorded that the clutch size of Turtle Dove are two. Also the clutch size of Mourning dove are two (Westmoreland *et al*., 1986). Wallace (1963) and Farner(1971) reported that generally birds lay from 1to20 eggs per clutch..

Brooke, (1978) attributed the variations in clutch size to food abundance, habitat and age of breeding birds.Vijayan (1980) observed that the variation in the clutch size is correlated with the availability of food; the larger clutch is laid when the food for young is most abundant. According to lack's hypothesis (Lack,1954) that the clutch is a hereditary characteristic of each species and has evolved through natural selection to correspond with larger number of young for which the parent can, on the average, provide enough food .Roff (1992) observed that the clutch size reduction under high risk of nest predation has been hypothesized to be adaptive for at least these two reasons .

The smallest eggs size were found at site with little food (semidesert area) but the largest eggs size were found in human habitation(trees or building eaves) where food was abundant. O'Connor(1984) stated that eggs are smaller whenever a female has difficulty in acquiring enough food for egg formation, and are larger in good feeding condition.Takagi (2003) stated that the natural selection should favour females that produce larger eggs. According to Horak *et al*., (1995) high investment into egg size might be in conflict with energetic demands of female and her willingness to produce more off spring. The variation in eggs quality and size is probably due to the type and quantity of food. Martin (1987) considerd that the correlation of egg quality with food abundance is a direct measure of energy limit, since the egg quality can affect hatching success and survival of young, egg size and quality have been found to increase with food abundance in some altricial species.

The mean shape index of Laughing Dove was found to be 76.95%, and the mean of egg weight was 5.02g . Seyed Masoud Hosseini *et al*., (2013) reported that the shape index of Collared dove(*Streptopelia decaocto*)was75.77 and the mean of egg weight was 8.64g. Reddy *et al.*, (1979) observed that there was an adverse relation between decreased shape index and increasing egg weight .The mean egg shape does not differ significantly in different months (Patel, 1986). The shape index depended on weight. A positive correlation between egg size (weight or an index of volume derived from the breadth and length of eggs), and nesting survival, or growth, has been found for most bird species studied by Schif ferli (1973).

Seyed Masoud Hosseini, *et al*., (2013) reported that the K-value constant coefficient value of the Collared Dove was 0.4866 (0.506), and the K-value of Laughing Dove in this study was 0.505

Also there were different in shape of eggs in the study area . Romanoff, A. L. and A. Romanoff,(1949) reported that the shape of the egg is recognizable species characteristic, species lay egg diverge widely from oval to conical shape, with one end rounded and the other more pointed ,or two rounded end as my observation especially in semidesert areas

Deeming and Ferguson (1991) suggested that evolution played a factor in determining the shape of avian eggs . They related the diversity of eggs shape to the need to: maintain surface to volume ratios; prevent rolling off the eggs ; increase the volume of eggs, in addition, elongated eggs facilitate the passage through the pelvis due to small diameter per unit volume and the resultant increase in the surface areas of eggs contributes to the respiration of embryo .

In this study the correlation between egg length and egg weight and between egg breadth and egg weight was found to be statistically significant ($p<0.05$). Egg weight and shell thickness were statistically insignificant ($p>0.05$).The eggshell resist incidental traumas received in the nest.Egg shape and structure both contribute to eggs shell strength. The egg shell may be thick or thin depending on the species and the subsequent incubation behaviour. Sandpipers and Doves because they have the thinnest shelled eggs they incubate it constantly to protect it from mechanical hazards, Woodpeckers lay eggs with transparent shells because the ants they feed on are rich in formic acid Welty,(1975).

There were three sub species of *Streptopelia senegalensis* the measurement of eggs length width and weight; *S s. phoenicophila* ; 27 ×21 mm (26-29)×(19-22) n=8 calculated weight 6g . S.s aegyptica; 26×20mm(24-28×19-21) n=40 calculated weight 5 g . (Schonwetter1967) *S.s ermanni*; 25-32× 20-32mm weight 4.4-8.4g n=157 (Kekilova1973) . In this study the measurement of eggs is typical with the sub species *S.s aegyptica* which were distributed in Nile valley. The measurement of eggs in this study was, 25.6×19.7mm(23.9-28×18.9-20.8) n=30, weight 5g.

Assessment of mineralogical content of Laughing Dove egg shells (Calcium, Magnesium, Iron,and Zinc) in two different habitat (natural habitat and man made habitat) in concenteration of these minerals was insignificant ($p>0.05$).

This result can not explain the difference in colour between natural habitat and in man made habitat,due to feeding habitat area. In study area these difference in colour may be according to the difference in environmental condition in man made habitat the nest almost in shading site and the incubation were continuosly, but in natural habitat the nest in direct

sunlight site for that the nest was left in the midday as my observation . Researchers have proposed two primary functions of egg colouration. When in direct sunlight, uniformly light-colored eggs are less likely to overheat than darker eggs (Montevecchi ,1976a) because light colors generally reflect solar radiation more efficiently. Columbid parents incubate continuously (Kendeigh, 1952), so white eggs and constant incubation make columbids ideal for studies of egg coloration. Columbids may have evolved constant incubation to cover their white eggs, aspects of columbid incubation behavior suggest that continuous incubation evolved, at least partially, as a mechanism to reduce the conspicuousness of white eggs. Constant incubation also eliminates the need for incubation patches in adults, and minimizes the negative effect of conspicuous egg coloration. Hanley, (2012) found suggestive evidence that eggshell pigments could be adapted to protect the embryo from harmful solar radiation.This has important implications for employing eggshell pigmentation as a non-destructive indicator, future investigations of the hypothesis that eggshell pigments protect the developing embryo from solar radiation would benefit form careful experimentation on the influence of light transmission on embryonic growth and development (Hanley,2012) .

brightness were the most heritable aspects of eggshell colouration (Morales, *et al.*, 2010).These investigations establish that there is a genetic component to egg colouration on which selection may operate, despite there also being a significant environmental component (Avilés *et al*., 2007; Jagannath *et al.*,, 2008; Morales *et al*., 2011).

In this study the concentration of lead(Pb) in egg shells and cobalt (Co) in egg shells which detected in semidesert habitat , in a few level that mean there was no environmental contaminants in the semidesert habitat (pollution has no effect in egg shells colour in semidesert habitat).

Hanley,(2012) found that environmental contaminants have a significant influence on egg colour .

The incubation period in this study was 12-14days, (average 13 days) . Tarakini and Gamundani. (2013) found that the incubation period in Laughing Dove ranged from 11-14days. Male and female shared the incubation period this species is monogamous .With my observation during the study period, the nesting bird would suddenly fly off and within seconds the other would fly in these happened already in many times of day the same result was found by (Wee , 2005). The incubation duration increasing at night, obviously to shield eggs from low temperature. Incubation was carried by females only at night . Earlier observations of a nesting pair of pink-necked green Pigeons (*Treron vernans*) showed that the male took on the day duty while the female, the night shift (Wee, 2005). duration of incubation may be reduced as adults spent more time on the nest, but time available for foraging reduced by spending more time incubating(Martin, 1987). In this study incubation was almost continuous near hatching time even if there were strong wind,because the birds invested much in their eggs. Walsberg and Voss-Roberts(1983), reported that when they were approached, incubating Mourning Doves crouch on the nest and do not flush until almost in contact with the intruder, this is similar to my observation during incubation period .

Patel(1986) reported that the length of incubation period is dependent upon the ambient air temperature and the nestling period upon the light hours. Elshiekh(2007)mentioned that short period of incubation can be beneficial because the probability of weight on both eggs and young increases with exposure time. However, the extent of reserve depletion during incubation will vary among groups of birds. Birds with precocial young that do not use energy to feed their young after hatching may deplete

their energy reserves during egg production and incubate much more than the birds with altricial young (Martin1987).Hassan (2001) said abandonment of nests by emaciated females and mortality due to starvation by incubating females are generally reported for precocial rather than altricial birds. Yet, in both groups of birds, attentiveness to the nest during incubation should increase with the increase in body reserves or greater provisioning by mates in such a way that incubation is shorter and hatching success is higher(Martin,1987).

In semidesert area during incubation period parents did not sit on egg continuosouly in midday because they exposure to high temperature,for they building the nest in dead tree with no leaves cover it, or in plant with no dense leaves like Usher(*Calotropis Procera*). Elshiekh(2007) showed that , birds that nest in harsh environmental conditions expose their egg to these condition every time they leave the nest. Hatching success is influenced by the temperature of eggs during incubation, as a result in poor condition. Females that must leave the nest more often to forage thus increase the probability of temperature variation which may reduce hatching.

The young fledge and leave the nest after about 12-16 days with an averge of 14 days. But nestling will be in the nest area about 4-6 days after fledging, if the area around the nest site was suitable .The young fledge and leave the nest after about 14 to 16 days, independent 4-7days later (Manakadan.1995 ;George and John ,2000). In one case in this study the nestling fledged in ten days. This may be due to the presence of the domestic cat around the nest site. The same result was recorded by (Geissler *et al*., 1987, Westmoreland and Best, 1985). The nestling period probably depended up on the number of young in a brood, productivity of the habitat, nest height and age of parents (Dhanda and Dhindsa1998)

All the adult in family Columbidae, soon after hatching of the egg seen nodding its head and feeding the chicks with crop milk. This is a protein-rich secretion that needs no diet supplement like insects and allows the chicks to develop and fledge in a relatively short time, thus reducing the most vulnerable period in the life cycle (Gibbs *et al*., 2001). Ashmole&Tovar(1968)suggested that prolonged parental care is developed in species in which the young might require an extended amount of time in learning foraging skills.

The development varies with the young the two nestling were not similar one was fater than the other one, the oldest one which was fater take care about the arrival of his parent and begged vigrously.

The nesting success in 2013 in Khartoum was 42.1% and in Bahari was 37.9%. In 2014 the nesting success were higher in Khartoum was 47.8% and in Bahari was 48.3%. As the result showed that there were no differences between two localites (Khartoum and Bahari) because the two localites extended in the range of the semidesert area for that there were similar in rain amount , and in the degree of temperature and in the velocity of wind(table, I) , Also the vegetation covered the area and the kinds of predation between the two towns(Khartoum and Bahari) were similar. But in 2014 the nesting success was higher than 2013, the highest rate of rains fall (Figure, 6) and the extended of rainy season until the October which reflect to abundance of nesting materials, half ripe grass seeds and insects which form the diet for young in time of hatching . Newton (1964) reported that the year to year variation in the breeding season .Other studies have also shown that breeding success is linked to availability of nesting habitat (Drobney *et al*. 1998; Browne *et al.* 2005) and season (Lepage *et al*. 2000; Herényi *et al*. 2014). Nest survival differed between years and nesting stages(Boukhrissand Selmi 2009; Khoury, Janaydeh, and Al-Hmoud 2009;

Bensouilah *et al*. 2014). Hanane and Baamal (2011)reported that nest survival of the Turtle Dove varied greatly from year to year. In addition, other researchers found that the type of habitat(Khoury, Janaydeh, and Al-Hmoud 2009; Hanane and Baamal, 2011) and microhabitat selection (Wilson and Cooper 1998) had great impact on nest survival which differed between years and nesting stages.

Also Ali,(1930) noted that out of six nests of *P. cafer* under his observation none produced a fledgling that flew. It might be depending on place, time, environmental conditions and parents care, etc

In the study area there were two reasons effecting the breeding success.The first reason was inclement weather (heavy and stormy rains and wind) in wet season , wind velocity and stormy wind in winter season. The second reason was predation of the egg and nestling. This will be actively in some cases especially, the nest in low height in trees, the site with no dense leaf concealing the nest.With my observation that the type of habitat and microhabitat selection had great impact on nest survival,for example the most important site which was located in man made structure or dense folige trees with great height which was protected from rain, wind, predation . Predation may also increase in lower nests (Monkkonen *et al*., 2007). These predators may be able to reach lower nests more easily and provide parent birds less time to detect and perhaps dislodge climbing nest predators (Nilsson, 1984). Ability to detect and attack predators may also be reduced by dense foliage near the cavity (Finch,1989).Conversely, dense foliage near nests may reduce predation by concealing the nest (Martin 1993). Nest predation is usually the main cause of chick mortality (Mezquid and Marone, 2002). Nest predation is usually the primary source of nest mortality for both open – and cavity –nesting birds(Nilsson, 1984) .

O'Connor, (1984) recorded that the extent of distribution of nests are mainly affected by predation. The solitary well hidden nests and the nests which was higher were difficult to attack due to inaccessibility.Desiree (2013) recorded that the environmental factors, predation and sometimes dearth of food etc. are responsible for lower breeding success of *S. senegalensis*.. Maha, (2014) reported that high wind velocity, heavy rainfall as well as predators were responsible for average hatching success Laughing Dove. The main cause of mortality in Morning Dove were storm wind,strong wind, and rain, or snow, (Jonathan and Armbruster, 1994;Coon *et al*., 1981).

The most important predators in the study area was snake. Which was seen several times in study area. Snake may arguably be the most important avian predators in the semidesert area. It is known that snake activity is more important during the summer months (dry season),this agrees with the findings of Sperry *et al*., (2008). Peak, (2007) reported that the number of chicks fledged per nest could reflect a change in predator activity over the course of the breeding season . Also Boukhriss and Selmi (2009) found that predation level by snakes seems to be higher near oasis edges, where the environment is more open and sunny, facilitating the activity of reptiles. Aside from birds, mammals and reptiles are important nest predators of birds.(Ricklefs, 1969; Bosque and Bosque 1995; Weatherhead and Blouin-Demers 2004;Sinclair *et al*., 2005; Cain *et al*., 2006). AlsoWeatherhead and Blouin-Demers, (2004)found that Snakes the most important avian nest predators in some parts of the world.

In this study the Laughing Dove in suitable site reused the same nest several times during the breeding season raised up to fourth broods. The

same result was recorded by Blockstein *et al.*, (1986) they recorded that Mourning doves *Streptopelia capicola* are well adapted for multiple brooding(4 to 6) broods because they produce food(crop milk) for young nestling and feed older nestling. Other factors such as fast nestling growth, fledging at low weight and small clutch size allow females to initiate new clutches.

Monrthly number of birds recorded

There were noticeable changes in the bird species in the study area between dry season (April-May) and wet season (June –October). There is little doubt that these changes were associated with the climatic changes. From the onest of rains (in 2013, 4987 individuals were recorded during the wet season and only 884 individuals were recorded during the dry season. In 2014,6575 individuals were recorded during the wet season and only 1332 individuals were recorded during the dry season) (table,VIIb). It is probably that habitats, in the study area flourished during the rainy season and became attractive to birds. During the rainy (September to October) palearctic species arrived in the area . There were an increase in numbers of individual species as far as migratory birds are concerned. Some species bred in area. Presumably the area had satisfied two basic requirements for these birds .First,availability of potential nesting sites and nesting materials . Second probably there is increase in insect, fish, amphibian and worms and cultivated land (Sorghum) and vegetable farming . Some of the passage migratory birds used the banks of the rivers and the woodland as stop-over places to rest and feed (36species was palearctic migrants ,6 species local migratory and 8species summer visitor).

Migration is particularly well developed in the cold and temperate regions of the northern hemisphere, where strongly marked seasonal climatic

changes force most birds to seek refuge during the winter in more hospitable regions (Dorst, 1962).

Seasonal changes in the bird fauna there seemed likely to occur as a consequence of the migratory habits of different species (Hamed, 1998). Factors responsible for changes in bird population densities and local distribution include climatic and /or resource variation on a local regional or contiuental scale (Blake, *et al*., 1994), inter-spcific competition, density fluctuations of predators and changes in the type, amount and spatial configuration of available habitat(Holmes and Sherry.2001).

Hamed and Evans (1982) observed similar pattern at Hantoub Sudan, also Hamed (1994) found a similar pattern at Dinder National Park.

Change in species composition occur because resident and migrant species contribute in varying proportions at different periods of the year (Avery and Van Ribber, 1989). Some resident African birds also migrate from one part of the continent to another. The large number of African birds have regular seasonal movements within the continent always coinciding with the rainy season (Hamed and Evans, 1982).

Greig-Smith (1980) provides evidence that birds inhabiting such habitats (Savannah) tend to have local migration. He reports that Savannah bird species in west Africa are wide ranging in their habitats and attributed this to the patchy distribution of food in such places

Dodman and Diagana (2006) considerd intra-Africa migration as 'the movement of birds within Africa according to continental weather patterns, especially rainfall. Nomadism is displayed by animals that move irregularly. Nomads are wanderers, though their movements away from and to particular areas may be predictable, usually relating to climatic conditions. Afew species such as Abdim's Stork (*Ciconia abdimi*) come to the Sudan from central Africa to breed during the rainy season.

During this study, over all 84 bird species were recorded in study area .Among the recorded species, total of 36 species were palearctic migrants 26 species resident throughout of study period 8Summer visitor 8 vagrant,and 6 local migrant, throughout the study period

according to Huyam *et al*., 2012 over all 87 bird species were recorded in Al-Sunut Forest in Khartoum State. Among the recorded species, 50 were palearctic migrants, 8were local migrants and 29 species were resident. (Lado 1994; Abd-Alrahman,1998) recorded that; Al – Sunut forest contains at least 70 species (among which 26 are migrants).

The species richness (R value) for 2013(84) was almost similar to year 2014(82). This study showed that the value of Shannon diversity indices for avian species in 2013 was (3.26) and in 2014was (3.27), while the species evenness (E value) for 2013 (0.735) was similar to 2014(0.738) (table, XIIb) Because there were no changes in environmental condition in these two years,for that there were similar in two value in the two years (table,(I) and Figures,(5) and (6)

The Shannon diversity indices in six point which were studied in two seasons(2013 and 2014) in the study area(table,(XIII) and table, (XVa) . The study showed that the value of Shannon diversity indices for avian species were highest in Omdurman1 and Omdurman2 in 2013 and 2014 in Om1(3.55and 3.54) and in Om2(3.56 and 3.57) respectively . Because the marked variation in birds community structure in Omdurman1and Omdurman2 suggest that existence of considerable habitat variability that affects bird communities at the two sites. The most important habitat difference regards the floral structure; in Sunut forest, one tree species, *Acacia nilotica*, dominates the plant cover. The direct influence of ponds in Al Sunut forest with shallow water depth are ecologically important for

water birds(the highest water bird speces 22 species during study period in (table,IXb and Xa) in Omdurman1and Omdurman2) . ponds waters provide rich new food sources for many water birds, as dwelling invertebrates and nutrient loads become exposed. As waters gradually recede, feeding conditions are optimal at water edge where waders densities increase .This attributed to the Palearctic and local migrants that visits the area. The area Omdurman1 and Omdurman2 were surrounded by agricultural fields where vegetables were grown. It is widely accepted that the number of waterbirds using a wetland site is a good indicators of that site's biological importance (Scott,1980).Bird count can also provide vital evidence for the protection of wetlands should they become threatened. Kushlan(1993) assessed the value of waterbirds as bio–indicators of wetland change, and one of his conclusions was that "population level data show special promise as sentinel bio-indicators).

The Shannon diversity indices for avian species.was2.98 in Jabal Awlia Dam,there was a noticable increase in number of individuals of some species during the wet season . Particularly the number of Ardeidae (Cattle egret , Little egret , Great white egret),the aviafauna at the Sunut woodland surrounding the dam was found to show considerable temporal fluctuations with respect to the abundance and species diversity. These variations can be attributed to two main factors first, the seasonal change in water availability which is associated with the Nile flood, this change influences both vegetation cover and insect density at the woodland , and thus affects the attractiveness of the site for bird First highly diversity of flora presenting abundance of potential nesting sites and nesting material. Second a lot of insect, fish, amphibian and worms. Mac Nally, 1996and Yahner, 1997 found similar result in their study . The change in of microhabitat variables such as vegetation was clear, the seeds, seedling ,roots, stems, leaves, vegetable all of them are important food source for

different species of waterbirds, as , well as insect, worm, frogs, snakes,and invertebrates which appertain to vegetation (David,*etal*.,2002; Samuel *et al*.,2001,Robert,*et al*., 2002).

This study showed that the value of Shannon diversity indices for avian species in Soba- Elbagair was (2.93).This value may be attribute to the intensive farming around the reserve as a result of its good breeding sites, Factors that promoted the high diversity include a wide variety of resources, high productivity and moderate levels of predation. But one of the most important factor observed the moderate levels of disturbances from outside the community. This may be because of the different plant species precisely their fruits, seeds, leaves and grasses.The arboretum in this area were important to some insects. Also Ezealor (2002) reported that the arboretum serves as a suitable feeding, nesting and breeding habitats. Also the area had density in vegetation cover. Vegetation cover is known to have a strong influence on the avifauna (Scott Mills *et al*., 1989), it is expected that the bird diversity became richer. the flora is much more diverse and complex, containing variable trees, shrubs and grasses. This difference implies that Soba –El Bagair wider range of microhabitats for different species of birds and hence the higher species richness. Another important habitat difference is that the extensive agricultural activity at Soba-ElBagair leads to higher food availability for resident and migrating birds more attractive for both seed-eating and insect-eating birds. Then the point of Khartoum Bahari was (2.79). The last point in Sharq El Nile was(2.62) more heterogeneous and diverse plant cover the study area, thus attracting birds with variable feeding habits and life styles. The availability of food sources causes the higher bird abundance but it also leads to the lower species evenness at the site; agriculture favors particular species of birds (e.g. insectivorous, granivorous species) thus driving these species toward large population.

In the study area the high numbers of birds was recorded in family Passeridae ,House Sparrow,Sudan golden Sparrow (28.3%) which included the highest number of birds in urban area,House sparrow. Harney(2014) reported that, many species of birds may be forced to inhabit the urban areas, they have adapted well to the rapid urbanization and growth in human population.The House Sparrow is now established as cosmopolitan species(Mala Ramesh *et al*., 2014). Many bird species have expanded their home ranges because of their ability to exploit landscape transformed by humans and thus have become more widespread and abundant (Akogwu,2012).In general, these studies illustrate that increased urbanization leads to a reduction in species richness and increases in avian biomass (Chace and Walsh,2006). The second family Ploceidae(16.3%) which included Northern Red Bishop,Black headed Weaver, Little Weaver and Northern Masked Weaver. There were high number of Black headed Weavers and Northern Masked Weavers in agriculture fields and farms or near water source, also its tendency to dwell among human habitations, from which it may gain some protection from predators.They formed larger colony , and numerous nests may placed very close to each other. The study area was covered by grass species which provided seeds for birds and nestling, and some species of trees which provided some materials for example Palm trees,*Phoenix dactylifera* or Nagela,*Cynodon dadylon*, also they were used some trees as nesting site for example Ban *Eucalyptus sp* , Mahogany *Khaya senegalensis*,and Meskate, *Prosopis sp*.and Sunut tree *Acacia nilotica* in which their nests were hanging over the water .

The Columbidae (8.9%) which were included a lot of species : Speckled Pigeon, Namaqua Dove, Ring –necked Dove,Mourning Dove,Pink-headed Dove,Laughing Dove, Turtle Dove.

The Laughing Dove which has the largest number and wide distribution, Mourning Dove which was found around human habitation in urban area , Namaqua Dove and Ring –necked Dove which were found in farm land mainly or semi desert area with scattered vegetation.And Speckled Pigeon which was seen in semi desert area around human habitation, all these species were sedentary , but the Pink-headed Dove has seasonal movements during the rainy season.

The family Ardeidae (5.8%) , which were included :Little Egret, Cattle Egret and Great white Egret, were seen in large numbers in the Forest of Jabal Awlia dam. They were breeding colonially in the forest in wet season, with open nest on AlSunut tree *Acacia nilotica* . There were sufficient cultivation in the area that provides grass seeds and insects. The Yellow billed Egret which were seen only in Omdurman1 and Omdurman2, Grey heron which were seen in few numbers in Om1 and Jabal Awlia area.

Estrildidae(5.3%) Red billed Fire finch, Crimson-rumped Waxbill,Red-cheecked Cordon-bleu,African Silverbill,Village Indigo Bird and Pin-tailed Whydah , were seen in large numbers in farmland. This may be as a result of the growth of secondary species, such as succession plants which are known to provide insects and other food and shelter for variety of birds species. Thus, great abundance of species may be attributed to these well vegetated edges which provided additional resources such as food and cover.

There were sufficient cultivation in the area that provides grass, seeds and insects to support large numbers of birds. This suggests that the availability of nesting site is one of the principal factors that determine the structure of bird community in agricultural landscape(Soderstrom *et al*, 2003and Soule,1988).Field observation showed that high population of

granivores and omnivores were mostly recorded in the farmlands. (Usher, 1991)

Further surveys were needed on species and diversity of birds and their habitat in Khartoum State .The study emphasized the need for more field work on breeding biology of Khartoum birds.

Conclusions

The main findings of this present study are

1. The Laughing dove (*Streptopelia Senegalensis*) started their breeding cycle from January to December in 2013&2014.

2. They bred solitary at tree or at building eaves around human habitation. The nest was built of stem or stick or wire of plastic

3. The Laughing dove (*Streptopelia Senegalensis)* in Sudan has preference for certain plant species as nesting Tamrhindi *Pterolobium exosum*. Tundub, *Capparis deciduas*. Sedir, *Ziziphaus spinachristi* Heglieg, *Balanites aegyptiaca*

4. Both sexes share in the breeding activities and lay 2 eggs

5.Incubation period lasted 12-14 days, and the mean time from hatching to fledging was found to be 12-16 days.

6. Chick are altricial, hatched naked , blind. They stay in the nest and depend on their parents for food and protection.

7. Breeding success was moderate. The percentage of nesting success in the first breeding season (2013) was 42.1 % and the fledgling success was 42.1% in Khartoum based on 8 nests studied carefully, the percentage of nesting success in the first breeding season (2013) was 37.9 % and the fledgling success was37.9% in Bahari based on 6 nests studied carefully. In the second breeding season (2014) the percentage of nesting success was 47.8% and the fledgling success was 47.8%in Khartoum based on 11nests studied carefully, and the percentage of nesting success in Bahary was 48.3% and the fledgling success was48.3% based on 8 nests, in Omdurman the percentage of nesting success was 40% and the fledgling success

was40% based on 3nests.The high number of nests were in wet season and winter.

8. Wetlands in Khartoum State area take two forms, The Jabal Awlia dam and the second water pools at the right side of the extention of these two sites in Omdurman which passed through the new White Nile Bridge which was constructed as reclamation of the Sunt Forest land.

9. Total of 84 species in 2013 and 82 species in 2014belong to 36 families

10.Six rare species were recorded during the study period, these were Golden pipit, Pied kingfisher, Speckled pigeon, Hoopoe lark l, White Fronted sparrow lark.

11. Some species were recorded breeding in Khartoum State.

12. Khartoum State (Jabal Awlia dam and a part of AlSunt Forest) are very important habitat for water birds due to availability of water and food, there were experienced considerable temporal variations in bird diversity and abundance, the two sites considered as an important sites for some migratory birds

Recommendations

The following recommendations are suggested.

1. The study emphasized the need for more field work on the breeding biology of Khartoum birds.

2.Additional studies were also needed on the rare species

3. Further surveys were needed on species and diversity of birds.and their habitat in Khartoum State

5.Dialogue should be initiated between the Wildlife Administration , local communities, environmentalists and corporate bodies operating in the Khartoum State, as a confidence building measure.

6.Effect of disturbance by man of nesting success and need further research in the study aeas.

7.Conservation awareness should be raised among s to alleviate birds especially family Columbidae, nest site to compensate for the destruction of nesting trees for furniture or building purposes. Nowdays the environmental Changes, influence the distrbution of birds in natural habitat and their breeding for example they are new species invade urban area African Silverbill and Namaqua dove.

8. to translate scientific knowledge into conservation action for bird species and breeding success.

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Appendices

Appendix Table 1 Number of different species of bird composition at Jabal Awlia between April to November 2013 and April to November 2014

Common name	Scientific name	2013								2014							
		Apr	May	Jun	July	Aug	Sep	Oct	Nov	Apr	May	Jun	July	Aug	Sep	Oct	Nov
White Pelican	*Pelican onocrotalus*	0	0	0	0	3	2	0	0	0	0	0	3	6	5	2	0
Long tailed cormorant	*Phalacrocorax africanus*	2	1	0	0	0	0	0	0	3	6	0	0	0	0	0	0
Grey Heron	*Ardea cinerea*	1	2	0	0	0	0	2	0	3	5	0	0	0	0	3	1
Cattle Egreet	*Bubulcus ibis*	0	1	3	13	15	23	17	3	5	5	15	18	35	29	32	2
Little Egret	*Egretta garzetta*	6	5	9	16	27	14	6	1	9	12	27	40	38	21	8	0
Great White Egret	*Egretta alba*	4	2	1	10	9	6	2	1	2	6	9	11	14	4	1	0
Yellow Billed Egret	*Egretta intermedia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Open –bill Stork	*Anastomus lamelligerus*	7	5	0	0	0	0	0	0	9	4	0	0	0	0	0	0
Abdims Stork	*Ciconid abdimii*	4	0	5	2	0	0	0	0	5	0	1	7	4	0	0	0
White Stork	Ciconia ciconia	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0
Glossy Ibis	*Plegadisfalcinellus*	0	0	0	2	3	0	0	0	0	0	0	2	4	0	0	0
Sacred Ibis	*Threskiornis aethiopicus*	1	0	0	2	4	2	0	0	0	0	0	3	5	2	0	0
African Spoon bill	*Platalea alba*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurasian Spoonbill	*Platalea leucorodia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern	*Spatulaclype*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Shoveler	*ata*																
Black Kite	*Milvusmigrans*	4	5	3	4	2	10	8	9	7	5	6	9	11	10	5	6
Spur-winged Plover	Vanellus spinosus	1	4	1	6	3	1	0	0	1	2	3	5	7	1	0	0
Black – headed Plover	*Vanellus tectus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Sandpiper	*Actitis hypoleucos*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood sandpiper	*Tringa glareola*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marsh Sand piper	*Triinga stagnatilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green Sandpiper	*Tringa ochropus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Snipe	*Gallingo gallingo*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Stint	*Calidris minuta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black winged Stilt	*Himantopus himantopus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Whiskered Tern	*Chlidonias hybrida*	2	0	0	0	0	2	2	0	0	2	0	0	0	2	0	0
Chestnut-bellied Sandgrouse	*Pterocles exustus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speckled Pigeon	*Columba guinea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Namaqua Dove	*Oena capensis*	8	3	0	3	0	2	0	0	15	2	6	0	8	5	2	3
Mourning Dove	*Streptopelia decipiens*	2	0	0	0	0	3	2	1	0	2	1	0	4	1	2	0
Ring–necked Dove	*Streptopelia capicola*	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0
Laughing Dove	*Streptopelia sengalensis*	11	5	4	8	6	11	7	8	11	8	3	10	15	13	11	8
Pink-headed	*Streptopelia*	2	1	0	0	0	0	2	4	6	1	4	0	2	0	2	5

Dove	*roseogrisea*																
Turtle Dove	Streptopelia turtur	0	0	0	0	0	0	0	3	0	0	0	0	0	3	1	0
Rose-ring Parakeet	*Psittacula krameri*	0	0	0	0	0	4	3	0	2	0	0	0	0	4	2	0
Common Cuckoo	*Cuculus canorus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
long-tailed Nightjar	*Caprimulgus climacurus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurasian Swift	*Apus apus*	12	0	0	0	9	18	4	0	13	10	0	11	20	8	3	3
Alpine Swift	*Apus melba*	0	0	0	0	0	0	14	7	6	0	0	0	0	0	13	12
Blue-napped Mouse bird	*Urocolius macrourus*	3	0	0	0	4	0	0	3	5	0	3	0	0	2	0	4
Pied Kingfisher	*Ceryle rudis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
European Bee-eater	*Merops apiaster*	0	0	0	0	0	35	20	0	28	0	0	0	0	35	32	0
Little Green Bee-eater	*Merops orientalis*	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0	0
Little Bee-eater	*Merops pusillus*	2	0	2	0	0	0	0	3	0	3	0	4	0	2	0	0
Abyssinian Roller	*Coracias abyssinicus*	0	0	0	1	3	6	1	0	0	0	0	1	9	3	3	0
Eurasian Roller	*Coracias garrulus*	0	0	0	1	2	4	0	0	0	0	0	1	6	4	1	0
Common Hoopoe	*Upupa epops*	1	0	0	0	2	3	0	1	2	0	0	0	4	2	2	0
Red-billed Hornbill	*Tockus erythrorhynchus*	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0
Hoopoe lark	*Alaemon alaudipes*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short –toed Lark	*Calandrella brachydactyla*	0	0	0	0	0	0	11	9	0	0	0	0	0	0	9	6
Chestnut-back	*Eremopterix leucotis*	0	0	0	0	7	8	0	0	0	0	0	9	5	0	0	0

Sparrow Lark																	
White-fronted Sparrow Lark	*Eremopterix nigriceps*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crested Lark	*Galerida cristata*	2	0	1	0	0	1	0	0	1	0	2	0	4	0	0	2
Eurassian Swallow	*Hirundo rustica*	2	0	0	0	1	2	1	0	2	3	1	0	3	0	0	3
Ethiopian Swallow	*Hirundo aethiopica*	1	0	0	0	0	2	0	0	1	0	0	0	0	2	3	1
Sand Martin	*Riparia riparia*	0	0	0	0	1	2	0	1	0	0	0	0	0	3	1	2
Drongo	*Dicrurus adsimilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White head babler	*Turdoides leucocephalus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Bulbul	*Pycnonotus barbatus*	0	2	4	0	2	3	2	0	2	1	7	5	6	4	2	0
Rufous Bush Chat	*Cercotrichas galactotes*	1	1	0	0	0	0	0	2	2	1	0	0	0	0	1	0
Black Bush Robin	*Cercotrichas podobe*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desert Wheatear	*Oenanthe deserti*	0	0	0	0	0	0	1	1	0	0	0	0	0	0	5	2
Black-eared Wheatear	*Oenanthe hispanica*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Northern Wheatear	*Oenanthe oenanthe*	0	0	0	0	0	0	0	1	3	0	0	0	0	0	1	1
Tawny Pipt	*Anthus campestris*	0	0	0	0	0	0	2	3	3	0	0	0	0	0	1	1
White wagtail	*Motacilla alba alba*	1	0	0	0	0	3	4	8	1	0	0	0	0	0	9	7
Yellow Wagtail	*Motacilla flava*	1	0	0	0	0	1	4	2	1	0	0	0	0	0	5	9
Golden pipit	*Tmetothylacus tenellus*	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0
Lesser Grey Shrike	*Lanius minor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue -eared Glossy	*mprotornis chalybaeus*	0	0	8	4	5	7	1	0	0	0	14	12	16	13	3	0

Starling																	
Ruppells-long tailedGliossy Starling	*Lamprotornis purpuropterus*	0	0	3	4	4	3	0	0	0	0	3	7	8	4	1	0
Beautiful Sunbird	*Nectarinia pulchella*	0	0	2	0	0	3	0	0	0	0	0	2	0	0	2	0
Northern Red Bishop	*Euplectes franciscanus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Weaver	*Ploceus luteolus*	2	0	0	0	4	0	0	0	0	1	0	2	0	3	0	0
Black headed Weaver	*Ploceus cucullatus*	0	10	20	23	30	25	0	0	4	11	30	46	40	34	0	0
Northern Masked Weaver	*Ploceus taeniopterus*	0	6	12	17	23	17	0	0	0	9	10	14	25	18	2	0
House Sparrow	*Passer domesticus*	53	34	56	62	68	92	50	30	85	51	73	85	115	71	100	44
Sudan golden Sparrow	*Passer luteus*	0	0	10	7	0	0	0	0	0	0	8	12	16	0	0	0
Village Indigo Bird	*Vidua chalybeate*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pin-tailed Whydah	*Vidua macroura*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crimson-rumped Waxbill	*Estrilda rhodopyga*	0	0	7	0	0	5	0	0	0	0	0	0	13	0	10	7
Red-cheecked Cordon-bleu	*Uraeginthus bengalis*	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Red billed Fire finch	*Lagonosticta Senegala*	0	0	0	0	0	2	4	2	0	0	0	3	0	4	6	2
African Silverbill	*Lonchura malabarica*	3	2	0	3	0	5	4	6	5	6	0	5	0	0	9	12

Appendix Table 2 Number of different species of bird composition at Soba - Elbagair between April to November 2013 and April to November 2014

Common name	Scientific name	2013								2014							
		Apr	May	Jun	July	Aug	Sep	Oct	Nov	Apr	May	Jun	July	Aug	Sep	Oct	Nov
White Pelican	*Pelican onocrotalus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Long tailed cormorant	*Phalacrocorax africanus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grey Heron	*Ardea cinerea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cattle Egreet	*Bubulcus ibis*	1	0	0	1	2	3	2	2	0	0	0	1	4	3	1	0
Little Egret	*Egretta garzetta*	3	1	1	2	0	0	0	0	2	1	3	2	3	0	0	0
Great White Egret	*Egretta alba*	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0
Yellow Billed Egret	*Egretta intermedia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Open –bill Stork	*Anastomus lamelligerus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Abdims Stork	*Ciconid abdimii*	0	0	0	4	2	0	0	0	3	0	0	6	2	0	0	0
White Stork	Ciconia ciconia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossy Ibis	*Plegadis falcinellus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sacred Ibis	*Threskiornis aethiopicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Spoon bill	*Platalea alba*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurasian Spoonbill	*Platalea leucorodia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Shoveler	*Spatula clypeata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Kite	*Milvus migrans*	4	1	2	3	5	12	9	5	6	5	7	5	11	12	8	5
Spur-winged Plover	Vanellus spinosus	2	0	3	2	0	6	4	0	0	6	2	2	7	2	0	0

Black – headed Plover	*Vanellus tectus*	0	2	0	3	0	5	2	0	0	0	0	0	0	0	0	0
Common Sandpiper	*Actitis hypoleucos*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood sandpiper	*Tringa glareola*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MarshSand piper	*Triinga stagnatilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green Sandpiper	*Tringa ochropus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Snipe	*Gallingo gallingo*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
Little Stint	*Calidris minuta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black winged Stilt	*Himantopus himantopus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Whiskered Tern	*Chlidonias hybrida*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chestnut-bellied Sandgrouse	*Pterocles exustus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speckled Pigeon	*Columba guinea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Namaqua Dove	*Oena capensis*	5	3	0	2	1	5	0	2	9	2	3	4	6	3	0	0
Mourning Dove	*Streptopelia decipiens*	2	2	1	0	0	2	1	2	2	2	0	4	2	0	1	2
Ring–necked Dove	*Streptopelia capicola*	4	2	0	3	5	6	2	1	8	2	2	4	8	6	4	2
Laughing Dove	*Streptopelia sengalensis*	12	8	11	12	10	17	14	10	15	9	11	13	20	12	9	7
Pink-headed Dove	*Streptopelia roseogrisea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turtle Dove	Streptopelia turtur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rose-ring Parakeet	*Psittacula krameri*	0	0	2	3	0	2	0	3	0	2	3	0	2	2	0	4
Common Cuckoo	*Cuculus canorus*	0	1	2	0	2	4	0	0	0	0	0	0	0	0	0	0

long-tailed Nightjar	*Caprimulgus climacurus*	7	5	0	0	0	0	0	2	9	5	0	0	0	0	0	4
Eurasian Swift	*Apus apus*	7	0	0	0	11	14	6	1	10	0	0	0	15	7	5	1
Alpine Swift	*Apus melba*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue-napped Mouse bird	*Urocolius macrourus*	2	0	4	5	7	9	4	0	0	3	4	5	7	2	6	0
Pied Kingfisher	*Ceryle rudis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
European Bee-eater	*Merops apiaster*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Green Bee-eater	*Merops orientalis*	0	0	0	0	0	3	1	5	1	0	0	0	0	0	1	3
Little Bee-eater	*Merops pusillus*	2	0	0	2	0	3	0	4	2	0	0	4	0	0	2	2
Abyssinian Roller	*Coracias abyssinicus*	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Eurasian Roller	*Coracias garrulus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Hoopoe	*Upupa epops*	2	1	0	0	0	5	4	4	2	0	0	0	4	3	2	0
Red-billed Hornbill	*Tockuserythrorhync*	1	0	0	2	0	2	1	0	0	1	1	0	0	1	0	0
Hoopoe lark	*Alaemon alaudipes*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short –toed Lark	*Calandrella brachydactyla*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chestnut-back Sparrow Lark	*Eremopterix leucotis*	0	0	0	0	0	6	0	0	0	0	0	0	9	0	0	0
White-fronted Sparrow Lark	*Eremopterix nigriceps*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crested Lark	*Galerida cristata*	0	2	1	1	2	3	0	1	1	0	2	1	3	2	0	0
Eurassian	*Hirundo rustica*	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0

Swallow																	
Ethiopian Swallow	*Hirundo aethiopica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sand Martin	*Riparia riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drongo	*Dicrurus adsimilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White head babler	*Turdoides leucocephalus*	4	5	2	0	6	3	0	3	0	5	4	2	9	5	0	3
Common Bulbul	*Pycnonotus barbatus*	3	2	7	2	5	6	0	2	1	2	7	4	7	4	5	1
Rufous Bush Chat	*Cercotrichas galactotes*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Bush Robin	*Cercotrichas podobe*	1	0	2	0	0	2	0	1	1	0	1	0	3	2	2	0
Desert Wheatear	*Oenanthe deserti*	0	0	0	0	0	0	2	2	0	0	0	0	0	0	2	3
Black-eared Wheatear	*Oenanthe hispanica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Wheatear	*Oenanthe oenanthe*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tawny Pipt	*Anthus campestris*	0	0	0	0	0	0	1	3	0	0	0	0	0	0	3	5
White wagtail	*Motacilla alba alba*	0	0	0	0	0	3	5	8	1	0	0	0	0	1	7	4
Yellow Wagtail	*Motacilla flava*	1	0	0	0	0	0	2	3	1	0	0	0	0	1	3	1
Golden pipit	*Tmetothylacus tenellus*	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Lesser Grey Shrike	*Lanius minor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue -eared Glossy Starling	*mprotornis chalybaeus*	0	0	18	11	14	13	3	0	0	0	20	17	19	12	3	0
Ruppells-long tailedGlossy Starling	*Lamp rotornis purpuropterus*	0	0	10	7	7	3	0	0	0	0	11	9	6	5	0	0
Beautiful Sunbird	*Nectarinia pulchella*	0	0	1	0	2	2	4	0	0	0	5	1	4	0	1	0
Northern Red Bishop	*Euplectes franciscanus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Weaver	*Ploceus luteolus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black headed Weaver	*Ploceus cucullatus*	0	17	32	41	49	36	0	0	6	21	50	66	84	58	0	0
Northern Masked Weaver	*Ploceus taeniopterus*	0	9	16	22	33	23	2	0	0	9	16	38	45	38	1	0

House Sparrow	*Passer domesticus*	34	13	30	35	38	70	50	33	56	16	26	45	89	36	47	32
Sudan golden Sparrow	*Passer luteus*	0	0	8	6	0	0	0	0	0	0	9	7	0	0	0	0
Village Indigo Bird	*Vidua chalybeate*	0	0	0	0	3	2	2	0	0	0	0	0	0	0	0	2
Pin-tailed Whydah	*Vidua macroura*	0	0	0	0	2	1	1	0	0	0	0	0	2	2	0	0
Crimson-rumped Waxbill	*Estrilda rhodopyga*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-cheecked Cordon-bleu	*Uraeginthus bengalis*	0	1	4	2	1	0	0	0	0	0	7	6	4	0	0	0
Red billed Fire finch	*Lagonosticta Senegala*	0	0	0	0	4	6	2	2	0	0	0	2	6	1	3	0
African Silverbill	*Lonchura malabarica*	0	0	3	0	5	5	6	7	0	0	5	2	8	6	5	7

Appendix Table 3 Number of different species of bird composition at Omudrman1 between April to November 2013 and April to November 2014

Common name	Scientific name	2013								2014							
		Apr	May	Jun	July	Aug	Sep	Oct	Nov	Apr	May	Jun	July	Aug	Sep	Oct	Nov
White Pelican	*Pelican onocrotalus*	0	0	0	0	0	2	3	0	0	0	0	0	0	3	5	3
Long tailed cormorant	*Phalacrocorax africanus*	0	0	0	0	0	0	5	3	0	0	0	0	0	5	6	0
Grey Heron	*Ardea cinerea*	0	0	0	0	0	0	3	5	0	0	0	0	0	0	3	1
Cattle Egreet	*Bubulcus ibis*	1	0	3	6	6	9	3	0	3	0	2	6	13	12	9	0
Little Egret	*Egretta garzetta*	1	2	4	5	1	0	0	0	0	2	6	7	5	0	0	0
Great White Egret	*Egretta alba*	2	1	3	1	0	2	0	0	4	3	5	0	0	1	1	0
Yellow Billed Egret	*Egretta intermedia*	0	0	0	0	0	2	1	1	0	0	0	0	0	5	3	0
African Open –bill Stork	*Anastomus lamelligerus*	0	0	0	0	0	0	8	5	0	0	0	0	0	0	9	7
Abdims Stork	*Ciconid abdimii*	0	0	2	1	3	4	0	0	2	0	0	4	5	0	0	0
White Stork	Ciconia ciconia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossy Ibis	*Plegadis falcinellus*	0	0	0	0	2	6	4	0	0	0	0	0	8	5	3	0
Sacred Ibis	*Threskiornis aethiopicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Spoon bill	*Platalea alba*	0	0	0	0	0	0	2	1	0	0	0	0	0	0	2	4
Eurasian Spoonbill	*Platalea leucorodia*	0	0	0	0	0	0	3	7	0	0	0	0	0	0	5	9
Northern Shoveler	*Spatula clypeata*	0	0	0	0	0	0	19	24	0	0	0	0	0	0	40	34
Black Kite	*Milvus migrans*	2	4	3	1	1	5	7	4	3	4	2	3	7	5	3	6
Spur-winged Plover	Vanellus spinosus	0	0	0	0	0	8	7	5	0	0	0	0	8	9	2	6

Black –headed Plover	*Vanellus tectus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Sandpiper	*Actitis hypoleucos*	0	0	0	0	0	3	2	2	0	0	0	0	1	4	3	1
Wood sandpiper	*Tringa glareola*	0	0	0	0	0	2	1	1	0	0	0	0	3	3	5	2
Marsh Sand piper	*Triinga stagnatilis*	0	0	0	0	0	2	2	1	0	0	0	0	0	5	3	2
Green Sandpiper	*Tringa ochropus*	0	0	0	0	0	4	4	2	0	0	0	0	0	6	4	4
Common Snipe	*Gallingo gallingo*	0	0	0	0	0	0	1	3	0	0	0	0	0	3	2	0
Little Stint	*Calidris minuta*	0	0	0	0	0	6	8	6	0	0	0	0	0	9	8	5
Black winged Stilt	*Himantopus himantopus*	0	0	0	0	0	10	8	6	0	0	0	0	0	10	10	9
Whiskered Tern	*Chlidonias hybrida*	0	0	0	0	0	4	4	3	0	0	0	0	4	4	2	3
Chestnut-bellied Sandgrouse	*Pterocles exustus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speckled Pigeon	*Columba guinea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Namaqua Dove	*Oena capensis*	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Mourning Dove	*Streptopelia decipiens*	1	2	0	0	0	2	0	0	1	2	0	0	3	0	0	2
Ring–necked Dove	*Streptopelia capicola*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laughing Dove	*Streptopelia sengalensis*	2	1	1	2	3	4	2	6	9	4	1	2	5	3	2	4
Pink-headed Dove	*Streptopelia roseogrisea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turtle Dove	Streptopelia turtur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rose-ring Parakeet	*Psittacula krameri*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Cuckoo	*Cuculus canorus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
long-tailed	*Caprimulgus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Nightjar	*climacurus*																
Eurasian Swift	*Apus apus*	1	0	0	0	1	3	0	0	8	0	0	1	12	0	0	0
Alpine Swift	*Apus melba*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue-napped Mouse bird	*Urocolius macrourus*	4	0	5	0	0	3	0	5	0	3	0	0	6	0	0	0
Pied Kingfisher	*Ceryle rudis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
European Bee-eater	*Merops apiaster*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Green Bee-eater	*Merops orientalis*	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Little Bee-eater	*Merops pusillus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Abyssinian Roller	*Coracias abyssinicus*	0	0	0	0	0	2	0	0	0	0	0	0	5	0	0	0
Eurasian Roller	*Coracias garrulus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Hoopoe	*Upupa epops*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-billed Hornbill	*Tockus erythrorhynchus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hoopoe lark	*Alaemon alaudipes*	0	1	0	2	0	4	0	0	0	0	2	1	4	0	1	0
Short –toed Lark	*Calandrella brachydactyla*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chestnut-back Sparrow Lark	*Eremopterix leucotis*	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0
White-fronted Sparrow Lark	*Eremopterix nigriceps*	0	0	0	0	3	5	0	0	0	0	0	0	6	4	0	4
Crested Lark	*Galerida cristata*	0	2	0	1	0	3	0	0	2	0	2	0	4	2	5	0
Eurassian Swallow	*Hirundo rustica*	0	0	0	0	1	2	0	0	0	0	1	2	3	2	0	0
Ethiopian Swallow	*Hirundo aethiopica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sand Martin	*Riparia riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drongo	*Dicrurus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	adsimilis																
White head babler	*Turdoides leucocephalus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Bulbul	*Pycnonotus barbatus*	0	0	4	0	0	5	0	0	0	0	6	0	6	0	0	0
Rufous Bush Chat	*Cercotrichas galactotes*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Black Bush Robin	*Cercotrichas podobe*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desert Wheatear	*Oenanthe deserti*	0	0	0	0	0	0	2	1	0	0	0	0	0	0	3	4
Black-eared Wheatear	*Oenanthe hispanica*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Northern Wheatear	*Oenanthe oenanthe*	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Tawny Pipt	*Anthus campestris*	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3
White wagtail	*Motacilla alba alba*	0	0	0	0	0	2	1	3	0	0	0	0	0	2	5	3
Yellow Wagtail	*Motacilla flava*	0	0	0	0	0	5	7	4	0	0	0	0	0	3	8	4
Golden pipit	*Tmetothylacus tenellus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesser Grey Shrike	*Lanius minor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue -eared Glossy Starling	*mprotornis chalybaeus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Ruppells-long tailedGliossy Starling	*Lamprotornis purpuropte rus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beautiful Sunbird	*Nectarinia pulchella*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Red Bishop	*Euplectes franciscanus*	0	0	0	0	0	4	9	10	0	0	0	0	8	3	2	8
Little Weaver	*Ploceus luteolus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black headed Weaver	*Ploceus cucullatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Masked Weaver	*Ploceus taeniopterus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
House Sparrow	*Passer domesticus*	5	3	2	6	4	7	4	2	24	8	6	3	12	7	8	7
Sudan golden Sparrow	*Passer luteus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Village Indigo Bird	*Vidua chalybeate*	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	6
Pin-tailed Whydah	*Vidua macroura*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crimson-rumped Waxbill	*Estrilda rhodopyga*	0	0	0	0	0	0	6	5	6	0	0	0	5	0	0	6
Red-cheecked Cordon-bleu	*Uraeginthus bengalis*	0	0	0	0	0	2	0	0	0	0	0	0	2	0	3	0
Red billed Fire finch	*Lagonosticta Senegala*	0	0	0	0	2	3	2	0	0	0	0	0	6	3	2	2
African Silverbill	*Lonchura malabarica*	0	0	3	0	0	4	0	5	3	0	0	0	8	5	6	6

Appendix Table 4 Number of different species of bird composition at Omudrman2 between April to November 2013 and April to November 2014

Common name	Scientific name	2013								2014							
		Apr	May	Jun	July	Aug	Sep	Oct	Nov	Apr	May	Jun	July	Aug	Sep	Oct	Nov
White Pelican	*Pelican onocrotalus*	0	0	0	0	0	1	2	0	0	0	0	0	0	2	4	4
Long tailed cormorant	*Phalacrocora x africanus*	0	0	0	0	0	4	3	2	0	0	0	0	0	4	3	2
Grey Heron	*Ardea cinerea*	0	0	7	4	5	10	7	0	4	2	6	8	15	9	13	4
Cattle Egreet	*Bubulcus ibis*	2	0	2	1	1	0	0	12	0	2	5	2	2	0	0	12
Little Egret	*Egretta garzetta*	0	0	5	2	0	1	0	0	2	5	4	2	1	0	0	0
Great White Egret	*Egretta alba*	0	0	0	0	0	1	0	0	0	0	0	0	2	1	0	0
Yellow Billed Egret	*Egretta intermedia*	0	0	0	0	0	7	3	4	0	0	0	0	0	0	6	4
African Open –bill Stork	*Anastomus lamelligerus*	0	0	0	4	0	1	0	0	3	0	0	6	2	1	0	0
Abdims Stork	*Ciconid abdimii*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White Stork	Ciconia ciconia	0	0	0	0	0	3	5	0	0	0	0	0	6	4	5	0
Glossy Ibis	*Plegadis falcinellus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sacred Ibis	*Threskiornis aethiopicus*	0	0	0	0	0	0	2	3	0	0	0	0	0	0	2	2
African Spoon bill	*Platalea alba*	0	0	0	0	0	0	8	7	0	0	0	0	0	0	7	6
Eurasian Spoonbill	*Platalea leucorodi a*	0	0	0	0	0	0	16	20	0	0	0	0	0	0	39	35
Northern Shoveler	*Spatula clypeata*	2	1	2	3	4	6	4	5	2	1	2	5	10	7	6	5

Black Kite	*Milvus migrans*	0	0	0	0	0	6	5	3	0	0	1	0	9	5	3	7
Spur-winged Plover	Vanellus spinosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black – headed Plover	*Vanellus tectus*	0	0	0	0	0	3	1	1	0	0	0	0	0	5	3	3
Common Sandpiper	*Actitis hypoleucos*	0	0	0	0	0	4	2	3	0	0	0	0	0	5	1	4
Wood sandpiper	*Tringa glareola*	0	0	0	0	0	3	4	1	0	0	0	0	0	4	3	1
Marsh Sand piper	*Triinga stagnatilis*	0	0	0	0	0	2	2	1	0	0	0	0	0	7	6	0
Green Sandpiper	*Tringa ochropus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Common Snipe	*Gallingo gallingo*	0	0	0	0	0	9	4	5	0	0	0	0	6	9	8	4
Little Stint	*Calidris minuta*	0	0	0	0	0	11	8	7	0	0	0	0	0	13	9	9
Black winged Stilt	*Himantopus himantopus*	0	0	0	0	0	0	2	4	0	0	0	0	0	4	2	2
Whiskered Tern	*Chlidonias hybrida*	0	0	0	0	0	6	0	0	0	0	0	0	7	4	0	0
Chestnut-bellied Sandgrouse	*Pterocles exustus*	0	0	4	0	10	8	9	4	0	0	0	4	13	6	9	2
Speckled Pigeon	*Columba guinea*	0	3	0	2	0	3	0	3	3	0	0	0	2	0	3	0
Namaqua Dove	*Oena capensis*	2	0	0	0	0	4	0	0	2	0	0	0	3	0	2	0
Mourning Dove	*Streptopelia decipiens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ring–necked Dove	*Streptopelia capicola*	5	2	3	4	6	8	4	5	7	5	2	5	9	6	5	4
Laughing Dove	*Streptopelia sengalensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pink-headed Dove	*Streptopelia roseogrisea*	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4	1

Turtle Dove	Streptopelia turtur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Rose-ring Parakeet	*Psittacula krameri*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Cuckoo	*Cuculus canorus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
long-tailed Nightjar	*Caprimulgus climacurus*	6	0	0	0	3	7	5	0	6	0	0	3	13	5	0	0
Eurasian Swift	*Apus apus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alpine Swift	*Apus melba*	1	0	2	3	0	6	0	2	2	0	3	0	5	0	2	6
Blue-napped Mouse bird	*Urocolius macrourus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pied Kingfisher	*Ceryle rudis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
European Bee-eater	*Merops apiaster*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Green Bee-eater	*Merops orientalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Bee-eater	*Merops pusillus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Abyssinian Roller	*Coracias abyssinicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurasian Roller	*Coracias garrulus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Hoopoe	*Upupa epops*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-billed Hornbill	*Tockus erythrorhynchus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hoopoe lark	*Alaemon alaudipes*	0	0	0	0	0	0	19	0	0	0	0	0	0	0	12	0
Short –toed Lark	*Calandrella brachydactyla*	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	9
Chestnut-back Sparrow Lark	*Eremopterix leucotis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White-	*Eremopterix*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

fronted Sparrow Lark	*nigriceps*																
Crested Lark	*Galerida cristata*	0	0	0	2	2	4	2	0	0	0	0	3	5	2	1	0
Eurassian Swallow	*Hirundo rustica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethiopian Swallow	*Hirundo aethiopic a*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sand Martin	*Riparia riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drongo	*Dicrurus adsimilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White head babler	*Turdoides leucocephalus*	0	0	2	0	2	0	1	0	3	0	3	0	4	0	1	0
Common Bulbul	*Pycnonotus barbatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rufous Bush Chat	*Cercotrichas galactotes*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Bush Robin	*Cercotrichas podobe*	0	0	0	0	0	0	3	2	0	0	0	0	0	0	2	4
Desert Wheatear	*Oenanthe deserti*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Black-eared Wheatear	*Oenanthe hispanica*	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0
Northern Wheatear	*Oenanthe oenanthe*	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4
Tawny Pipt	*Anthus campestris*	0	0	0	0	0	4	2	6	0	0	0	0	0	5	3	7
White wagtail	*Motacilla alba alba*	0	0	0	0	0	5	6	8	0	0	0	0	0	3	7	8
Yellow Wagtail	*Motacilla flava*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Golden pipit	*Tmetothylacus tenellus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesser Grey Shrike	*Lanius minor*	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Blue -eared Glossy Starling	*mprotornis chalybaeus*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0
Ruppells-long tailedGlossy Starling	*Lamprotornis purpuropt erus*	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2

Beautiful Sunbird	*Nectarinia pulchella*	0	0	3	0	0	0	6	7	0	0	0	0	4	0	6	7
Northern Red Bishop	*Euplectes franciscanus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Weaver	*Ploceus luteolus*	0	0	5	4	0	9	3	0	0	0	0	5	8	6	0	0
Black headed Weaver	*Ploceus cucullatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Masked Weaver	*Ploceus taeniopterus*	8	3	7	6	4	10	9	8	35	8	7	5	12	9	10	7
House Sparrow	*Passer domesticus*	0	0	6	0	0	0	0	0	0	0	5	0	7	0	0	0
Sudan golden Sparrow	*Passer luteus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
Village Indigo Bird	*Vidua chalybeate*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pin-tailed Whydah	*Vidua macroura*	3	0	0	0	5	4	0	9	5	0	0	0	0	8	7	6
Crimson-rumped Waxbill	*Estrilda rhodopyga*	0	0	0	0	2	2	0	0	0	0	4	0	4	0	0	0
Red-cheecked Cordon-bleu	*Uraeginthus bengalis*	0	0	0	2	0	3	4	0	0	0	0	4	3	0	4	0
Red billed Fire finch	*Lagonosticta Senegala*	0	0	5	4	0	6	0	7	6	0	0	6	8	4	7	3
African Silverbill	*Lonchura malabarica*	0	0	0	0	0	1	2	0	0	0	0	0	0	2	4	4

Appendix Table 5 Number of different species of bird composition at Khartoum Bahari between April to November 2013 and April to November 2014

Common name	*Scientific name*	*2013*								*2014*							
		Apr	May	Jun	July	Aug	Sep	Oct	Nov	Apr	May	Jun	July	Aug	Sep	Oct	Nov
White Pelican	*Pelican onocrotalus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Long tailed cormorant	*Phalacrocorax africanus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grey Heron	*Ardea cinerea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cattle Egreet	*Bubulcus ibis*	2	2	1	3	6	6	2	1	2	0	1	3	7	2	3	0
Little Egret	*Egretta garzetta*	3	1	2	4	0	1	0	0	0	1	4	2	5	0	0	0
Great White Egret	*Egretta alba*	0	1	4	0	0	0	0	0	0	1	2	0	0	0	0	0
Yellow Billed Egret	*Egretta intermedia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Open – bill Stork	*Anastomus lamelligerus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Abdims Stork	*Ciconid abdimii*	2	0	0	3	2	0	0	0	2	0	8	5	4	0	0	0
White Stork	Ciconia ciconia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossy Ibis	*Plegadis falcinellus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sacred Ibis	*Threskiornis aethiopicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Spoon bill	*Platalea alba*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurasian Spoonbill	*Platalea leucorodia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Shoveler	*Spatula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	clypeata																
Black Kite	*Milvus migrans*	2	1	3	4	6	8	8	2	5	4	8	7	10	9	6	5
Spur-winged Plover	Vanellus spinosus	3	0	0	2	0	4	3	1	5	4	0	3	5	3	2	0
Black –headed Plover	*Vanellus tectus*	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Common Sandpiper	*Actitis hypoleucos*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood sandpiper	*Tringa glareola*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marsh Sand piper	*Triinga stagnatilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green Sandpiper	*Tringa ochropus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Snipe	*Gallingo gallingo*	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Little Stint	*Calidris minuta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black winged Stilt	*Himantopus himantopus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Whiskered Tern	*Chlidonias hybrida*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chestnut-bellied Sandgrouse	*Pterocles exustus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Speckled Pigeon	*Columba guinea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Namaqua Dove	*Oena capensis*	2	0	0	0	0	1	0	0	4	3	1	0	3	0	0	0
Mourning Dove	*Streptopelia decipiens*	1	0	0	2	0	2	2	0	3	2	0	0	4	2	1	0
Ring–necked Dove	*Streptopelia capicola*	2	4	0	0	2	6	5	1	2	3	0	2	6	0	5	1
Laughing Dove	*Streptopelia sengalensis*	9	3	2	10	7	12	11	8	12	9	7	10	15	12	8	9

Pink-headed Dove	*Streptopelia roseogrisea*	2	0	0	0	0	4	2	1	2	0	0	0	4	3	0	0
Turtle Dove	Streptopelia turtur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rose-ring Parakeet	*Psittacula krameri*	0	0	3	0	0	4	0	0	2	0	0	1	2	0	0	0
Common Cuckoo	*Cuculus canorus*	0	0	0	0	1	3	0	0	0	0	0	0	2	0	0	2
long-tailed Nightjar	*Caprimulgus climacurus*	4	0	0	0	0	0	5	0	5	4	0	0	0	0	0	4
Eurasian Swift	*Apus apus*	7	3	0	6	7	12	2	0	5	3	0	6	13	8	1	0
Alpine Swift	*Apus melba*	4	0	0	0	0	0	5	0	2	0	0	0	0	0	3	2
Blue-napped Mouse bird	*Urocolius macrourus*	3	0	0	0	0	5	3	0	4	0	5	4	4	0	3	0
Pied Kingfisher	*Ceryle rudis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
European Bee-eater	*Merops apiaster*	9	0	0	0	0	17	7	9	0	0	0	0	12	9	22	0
Little Green Bee-eater	*Merops orientalis*	0	0	0	0	0	5	2	0	1	0	0	0	0	0	4	5
Little Bee-eater	*Merops pusillus*	2	2	0	0	1	2	0	0	2	0	0	0	2	2	0	0
Abyssinian Roller	*Coracias abyssinicus*	0	0	0	0	4	1	0	0	0	0	0	0	7	3	1	0
Eurasian Roller	*Coracias garrulus*	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0
Common Hoopoe	*Upupa epops*	0	0	2	0	0	4	0	0	0	0	0	0	4	0	2	0
Red-billed Hornbill	*Tockus erythrorhynchus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hoopoe lark	*Alaemon alaudipes*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short –toed Lark	*Calandrella brachydactyla*	0	0	0	0	0	0	14	12	0	0	0	0	0	0	0	0
Chestnut- back	*Eremopterix*	0	0	0	9	0	6	0	0	0	0	0	0	14	0	0	0

Sparrow Lark	*leucotis*																
White- fronted Sparrow Lark	*Eremopterix nigriceps*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crested Lark	*Galerida cristata*	1	0	2	0	0	0	0	0	1	0	2	0	2	3	0	0
Eurassian Swallow	*Hirundo rustica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethiopian Swallow	*Hirundo aethiop ica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sand Martin	*Riparia riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drongo	*Dicrurus adsimilis*	2	0	2	0	2	4	0	1	1	0	2	2	6	2	0	0
White head babler	*Turdoides leucocephal us*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Bulbul	*Pycnonotus barbatus*	0	0	3	2	2	4	0	2	2	0	5	3	6	1	0	2
Rufous Bush Chat	*Cercotricha s galactotes*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Bush Robin	*Cercotricha s podobe*	1	0	0	1	0	2	0	0	2	0	0	1	3	0	0	0
Desert Wheatear	*Oenanthe deserti*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Black-eared Wheatear	*Oenanthe hispanica*	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0
Northern Wheatear	*Oenanthe oenanthe*	0	0	0	0	0	0	1	2	0	0	0	0	0	0	3	5
Tawny Pipt	*Anthus campestris*	0	0	0	0	0	0	4	0	0	0	0	0	0	0	3	1
White wagtail	*Motacilla alba alba*	0	0	0	0	0	4	6	3	0	0	0	0	0	5	7	10
Yellow Wagtail	*Motacilla flava*	0	0	0	0	0	6	7	2	0	0	0	0	0	8	2	8
Golden pipit	*Tmetothylac us tenellus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesser Grey Shrike	*Lanius minor*	0	0	0	0	3	6	4	1	1	0	0	0	9	7	5	3
Blue -eared Glossy Starling	*mprotornis chalybaeus*	0	0	9	7	7	5	0	0	0	0	14	12	13	9	0	0
Ruppells-long tailedGliossy	*Lamprotorn is*	0	0	2	4	3	0	0	0	0	0	7	6	6	2	0	0

Starling	*purpuropterus*																
Beautiful Sunbird	*Nectarinia pulchella*	0	0	2	0	0	2	0	0	0	0	4	0	3	0	0	2
Northern Red Bishop	*Euplectes franciscanus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Weaver	*Ploceus luteolus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black headed Weaver	*Ploceus cucullatus*	13	23	35	40	62	50	0	0	10	20	36	76	93	63	0	0
Northern Masked Weaver	*Ploceus taeniopterus*	3	15	25	32	29	22	0	0	0	14	33	48	54	34	0	0
House Sparrow	*Passer domesticus*	40	37	44	56	60	91	66	44	50	56	60	59	108	65	77	32
Sudan golden Sparrow	*Passer luteus*	0	0	6	0	0	3	0	0	0	0	0	8	10	0	0	0
Village Indigo Bird	*Vidua chalybeate*	6	0	0	2	7	13	10	0	20	0	0	0	23	11	0	10
Pin-tailed Whydah	*Vidua macroura*	1	0	0	3	2	4	2	0	4	1	0	2	6	3	0	0
Crimson-rumped Waxbill	*Estrilda rhodopyga*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-cheecked Cordon-bleu	*Uraeginthus bengalis*	0	0	2	5	0	0	0	0	0	0	2	0	6	0	0	0
Red billed Fire finch	*Lagonostict a Senegala*	0	0	0	0	2	3	6	7	0	0	0	4	2	6	4	2
African Silverbill	*Lonchura malabarica*	1	0	0	5	0	7	5	9	0	0	0	5	0	9	12	11

Appendix Table 6 Number of different species of bird composition at Sharq ELNeil between April to November 2013 and April to November 2014

Common name	Scientific name	2013								2014							
		Apr	May	Jun	July	Aug	Sep	Oct	Nov	Apr	May	Jun	July	Aug	Sep	Oct	Nov
White Pelican	*Pelican onocrotalus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Long tailed cormorant	*Phalacrocorax africanus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grey Heron	*Ardea cinerea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cattle Egreet	*Bubulcus ibis*	4	0	0	2	0	2	0	0	0	0	0	1	4	0	0	0
Little Egret	*Egretta garzetta*	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Great White Egret	*Egretta alba*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow Billed Egret	*Egretta intermedia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Open –bill Stork	*Anastomus lamelligerus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Abdims Stork	*Ciconid abdimii*	0	0	0	5	0	0	0	0	1	0	0	4	6	0	0	0
White Stork	Ciconia ciconia	1	0	0	0	0	0	2	1	3	0	2	0	0	0	3	1
Glossy Ibis	*Plegadis falcinellus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sacred Ibis	*Threskiornis aethiopicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
African Spoon bill	*Platalea alba*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurasian Spoonbill	*Platalea leucorodia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern	*Spatula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Shoveler	*clypeata*																
Black Kite	*Milvus migrans*	3	1	1	2	1	4	3	0	5	2	3	1	7	5	4	3
Spur-winged Plover	Vanellus spinosus	2	0	0	2	1	3	0	1	1	2	0	0	4	2	0	0
Black – headed Plover	*Vanellus tectus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Sandpiper	*Actitis hypoleucos*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood sandpiper	*Tringa glareola*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marsh Sand piper	*Triinga stagnatilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green Sandpiper	*Tringa ochropus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Snipe	*Gallingo gallingo*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Stint	*Calidris minuta*	0	0	0	0	0	16	20	23	0	0	0	0	0	13	20	15
Black winged Stilt	*Himantopus himantopus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Whiskered Tern	*Chlidonias hybrida*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chestnut-bellied Sandgrouse	*Pterocles exustus*	4	3	0	0	0	0	4	0	3	5	0	0	0	0	0	2
Speckled Pigeon	*Columba guinea*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Namaqua Dove	*Oena capensis*	5	3	1	0	1	2	0	0	8	2	0	0	4	0	2	1
Mourning Dove	*Streptopelia decipiens*	1	0	2	0	2	2	0	0	1	2	2	0	2	0	0	0
Ring–necked Dove	*Streptopelia capicola*	4	2	3	0	2	6	2	0	6	3	4	0	10	0	2	0
Laughing Dove	*Streptopelia sengalensis*	11	9	12	10	11	13	11	7	12	9	12	13	16	14	12	15
Pink-headed	*Streptopelia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Dove	*roseogrisea*																
Turtle Dove	Streptopelia turtur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rose-ring Parakeet	*Psittacula krameri*	2	0	3	0	2	4	0	1	2	0	3	0	2	4	0	1
Common Cuckoo	*Cuculus canorus*	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0
long-tailed Nightjar	*Caprimulgus climacurus*	0	0	0	0	0	0	0	0	7	5	0	0	0	0	0	0
Eurasian Swift	*Apus apus*	4	0	0	3	6	8	1	0	4	0	0	4	6	4	2	0
Alpine Swift	*Apus melba*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue-napped Mouse bird	*Urocolius macrourus*	3	0	0	0	2	3	2	0	3	2	2	0	4	2	1	0
Pied Kingfisher	*Ceryle rudis*	1	0	0	0	0	0	2	0	1	0	0	0	2	1	0	0
European Bee-eater	*Merops apiaster*	0	0	0	0	0	9	20	0	0	0	0	0	0	8	9	0
Little Green Bee-eater	*Merops orientalis*	0	0	0	0	0	5	1	3	0	0	0	0	0	1	3	5
Little Bee-eater	*Merops pusillus*	0	0	2	2	0	2	3	0	1	0	2	0	4	0	4	0
Abyssinian Roller	*Coracias abyssinicus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eurasian Roller	*Coracias garrulus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Hoopoe	*Upupa epops*	0	0	0	0	0	2	2	0	1	0	0	0	4	1	2	0
Red-billed Hornbill	*Tockus erythrorhynchus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hoopoe lark	*Alaemon alaudipes*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short –toed Lark	*Calandrella brachydactyla*	0	0	0	0	0	0	42	28	0	0	0	0	0	0	32	22
Chestnut-back Sparrow Lark	*Eremopterix leucotis*	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0

White-fronted Sparrow Lark	*Eremopterix nigriceps*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crested Lark	*Galerida cristata*	1	0	2	2	0	1	0	0	2	0	3	0	0	2	0	1
Eurassian Swallow	*Hirundo rustica*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Ethiopian Swallow	*Hirundo aethiopica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sand Martin	*Riparia riparia*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drongo	*Dicrurus adsimilis*	0	0	0	0	0	2	0	0	1	0	0	3	4	0	1	0
White head babler	*Turdoides leucocephalus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Bulbul	*Pycnonotus barbatus*	1	2	2	1	0	3	1	1	3	1	6	2	1	4	0	1
Rufous Bush Chat	*Cercotrichas galactotes*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black Bush Robin	*Cercotrichas podobe*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desert Wheatear	*Oenanthe deserti*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3
Black-eared Wheatear	*Oenanthe hispanica*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
Northern Wheatear	*Oenanthe oenanthe*	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3
Tawny Pipt	*Anthus campestris*	0	0	0	0	0	0	0	3	0	0	0	0	0	2	3	5
White wagtail	*Motacilla alba alba*	0	0	0	0	0	1	4	5	0	0	0	0	0	0	9	7
Yellow Wagtail	*Motacilla flava*	4	0	0	0	0	4	13	9	2	0	0	0	0	5	20	11
Golden pipit	*Tmetothylacus tenellus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesser Grey Shrike	*Lanius minor*	1	0	0	0	1	3	4	1	0	0	0	0	6	0	9	4
Blue -eared Glossy Starling	*mprotornis chalybaeus*	0	0	19	15	13	9	0	0	0	0	20	23	20	7	1	0
Ruppells-long	*Lamprotornis purpuropterus*	0	0	8	8	5	3	0	0	0	0	10	8	8	4	2	0

tailedGliossy Starling																	
Beautiful Sunbird	*Nectarinia pulchella*	1	0	2	1	0	4	0	2	1	0	1	2	5	1	2	2
Northern Red Bishop	*Euplectes franciscanus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Weaver	*Ploceus luteolus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black headed Weaver	*Ploceus cucullatus*	6	20	33	51	44	36	0	0	0	15	30	64	75	54	0	0
Northern Masked Weaver	*Ploceus taeniopterus*	0	0	0	0	4	6	0	0	0	0	0	0	0	0	0	0
House Sparrow	*Passer domesticus*	44	44	56	77	88	100	89	35	66	50	77	67	120	91	99	55
Sudan golden Sparrow	*Passer luteus*	0	0	5	4	2	0	0	0	0	0	8	5	0	0	0	0
Village Indigo Bird	*Vidua chalybeate*	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0
Pin-tailed Whydah	*Vidua macroura*	0	0	0	0	3	4	0	0	0	0	5	2	6	3	2	0
Crimson-rumped Waxbill	*Estrilda rhodopyga*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-cheecked Cordon-bleu	*Uraeginthus bengalis*	0	0	4	0	0	3	0	0	0	0	2	3	5	0	0	0
Red billed Fire finch	*Lagonosticta Senegala*	0	0	0	4	5	6	3	0	0	0	0	4	6	3	3	4
African Silverbill	*Lonchura malabarica*	6	0	4	0	0	6	5	6	5	0	4	2	7	6	9	12

Appendix Table 7 the nest measurement in study area in (cm) in 2013 and 2014

NO	length	width	depth
1	9	6	2
2	10	9	1
3	12	9	3
4	11	10	2
5	12	6	1
6	11	10	2
7	10	7	3
8	12	9	4
9	11	8	2
10	12	11	1
11	11	8	3
12	10	10	3
13	12	11	1
14	11	8	3
15	10	9	3
16	10	8	3
17	11	9	2
18	12	9	3
19	13	10	2
20	12	9	3
21	10	7	3
22	13	10	2
23	12	7	2
24	9	5	2
25	10	7	3
26	12	11	2
27	13	9	2
28	13	11	1
29	11	11	1
30	10	9	3
31	11	10	1
32	10	6	1
33	14	12	1
43	12	8	3
35	10	7	3
36	9	7	2
37	12	6	4
38	11	7	2
39	12	9	3
40	11	8	3
41	13	10	1
42	14	10	2
43	12	8	4
44	11	9	2
45	10	7	6
46	12	8	3
47	12	5	3
48	12	6	3

49	12	12	2
50	11	8	3
51	12	11	2
52	13	10	2
53	8	5	3
54	9	6	3
55	17	12	1
56	11	9	3
57	13	10	4
58	8	5	2
59	10	8	3
60	9	7	2
61	10	6	2
62	18	10	1
63	14	10	2
64	17	13	1
65	10	8	3
66	10	7	3
67	14	11	2
68	12	7	3
69	10	8	2
70	18	13	1
49	12	12	2
50	11	8	3
51	12	11	2
52	13	10	2
53	8	5	3
54	9	6	3
55	17	12	1
56	11	9	3
57	13	10	4
58	8	5	2
59	10	8	3
60	9	7	2
61	10	6	2
62	18	10	1
63	14	10	2
64	17	13	1
65	10	8	3
66	10	7	3
67	14	11	2
68	12	7	3
69	10	8	2
70	18	13	1

APPENDIX Table 8 Egg dimension in (mm)and egg weight in (g) at study area in 2013 and 2014 (N=30)

N0	Weight	Length	width	thickness
1	3.8	22.6	19.2	0.17
2	3.3	23.9	19.1	0.16
3	4.8	26.5	19.3	0.16
4	4.45	26.1	19.5	0.17
5	4.55	24.1	19	0.19
6	6.05	26.9	20.8	0.16
7	5.4	26.1	20.3	0.17
8	4.55	25.8	18.9	0.16
9	3.95	24.1	18.9	0.15
10	6.05	26.9	20.8	0.17
11	5.2	27.4	20.1	0.16
12	5.55	26	20.1	0.16
13	5.5	24.1	20.1	0.18
14	4.55	27	19.1	0.14
15	5.5	26.2	20.3	0.18
16	4.95	25.1	19.1	0.17
17	5.3	25.5	19.8	0.19
18	4.75	24.4	19.6	0.16
19	5.6	26	20.5	0.19
20	5.9	28.9	20.6	0.16
21	4.5	25.4	19	0.14
22	5.6	24.6	20.1	0.17
23	5.1	27.1	20.9	0.15
24	5.95	28.4	20.2	0.14
25	5.35	26.3	19.6	0.16
26	5.75	26	20.6	0.14
27	4.95	24.6	19.6	0.14
28	4.75	25	20.1	0.17
29	4.35	24	18.5	0.16
30	4.6	24.4	19.5	0.16

Appendix Table 9 Assessment of mineralogical content of laughing dove shell (ppm) in natural habitat

ca	Mg	Fe	Zn
9.708	0.414	0.016	0.0022
4.892	0.154	0.008	0.0016
15.14	0.296	0.018	0.0018
10.17	0.182	0.009	0.00046
15.82	0.478	0.011	0.0012
5.16	0.256	0.047	0.000995
11.9	0.4	0.031	0.000585
6.92	0.295	0.000149	0.000573
8.61	0.215	0.00255	0.000776

Appendix Table 10 Assessment of mineralogical content of laughing dove shell (ppm) in houses

Ca	Mg	Fe	Zn
18.486	0.526	0.012	0.0023
18.276	0.486	0.026	0.0035
8.38	0.319	0.019	0.000537
8.49	0.521	0.0055	0.0006
8.35	0.272	0.0062	0.000272

FINISH