THE DIURNAL ACTIVITY PATTERN OF THE GREY CROWNED CRANE, *BALEARICA REGULORUM GIBBERICEPS* IN MBARARA MUNICIPALITY, SOUTHWESTERN UGANDA

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MAY, 2014

DECLARATION

I NAGWERE NASSER, declare that the work presented in this research is my original work and has never been presented to any other institution of higher learning for any other award

Signed

…… ……

NAGWERE NASSER DATE

This report has been submitted to the faculty of science with my approval as a university supervisor.

Signed

…… …..……

GRACE RUGUNDA KAGORO (PhD) DATE

SUPERVISOR

DEDICATION

To my family for their abundant support, patience, understanding and for their love

To my father Kadooli Nagwere Abdul for showing me the excitement and joy of ornithology and for serving as an inspirational role model, my mother Nambuya Annet for leading her children into intellectual Pursuits.

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List of acronyms

MUST	Mbarara University of science and technology
IUCN	International Union for Conservation of Nature
SPSS	Statistical package for social scientists
CM	Centimeters
Dr.	Doctor
%	Percentage
SW	Southwest

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ABSTRACT

The study was conducted from January 2014 to April 2014. It was aimed at investigating the activity pattern of the grey crowned cranes, *balearica regulorum gibbericeps*. The number of the birds which were seen performing each activity at a particular time of the day beginning from 0700 to 1900 hours were documented. The diurnal activity patterns, habitat preference and association with other animals of the grey crowned cranes were studied in Mbarara municipality, south-western Uganda. The cranes were found in groups of up to 61 individuals. Groups of 3-12 individuals were the most frequently observed. Feeding was the most time consuming activity of the grey crowned cranes and juveniles were found to feed more frequently (31.2%) than the adults (28.8%) and calling was the least frequent daily activity (2.3%) for the adult and 1.9% for the juveniles. Frequencies of observation of feeding, flying, and calling showed two peaks, in early morning and late afternoon. Scanning, preening, and perching followed an inverse pattern, peaking at midday. The feeding habitat and the flock size changed between the morning and the evening. During the morning cranes showed a higher locomotor activity, foraging in smaller flocks and on grounds with higher food availability. On the contrary, during the afternoon, birds showed lower locomotor activity, aggregated in larger flocks, and foraged closer to each other on grounds with lower food availability. I explain these daily changes as a consequence of the risk-sensitive foraging behaviour of the cranes. Agricultural lands were the most occupied habitats by the grey crowned cranes (59%), followed by settlement areas (22%) and river banks were the least occupied habitats (19%). The grey crowned cranes associated more with the marabou storks and least with the sacred ibis. The activities varied according to season. Feeding was particularly more frequent in the wet season than the dry season. I recommend that a further study should be carried out to quantify the damage caused by cranes in the agricultural lands were they feed.

Keywords: Activity patterns, agricultural lands, feeding, grey crowned crane, river banks, scanning, and settlement areas.

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Grey Crowned-cranes (*Balearica regulorum*) belong to the family Gruidae and are found throughout the mixed wetland-grassland habitats of Eastern and Southern Africa (Walkinshaw, 1964; Meine and Archibald, 1996). They are non-migratory, yet make local and seasonal movements (Pomeroy, 1980, 1987) and are most abundant in Uganda, Kenya and Tanzania (Meine and Archibald, 1996). The general concept that birds select habitats based on vegetation structure or habitat physiognomy has been expressed by some researchers (Odum, 1950; James, 1971; Svardson, 1993). Avian population densities can be influenced by the singular or interactive influences of predation, intra and interspecific resource competition, parasites, diseases, habitat availability and weather (Andrewartha & Birch, 1954; Begon & Mortimer, 1986). The magnitude of the influence of these factors may vary in importance according to geographical area, food habits and migratory status of the birds (van Balen, 1980).

The grey crowned crane is omnivorous. It has been able to adapt to human settlement, foraging on crop species such as tips of grasses, seeds like groundnuts, soybeans, maize and millet, as well as native vegetation, invertebrates and small vertebrates.

Their conservation status is currently listed as vulnerable with an estimated population of approximately 47,000 – 59,000 animals (Bird Life International, 2009). However, due to loss of habitat (Meine and Archibald, 1996; Olupot *et al*., in press), populations are in swift decline (Beilfuss *et a*l., 2007). In Uganda, home of the subspecies *Balearica regulorum gibbericeps* and where the species is recognized as the national bird, current populations may be as low as 13,000 birds - a potential decline of more than 60% of the population since 1985 (Beilfuss *et al*., 2007). Of even greater concern is the low breeding success. Muheebwa- Muhoozi (2001) reported a decline in breeding success of 0.42 birds fledged per clutch over a 25-year period (1974/1975 - 1999/2000). If this trend continues, there

will be no successful breeding pairs within the country in the second half of this century. Understanding a species' fundamental niche (Hutchinson, 1957) and the threats to its survival are essential aspects for the future conservation of the species. Past research (Carswell *et al*., 2005) provided anecdotal information about the habitats where cranes are likely to be found and a map of the occurrence localities received from the National Biodiversity Data Bank at the Makerere University Institute of Environment and Natural Resources. Olupot and Plumptre (2006) conducted a nationwide study to determine the distribution of Grey Crowned-crane breeding sites throughout Uganda. This study will provide insight into the many different types of habitat preferred by the grey crowned crane, the food they eat and to find out the association between the grey crowned crane and other birds around Mbarara municipality.

Activity time budget data are useful in studying the ecological, behavioural and physiological aspects of birds (Verner, 1965; Evers, 1994; Lee, 1997; Hamilton *et al*., 2002; Jonsson & Afton, 2006), to develop appropriate survey techniques and ultimately to manage threatened or endangered species. Time-activity budgets reflect a combination of factors including individual physical condition, social structure and environmental conditions (Paulus, 1988). Information on diurnal activity patterns of the grey crowned crane around Mbarara municipality is scanty. This present study investigates the diurnal activity patterns of the grey crowned crane in different time blocks and habitats in Mbarara municipality, Mbarara District.

1.2 Literature review

There is an urgent need to know more about the world's most threatened bird species. These are officially listed in the Birdlife International publication, *Birds to Watch 2* (Collar *et al.,* 1994). The definition of globally threatened species has been agreed by the Species Survival Commission of the World Conservation Union (IUCN, 1994). The system puts different species into categories according to a set of criteria. In addition, threat might be measured as known or inferred change of extent or condition of habitat. This can only be applied if the habitat requirements of the target species are reasonably well known. For the

majority of bird species, and especially for many threatened species, these most basic parameters are simply unknown.

The Grey Crowned-crane is one of such threatened species. Cranes are large birds of open habitats that have adapted to life in wetlands and grasslands and have co-existed with growing human societies (Harris, 1994). On all the continents on which they occur, they are held in high esteem, and often feature in folklore. Within the past 150 years, human population growth, accelerating resource consumption, indiscriminate hunting, habitat destruction and competition with humans for wetland and grassland habitats, now threaten the survival of seven of the total of fifteen species of cranes. Cranes are among the world's most threatened families of birds (Harris, 1994; Meine & Archibald, 1996; Beilfuss *et al.*, 2007).

These fifteen extant species occur on five of the seven continents. The Family Gruidae are not represented in South America and Antarctica (Archibald, 1976; Krajewski, 1989; Harris 1994; Meine & Archibald, 1996; Morrison 1998). Archibald (1976) recognized fifteen species based on the unison calls as the primary characteristic distinguishing species. Krajewski (1989) revised the taxonomic relationships within the extant cranes using DNA- DNA hybridization and this study, together with further work by Fain *et al.* (2007) and Krajewski *et al.* (2010), confirmed the status of the fifteen extant species. Two distinct subfamily groups are recognized within the Gruidae namely the Balearicinae, or crowned cranes and the Gruinae or gruine cranes.

Six species of cranes occur in Africa. The Black Crowned Crane *Balearica pavonina* is near–threatened, the Wattled Crane *Grus carunculatus* and Blue Crane *Anthropoides paradiseus* are vulnerable, the Grey Crowned Crane and Eurasian Crane *Grus grus* are rapidly declining, and the Atlas Mountain population of Demoiselle Crane *Anthropoides virgo* is thought to be extinct (Beilfuss *et al.*, 2007).

The conservation status of the grey crowned crane is currently listed as vulnerable with an estimated population of approximately 47,000 – 59,000 animals (Bird Life International,

2009) and also due primarily to loss of habitat (Meine and Archibald, 1996; Olupot *et al*., in press), populations are in swift decline (Beilfuss *et al*., 2007). One of the major factors for the threat of cranes is the destruction of breeding and feeding habitats due to the shrinkage and conversion of wetlands into agriculture lands (Fry, 1987; Green and Hirons, 1991; Meyer and Turner, 1992; Archibald and Meine, 1996; Dady and Ayeni, 1996; Bento *et al*., 2007). The effect of livestock pressure, on the breeding activities of cranes however, has showed little significance in different studies (Ivey, 2007);

In Uganda, home of the subspecies *Balearica regulorum gibbericeps* and where the species is recognized as the national bird, current populations may be as low as 13,000 birds - a potential decline of more than 60% of the population since 1985 (Beilfuss *et al*., 2007). Of even greater concern is the low breeding success. Grey Crowned Cranes in East Africa and South Africa, breed during the wet seasons where there are wide expanses of wetlands and dense wetland vegetation. Muheebwa- Muhoozi (2001) reported a decline in breeding success of 0.42 birds fledged per clutch over a 25-year period (1974/1975 - 1999/2000). If this trend continues, there will be no successful breeding pairs within the country in the second half of this century.

Understanding a species' fundamental niche (Hutchinson, 1957) and the threats to its survival are essential aspects for the future conservation of the species. Past research (Carswell *et al*., 2005) provided anecdotal information about the habitats where cranes are likely to be found and a map of the occurrence localities received from the National Biodiversity Data Bank at the Makerere University Institute of Environment and Natural Resources. Olupot and Plumptre (2006) conducted a nationwide study to determine the distribution of Grey Crowned-crane breeding sites throughout Uganda.

Uganda contains an extensive network of wetlands and swamps, among the largest (per unit area) in Africa, which has important implications for conservation and management since cranes most often use wetland edges for nesting (Olupot and Plumptre, 2006). The country is also predominantly (38%) covered by cropland (Bartholomé and Belward, 2005), which often results in conflict with humans since many of these agricultural lands

border wetlands and are often used as nesting and foraging sites (Olupot and Plumptre, 2006). While Uganda is one of the most biodiversity-rich countries in Africa (Plumptre *et al*., 2007), it also harbors one of the highest human population densities (167.28 per km^2 (2010); World Bank report (2012). As such, providing accurate information about the extent of suitable habitat and the variables that may be important for driving crane site selection, are critically important for future conservation efforts Cranes need undisturbed nesting sites except the Indian race (Sarus crane) which is highly tolerant of the human activity. Wild cranes generally nest in isolated (privacy) places where the risk of predation is minimal (Archibald and Meine, 1996; Claire *et al*., 1996; Bento *et al*., 2007; Sundra, 2009).

1.2.1 Species account

The taxonomic history of crowned cranes has been controversial. Snow (1978) and Johnsgard (1983) regarded these two taxa as conspecific, whereas Walkinshaw (1973), Archibald (1976), Wood (1979) and Urban *et al.* (1986) treated them as separate species. Various molecular techniques have been used to study the phylogenetic relationships of this family. Ingold *et al.* (1989) used DNA- DNA hybridization and albumin micro-complement fixation (MC‘F) and compared the results to the electrophoretic techniques used by Ingold *et al.* (1987). Krajewski (1989) used DNA- DNA hybridization techniques and Fain *et al.* (2007) used DNA sequencing data from four mitochondrial and three nuclear loci to test previous hypotheses of interfamiliar relationships within the Family Gruidae. Krajewski *et al.* (2010) reviewed the phylogenetic relationships among all fifteen extant species of cranes using mitochondrial genomes to confirm that the genus Balearica is indeed part of the Family Gruidae. All these diverse approaches produced congruent patterns of evolutionary relationships, indicating that the two crowned cranes are best treated as two separate species.

Grey Crowned Cranes occur in developing countries, and are thus threatened primarily by population pressures and associated land-use changes which hinder conservation efforts (Allan *et al.*, 1997). These cranes are resident throughout their geographical range, from Kenya to South Africa, but exhibit restricted seasonal movements in response to the abundance and distribution of food and nesting sites (Pomeroy, 1980; Johnsgard, 1983; Meine & Archibald, 1996; Beilfuss *et al.*, 2007). The East African population *Balearica regulorum gibbericeps* makes up the majority of the Grey Crowned Crane numbers, being most abundant in Uganda, Kenya and Tanzania (Meine & Archibald, 1996).

Each of the two crowned crane species has two subspecies. The Grey Crowned Crane is divided into the South African Grey Crowned Crane, *B. regulorum regulorum* (Bennet, 1834) and East African Grey Crowned Crane *B.regulorum gibbericeps* (Reichenow, 1892).(Walkinshaw 1964; Meine & Archibald, 1996)(Figure 1). The two subspecies of Grey Crowned Crane are said to be biogeographically separated by the Zambezi River valley (Beilfuss *et al.*, 2007).

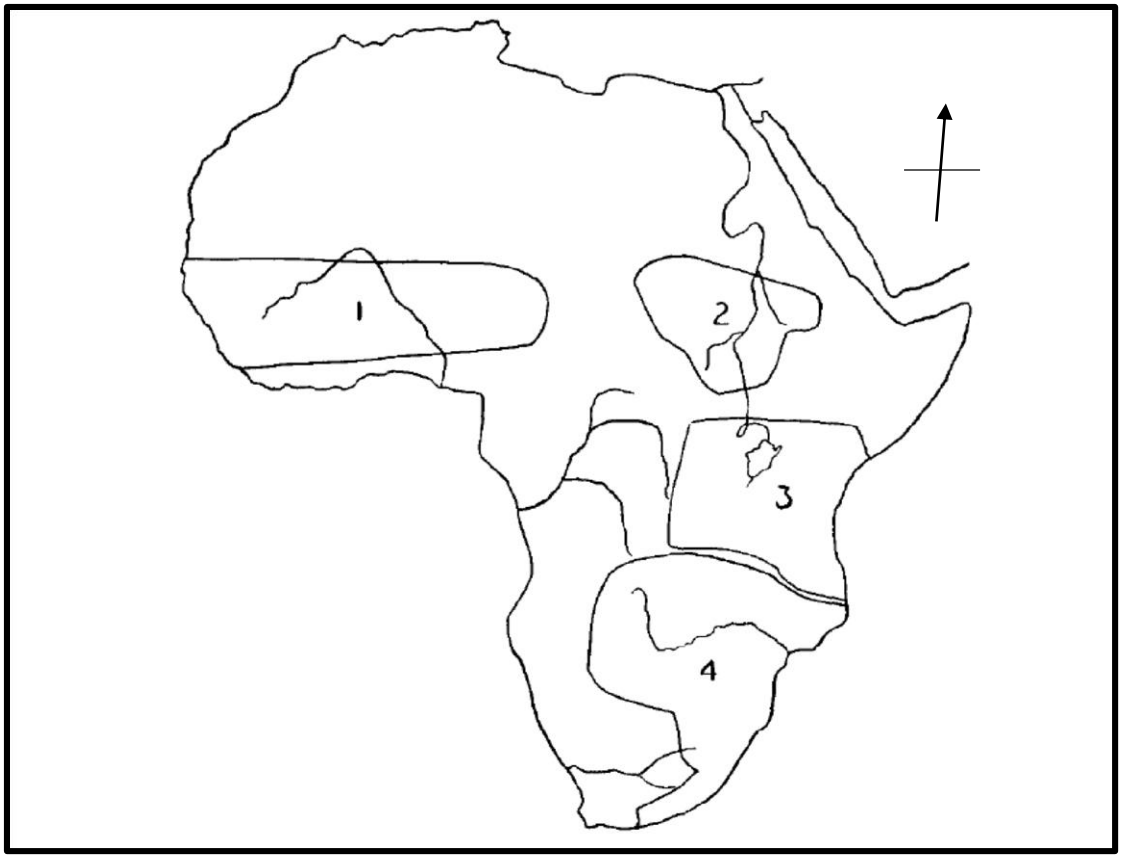


Figure 1: Ranges of the subspecies of the African crowned cranes: **(1) West African Black Crowned Crane Balearica pavonina pavonina (2) Sudan Black Crowned Crane Balearica pavonina ceciliae (3) East African Grey Crowned Crane Balearica regulorum gibbericeps (4) South African Grey Crowned Crane Balearica regulorum regulorum (Walkinshaw, 1964).**

The Black Crowned Crane *Balearica pavonina* of west Africa ranges from Senegal to Lake Chad, south to Sierra Leone, Ghana, northern Nigeria, Gambia, the Gold Coast and Guinea, with a small population occurring in the Sudan, western Ethiopia and northern Uganda (Walkinshaw, 1964; Johnsgard, 1983). The Grey Crowned Crane *Balearica regulorum* occurs in eastern and southern Africa, which includes Uganda, Rwanda, Burundi, Kenya, Tanzania, Malawi, Mozambique, Angola, Zambia, Zimbabwe and South Africa (Walkinshaw, 1964; Urban, 1986; Harrison *et al.*, 1997; Meine & Archibald, 1996; Parker, 2005).

The South African Grey Crowned Crane *B. regulorum regulorum* occurs in Angola, Zimbabwe, Mozambique and South Africa. Several hundred kilometers in Zimbabwe separate *B.r. regulorum* from the East African subspecies *B.r. gibbericeps* (Meine & Archibald, 1996; Morrison, 1998; Barnes, 2000; Parker, 2005).

1.2.2 Habits and diet

Grey Crowned Cranes are largely associated with wetlands, but forage extensively in associated dry land habitats. These may include short to medium height open grassland, lightly wooded savanna and agricultural fields (Walkinshaw, 1964; Pomeroy, 1980; Johnsgard, 1983; Meine & Archibald, 1996; Harrison *et al.*, 1997; Hockey *et al.*, 2005). According to Pomeroy (1980), cranes feed mainly in grasslands but require wetlands to breed in and where possible large trees for roosting. Johnsgard (1983), Meine & Archibald (1996) and Hockey *et al.* (2005) give comprehensive species accounts which mention that they forage predominantly in open grassland habitats. Grey Crowned Crane feed on leaves and especially the seeds of grasses such as couch grass *Cynodon dactylon* and sedges *Cyperus* spp (Hockey *et al.*, 2005). They feed by pecking and stripping grass seeds from the stem with an upward motion of the bill and stamp their feet to disturb insect prey. These insects may include locusts and grasshoppers Family: Acrididae, army worms *Spodoptera* spp. and millipedes Family: Sphaerotheriidae. According to Hockey *et al.* (2005) they probably eat fallen grain as well as germinating and planted seeds in crop lands.

Due to the fact that Grey Crowned Cranes have a generalist feeding strategy, the species has generally adapted well to settlement. In East Africa, most crane populations now occur in human-modified environments (Meine & Archibald, 1996). Muheebwa (2004) points out that Grey Crowned Cranes exploit cultivations and that maize is particularly important in their diet in Uganda. In South Africa, 56% of records of Grey Crowned Crane are from cultivated lands, 7% of which are recorded on maize fields (Hockey *et al.*, 2005). This supports the fact that cultivated lands are indeed utilized by Grey Crowned Crane as foraging areas.

According to Allan and Ryan (1993) however, detailed dietary analyses only exist for the Sandhill Crane, with some work done on the fecal analysis of Whooping Cranes by Hunt and Slack (1989). Reinecke and Krapu (1986) found that the composite diet of spring migrating Sandhill Cranes in Nebraska contained 97% maize. Cranes staging in September in Western Wyoming consumed 60-71% barley and wheat (Lockman *et al.*, 1987). Tacha *et al.* (1985) found that wheat constituted > 95% by volume of the aggregate volumes of foods consumed by Sandhill Cranes in Saskatchewan. These studies into the dietary composition of Sandhill Cranes illustrate the importance of maize within the diet of Sandhill Cranes in particular. No comparable studies of the diet of Grey Crowned Crane have however been undertaken.

1.3 Research problem

The grey crowned crane is associated with a mixture of wetland and open grassland habitats, including flood plains, marshes, rivers and savannah. Medium height open grassland near wetlands is preferred foraging habitat, while tall trees are required for nesting. However, there has been a lot of habitat destruction due to encroachment by humans on the wetlands for agriculture. This has forced most of the grey crowned cranes to migrate to the peri-urban region. The association of these birds with the people around and the new environment would influence them to behave in a certain manner different from that in their natural setting.

This species has been uplifted to Endangered by the international union for conservation of nature (IUCN) because threats such as habitat loss and the illegal removal of birds and eggs from the wild have driven very rapid declines during the past three generations (45 years).

The group dynamics of the grey crowned cranes, details of their distribution, ecology and habitat requirements, and foraging behavior among others for the species around the urban setting are not sufficient. This research is thus required to generate and document the general behavior pattern of the grey crowned crane in Mbarara municipality.

1.4 Aims and objectives of the study

1.4.1 General objective of the study

The general objective of the research was to establish the activity pattern of the grey crowned cranes in Mbarara municipality.

1.4.2 Specific objectives

The objectives of the study were to;

i. Estimate the group dynamics of the grey crowned crane in Mbarara municipality
ii. Determine the habitat preference of the grey crowned crane in Mbarara municipality.
iii. Determine the activity patterns of the grey crowned crane.
iv. Document the association of the grey crowned crane with other animals.

1.5 Research questions

The above objectives were meant to answer the following questions;

i. What is the number of adults and juveniles in a group of grey crowned cranes?
ii. Which habitat do grey crowned cranes prefer in an urban habitat?
iii. What is the most frequent activity by the grey crowned crane?
iv. Which other animals do the grey crowned cranes associate with?

1.6. Justification of the study

Studying the behavior pattern of the grey crowned cranes is helpful in shading more light to the full understanding of the general ecology of the grey crowned cranes in a peri-urban setting.

The findings of the study will also provide guidelines on how to conserve the species in an urban setting since the habitat preference, the activity day time budgets and the group dynamics would have been known.

CHAPTER TWO

2. MATERIALS AND METHODS

2.1 Study area

Mbarara town is the main commercial Centre in south-western Uganda and is located about 295 kilometers by road from Kampala, the capital city. The town has a municipality status. Mbarara town Centre lies on coordinates: 00 36’ 48”S, 0300 39’ 30”E (Latitude: -0.6132; Longitude: 30.6582) (Fig 2). In 2002, the national census estimated the population of Mbarara town at 69,363 (Population and Housing Census Report, 2002) but the Uganda Bureau of Statistics estimated the population of Mbarara at 97,500, in 2008 (UBOS Report 2008), from http://en.wikipedia.org/wiki/Mbarara).

2.1.1 Study habitats

Mbarara municipality is made up of three divisions of Kamukuzi, Nyamitanga and Kakoba. The study was carried out in three different habitats: agricultural lands, river banks and settlement areas. The three habitats were identified purposively by the researcher in each division depending on the presence and availability of the grey crowned cranes in these habitats. Flocks were located opportunely in all the habitats during regular circuits of the study area. I did not repeat the same circuit to avoid possible relationships between a particular division, habitat, daytime and activity of the birds. The agricultural lands were under cultivation of maize, millet and pea nuts (or ground nuts); river banks are characterized by the predominance of riverside vegetation and settlement areas have majorly buildings.



Figure 2: Map of Mbarara showing the study area.

2.1.2 Climate

On average, the temperatures are always high. Most rainfall (rainy season) is seen in March, April, October and November. Mbarara has dry periods in June and July. On average, the warmest month is February. On average, the driest month is June with 26 mm. Most precipitation falls in April, with an average of 132 mm. The warmest month of the year is March with an average temperature of 20.9 °C. In December, the average temperature is 19.8 °C. It is the lowest average temperature of the whole year. The difference in precipitation between the driest month and the wettest month is 106 mm. The average temperatures vary during the year by 1.1 °C.

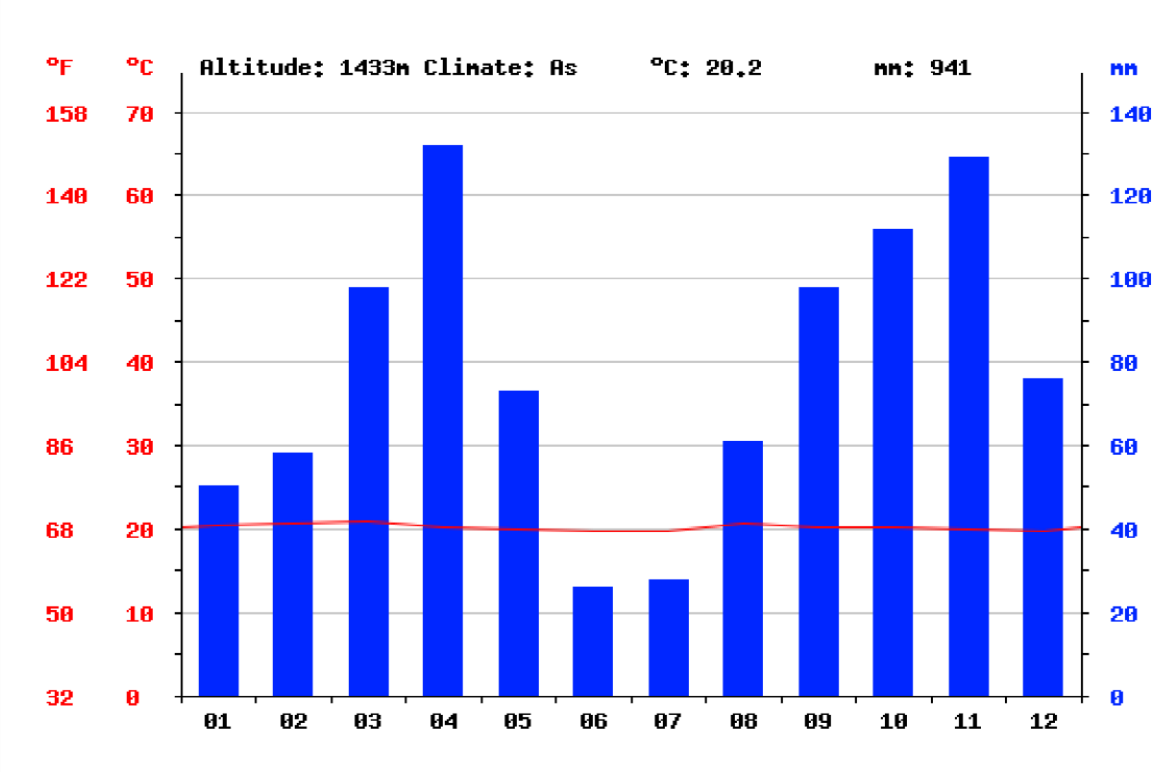


Figure 3: Mean monthly rainfall and temperature figures experienced in Mbarara

2.2 Materials used

The following materials were used during the study;

- **Binoculars**: these were used to observe the details of the activities of the grey crowned cranes at a distance.
- **Photographic camera**: this was used to take photographs of the grey crowned crane as it performs its activities of feeding, perching, among others.
- **Clock/watch**: this was used to for timing the activities of the bird as it carries out its activities.
- Notebook and pens to record the observations made in the field.

2.3 Methods used

2.3.1 Direct observation

Data was collected three time each week from February to March in all the three habitats. Each day was divided into four time blocks: early morning (0700-0950hr), late morning (0900-1250hr), midday or afternoon (1300-1550hr) and late evening (1600-1800hr).

Focal animal sampling method (Altman, 1974) was used to study activity patterns of the grey crowned crane. Each observation session was started with the choice of a focal individual bird, by selecting the closest readily visible individual. Possibly a single bird was observed throughout the day, if a bird gets out of sight another bird was selected wherever closest to the observer. Observations were conducted free from precipitation and strong winds to ensure clear vision of the bird. The focal individual was observed with 7 x 50 field binoculars continuously for 10 minutes followed by a 5-minute break. In one hour six such samples were taken and the frequencies were tallied and recorded.

A photographic camera was also used to take the photos of the grey crowned cranes as they fed, preened, and associated with other birds and as they moved in groups, which were later interpreted. The frequencies of observations of different activities were calculated and

from these values the percentage for each activity during different times on the day calculated. The activities were divided into eight categories: Scanning, flying, Feeding, Preening, Calling, dancing walking and perching.

In estimating the group dynamics, the flocks were located opportunely during regular circuits of the study area. I did not repeat the same circuit to avoid possible relationships between a particular site, habitat or daytime, and activity of the birds. From each flock I recorded the flock size, the number of adults and juveniles. Birds were aged as adults or juveniles on the basis of their head and neck colour (Cramp & Simmons 1980). I observed adults and juveniles in succession, in order to control for possible age differences in my sample due to flock size, food availability, ground type, or any other physical or social factor.

Habitat preference was determined by recording the number of times the birds were seen in the different habitats that is agricultural lands, settlement areas and riverbanks and the total frequencies were obtained to determine which habitat had the highest frequency.

2.4 Statistical analysis

The collected data from the field was analysed using Microsoft excel and were summarized in tables, figures and plates to enhance comprehension and interpretation as shown in the subsequent chapters.

CHAPTER THREE

3. RESULTS

3.1 The group dynamics of the grey crowned cranes

Various group dynamics were recorded by direct observation. The birds were categorized as adults or juveniles basing on the external features. The juvenile are grey overall with brown crown and nape. The body is grey to brown, the eyes are brown and the cheeks are feathered as compared to the adult.

The grey crowned cranes were found to interact in groups of three or more than three individuals. However, some individuals were solitary and others were found in pairs. Agriculture lands were found to sustain the highest group sizes and buildings also provided good perching areas for the birds.

The flocking pattern of the grey crowned cranes consisted of flying in lines, settling on the ground, buildings or tree branches and gathering in a tight bunch. The flock swam about for 2-3 minutes. After this, one bird landed followed by others. Flocks of these birds located harvested maize gardens and swam around them in decreasing circles. Once they finished feeding, they perched in flocks. They formed flocks at the roosting site.

Groups of about 3-12 individuals were the most frequently observed followed by pairs and singletons. However, big sizes of up to sixty one individuals were observed (Fig 4; Plate 1, A, B, C and D).

Nyamitanga division had the highest number of cranes followed by Kamukuzi and Kakoba division had the least number of cranes (Appendix 2).


A


B


C


D

Plate 1: ***A) pair of adult grey crowned cranes; B) A single grey crowned crane*****; C) A group of grey crowned cranes; D) An adult and juvenile.** Source: Field data 2014

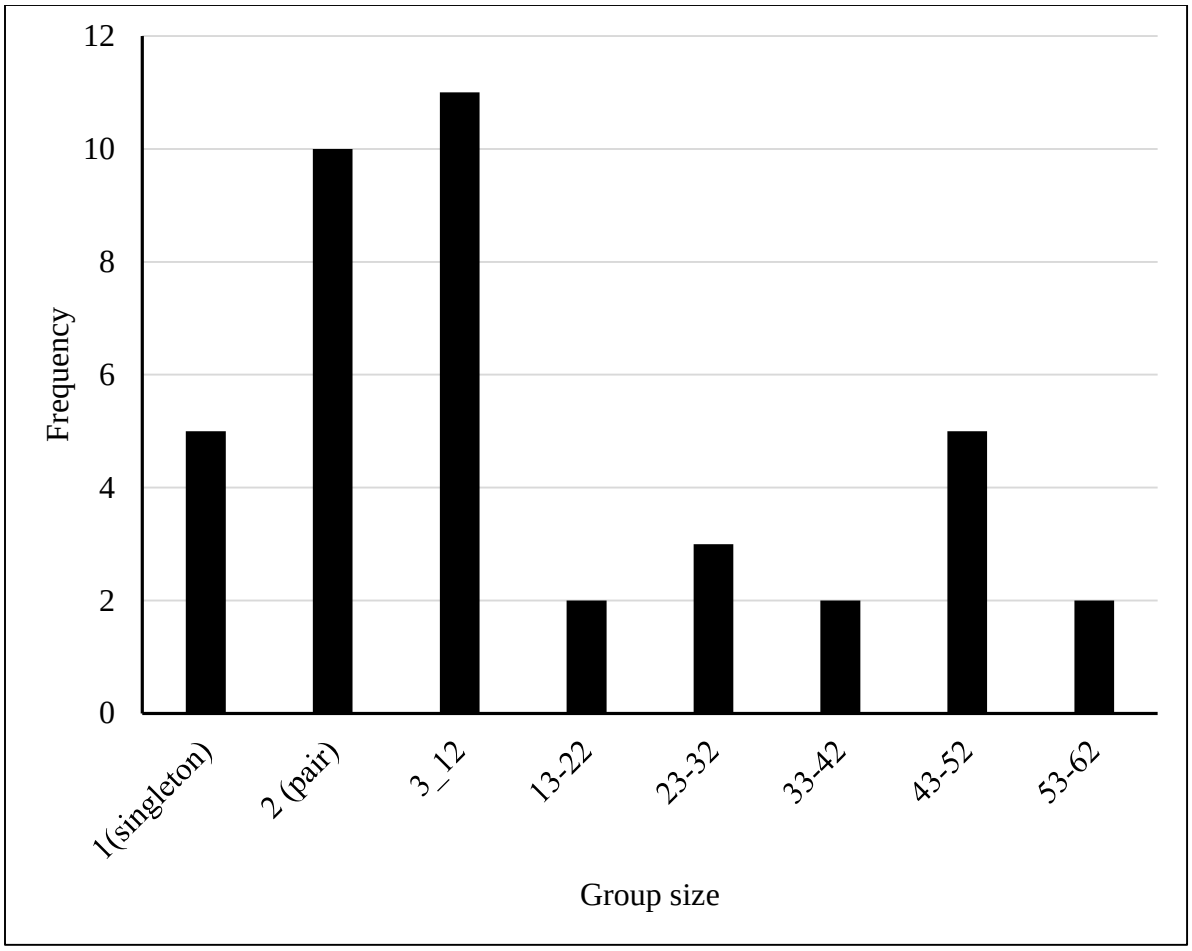


Figure 4: A bar graph showing the group dynamics of the grey crowned cranes

Generally, there were more adults in the groups than the juveniles, most pairs were observed without juveniles and others birds were completely single adults. (Table 3). The biggest group size contained 61 birds with 41 adults and 20 juveniles.

In general, group sizes increased from morning to evening with the biggest group observed between 1700-1750 hours (Fig. 5)

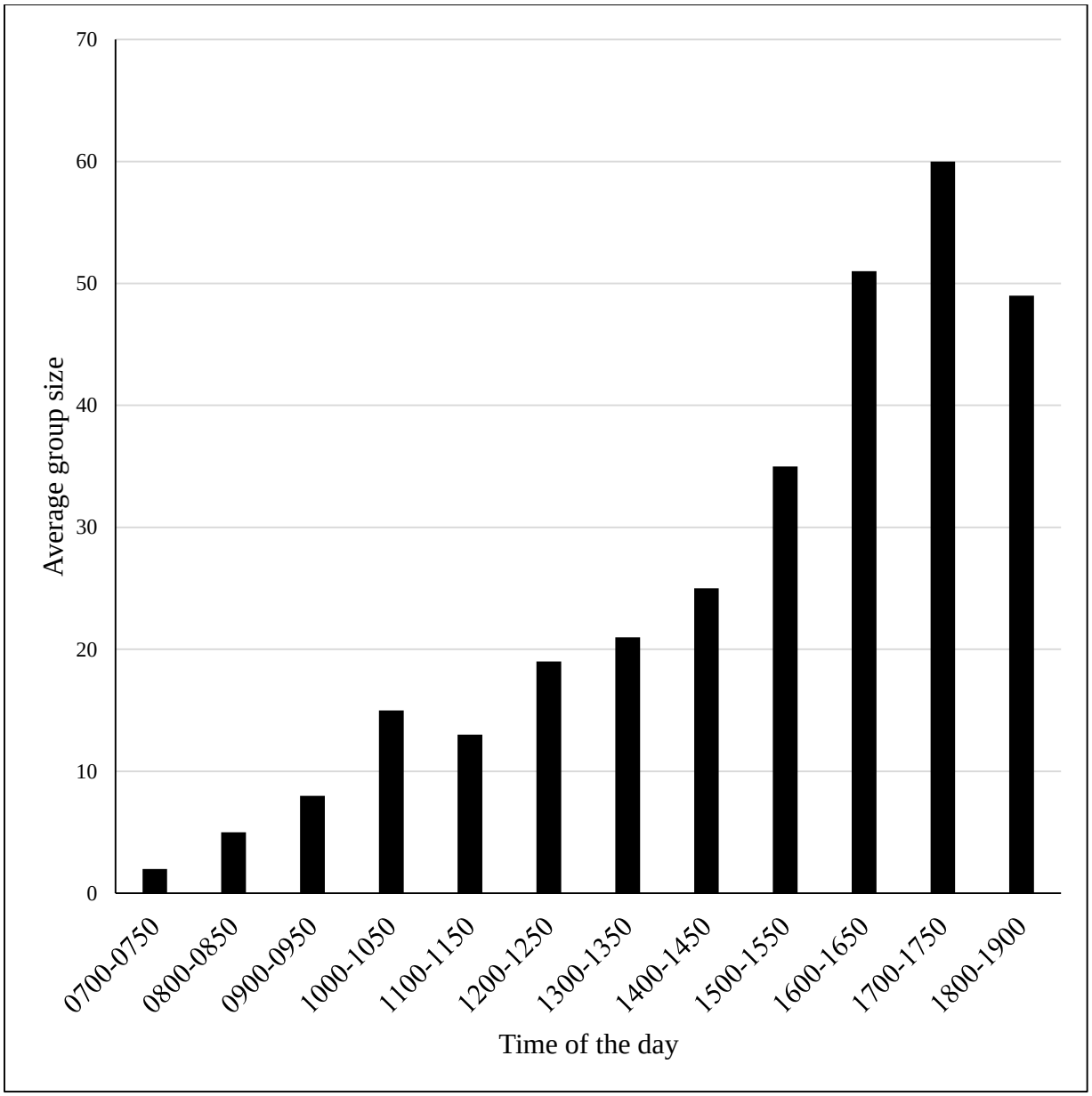


Figure 5: Variation in the average group sizes with time of the day

The table below shows the different proportions of adults and juveniles in relative to the group size

Table 1: showing the group sizes and the different proportions of adults and juveniles in each group

GROUP SIZE	ADULTS	JUVENILES
1(singleton)	1	0
2 (pair)	2	0
3	2	1
4	2	2
5	2	3
7	4	3
8	4	4
10	10	0
15	8	7
18	10	8
24	18	6
25	15	10
30	18	12
35	24	11
38	23	15
44	30	14
45	30	15
46	35	8
48	30	38
50	45	5
53	49	4
61	41	20

3.2 Habitat preference of the grey crowned cranes in Mbarara municipality

The habitat preference was studied by summing up the number of times the bird was seen in a particular habitat during each activity. The availability of the grey crowned crane in a particular habitat was greatly influenced by the type of food and the perching materials. Generally, agricultural lands were the most favourable habitat for the grey craned cranes as they were observed most of the time performing their activities there during the study (Figure 6). The grey crowned cranes preferred agriculture lands for foraging activities. However, river banks and settlement areas or infrastructural areas also provided a favourable habitat for preening and perching.

Cranes used cereal and maize stubbles and sown fields as their main feeding grounds. Use of grazing land was only supplementary. The type of foraging ground changed significantly throughout the day: cranes preferred grounds with much food on the ground during the morning and sown resting sites.

Generally, agricultural lands were the most frequently used habitat by the grey crowned crane (59%), followed by settlement areas (22%) and river banks were the least used habitat (19%) (Figure 5). The frequency of observation of different activities except flying varied according to type of habitat use. Frequency of observation of feeding were highest in agricultural lands (460) and lowest in settlement areas (150). Scanning, perching and preening usually were higher in settlement areas and the frequencies of flying, dancing, walking, and calling were almost similar in all the habitat types (Figure 7).

Amongst the three divisions of Mbarara municipality, the grey crowned cranes were observed in large numbers in Nyamitanga, followed by Kamukuzi and least observed in Kakoba division.

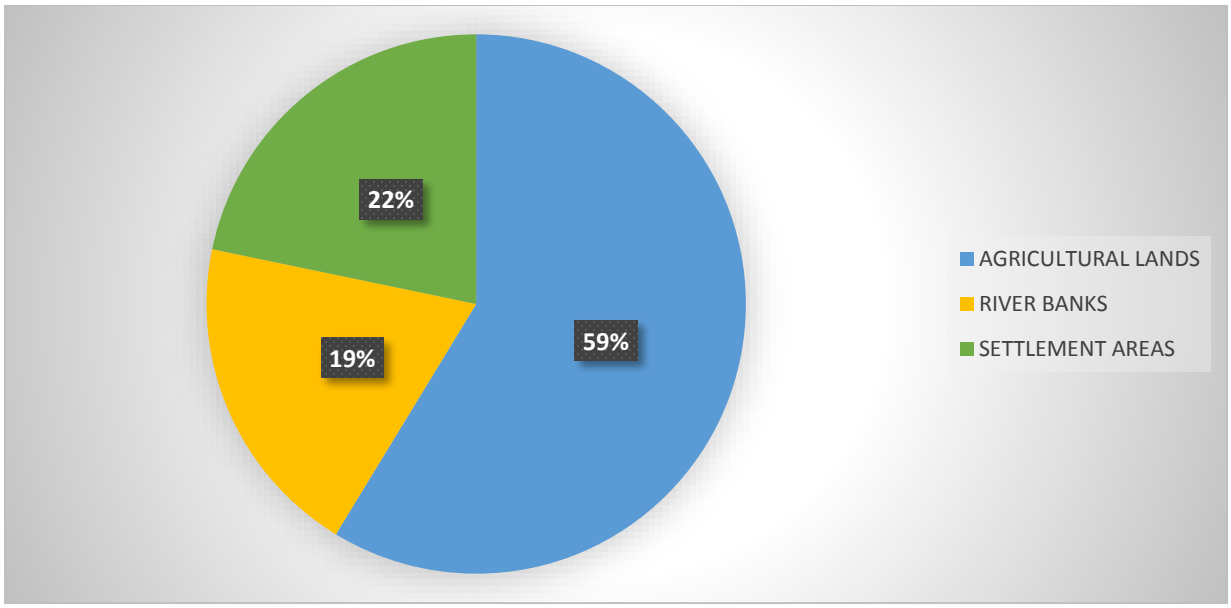


Figure 6: Overall (%) habitat use by the grey crowned crane

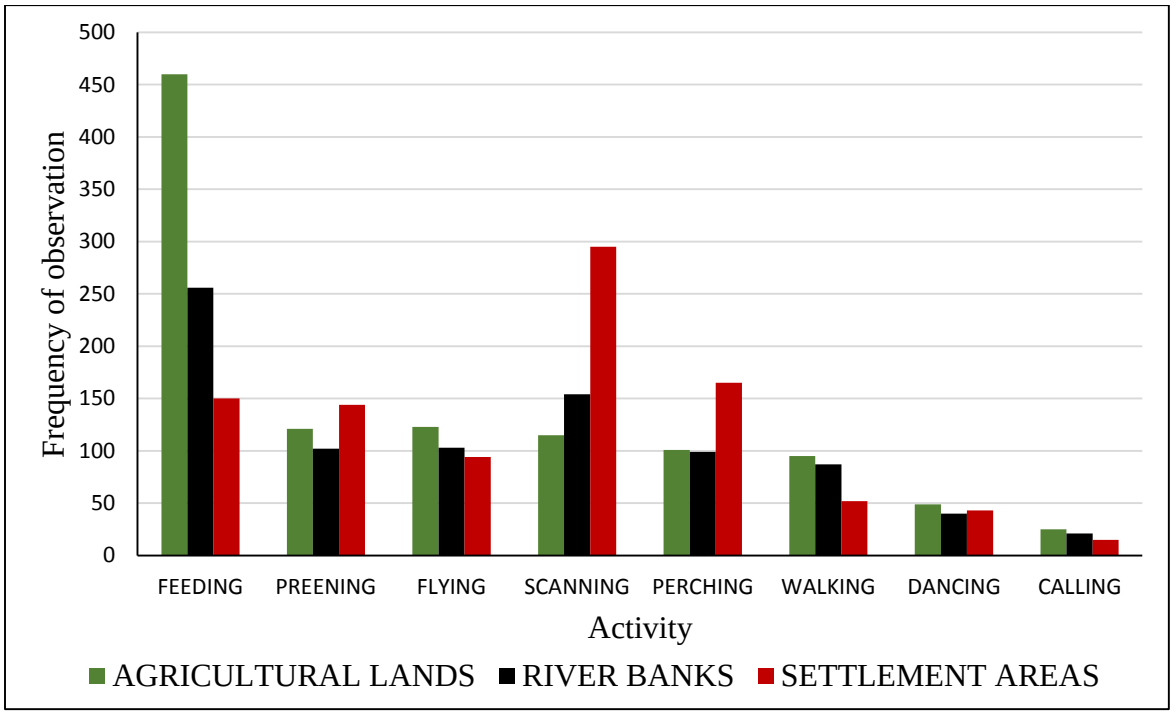


Figure 7: A clustered bar graph showing the frequency of observation of different activities according to habitat

3.3. Activity patterns of the grey crowned crane.

Generally, feeding was the most time consuming and important diurnal activity of the grey crowned crane for both the adult and the juvenile (28.8% and 31.2% respectively), followed by scanning (19.7% and 19.3 % respectively), preening (14.7% and 14.1 % respectively), perching (12.9 and 12.3% respectively), flying (11.2% and 10.8% respectively), walking (7.9% and 8.3% respectively), dancing (2.5% and 2.0% respectively)and calling (2.3% and 1.9% respectively) (Figure 8). There was a relationship between time allocated to each activity and time of day (Table 2). Frequency of observation of different activities except calling, walking and dancing varied according to type of habitat use (Appendix 5). Different activities of the grey crowned crane also varied in the different time blocks for both the adult and the juvenile (Table 2, A and B)

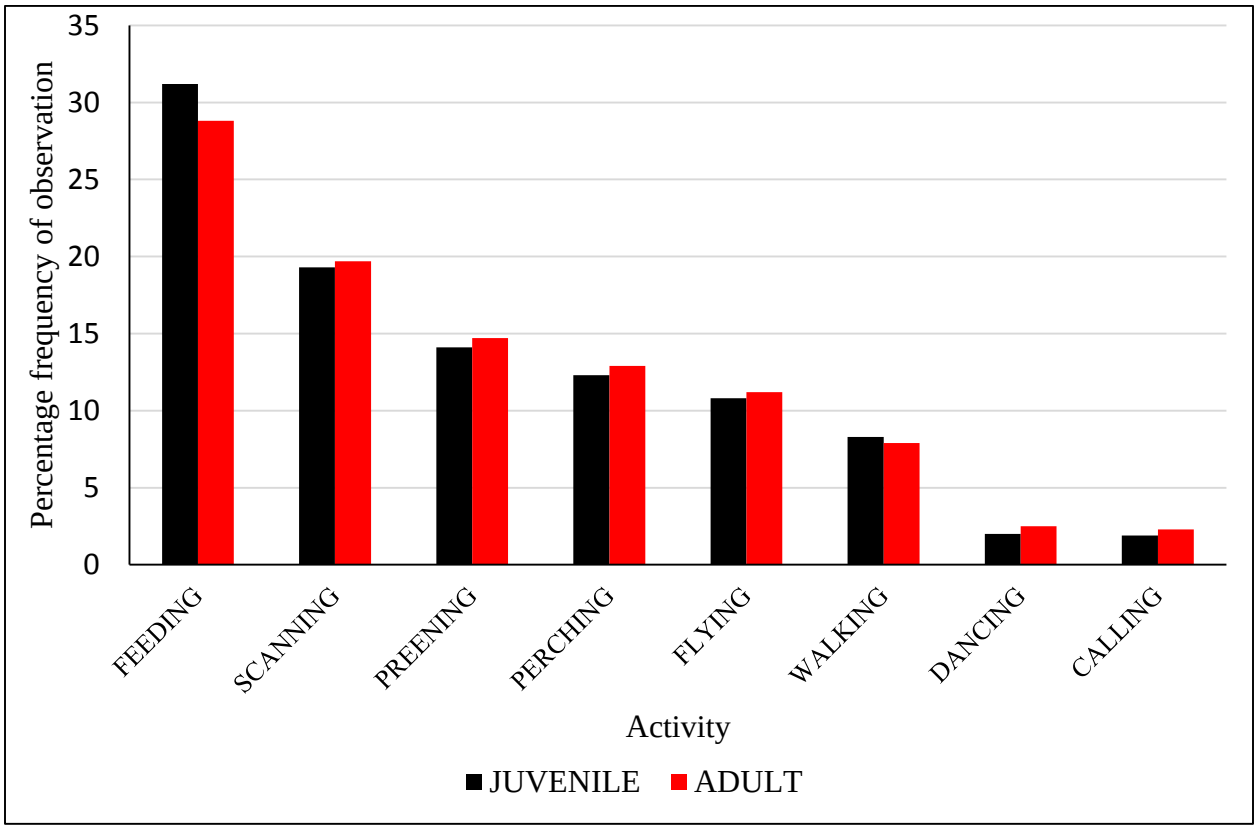


Figure 8: Overall percentage diurnal activities of the grey crowned crane

Table 2: Frequency of observation of different activities according to time of the day: A for the adult and B, for the juvenile

A

ACTIVITY	TIME OF THE DAY (HOURS)			
	0700-0950	1000-1250	1300-1550	1600-1900
FEEDING	240	196	176	232
PREENING	96	155	154	32
FLYING	106	47	61	116
SCANNING	148	47	61	116
PERCHING	72	90	163	53
WALKING	76	55	46	54
DANCING	22	13	27	12
CALLING	16	5	12	35

B

ACTIVITY	TIME OF THE DAY (HOURS)			
	0700-0950	1000-1250	1300-1550	1600-1900
FEEDING	251	210	185	242
PREENING	85	151	144	20
FLYING	104	44	55	106
SCANNING	141	174	147	87
PERCHING	63	89	152	47
WALKING	78	53	49	57
DANCING	11	14	22	11
CALLING	8	5	9	32

3.3.1 Feeding

Feeding activity varied among day light hours and was higher in the morning (0700-0950) and evening (1600-1900) than midday in both adults and juveniles (Table 5 A and B; Figure 9). The daily pattern of feeding activity showed two peaks both in adults and juveniles. The lowest feeding was observed between 1300 hours and 1450 hours (Figure 8). The frequencies of feeding were highest in agricultural lands and lowest in settlement areas (Appendix 5). Juvenile cranes were seen to feed more than the adults during all the hours of the day.

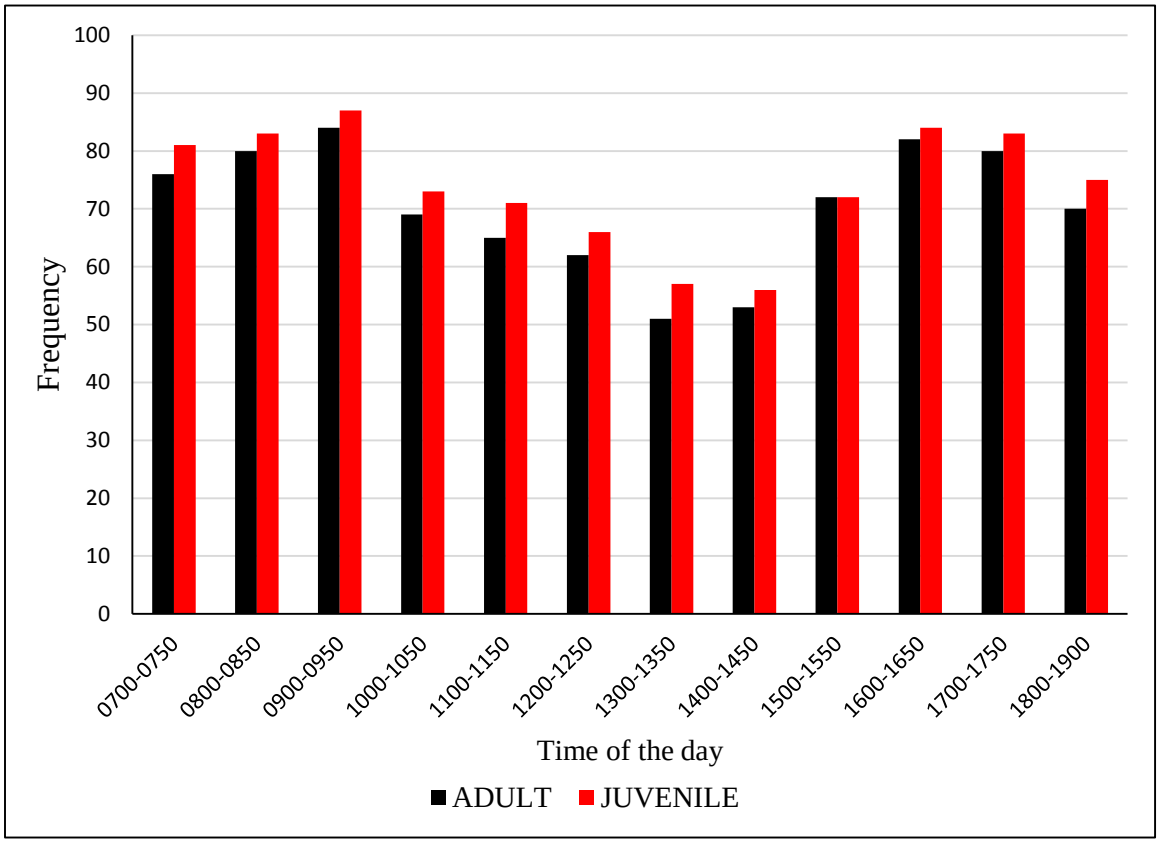


Figure 9: Variation in the frequency of feeding for both adults and juveniles with time of the day

3.3.1.1 Diet

Grey crowned cranes employ different foraging techniques for different food types. Tubers and rhizomes are dug and a crane digging for them will remain in place for some time digging and then expanding a hole to find them. They foraged for insects and animal prey by slowly moving forwards with their heads lowered and probing with their bills on the ground.

The grey crowned cranes fed on different types of food during the study period. The birds were observed to feed on maize, grasses, insects, millet, sorghum, ground nuts and other food types which were not clearly identified. The number of times the bird feed on a particular food type were observed and recorded. The graph below shows the types of food fed on by the bird.

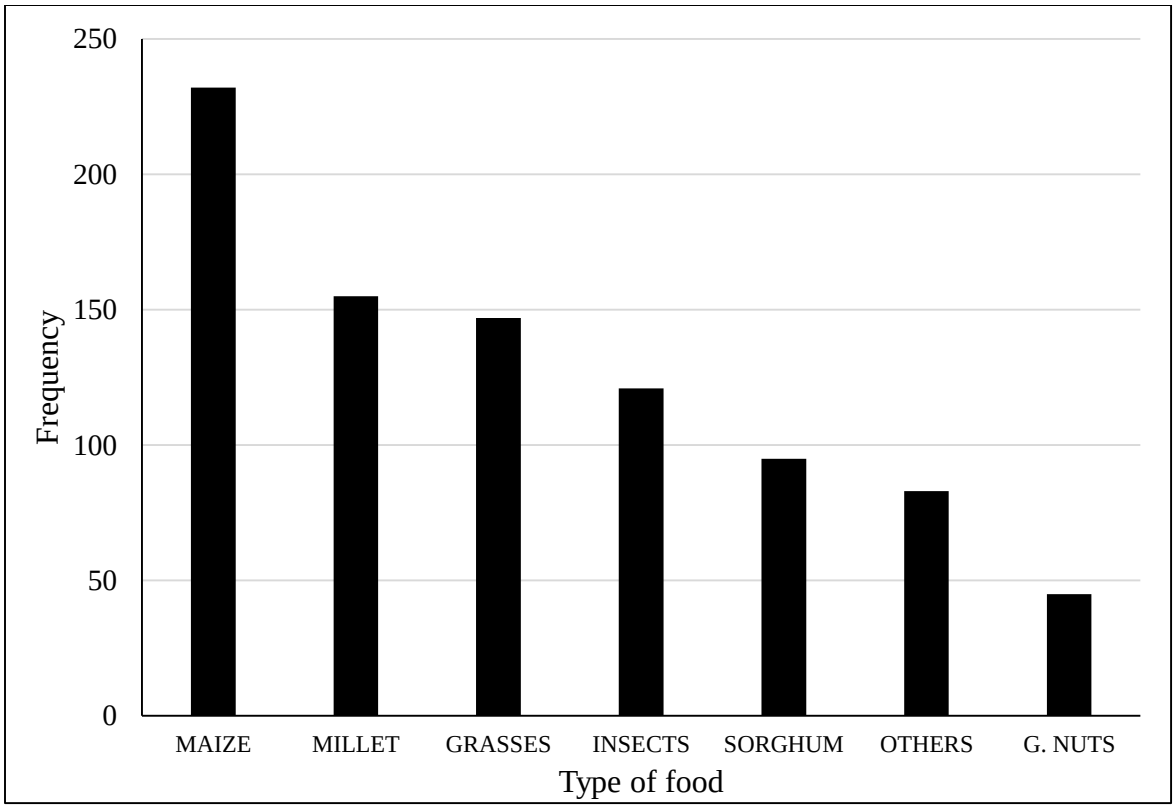


Figure 10: Types of food fed on by the grey crowned crane

3.3.2 Scanning

Scanning was the second most prevalent activity of the grey crowned crane. It was done in pursuit for food and to be vigilant against enemies. The adult bird scanned more than the juvenile. Scanning usually was higher in settlement areas and least in agricultural lands (Figure 7)

Scanning was highest at mid-day compared to the morning and evening. Scanning increased in the morning from 0700 hours to 1050 hours, it then decreased up to 1250 hours and attained a peak between 1300-1350 hours. It the decreased gradually until 1900 hours (Figure. 11).

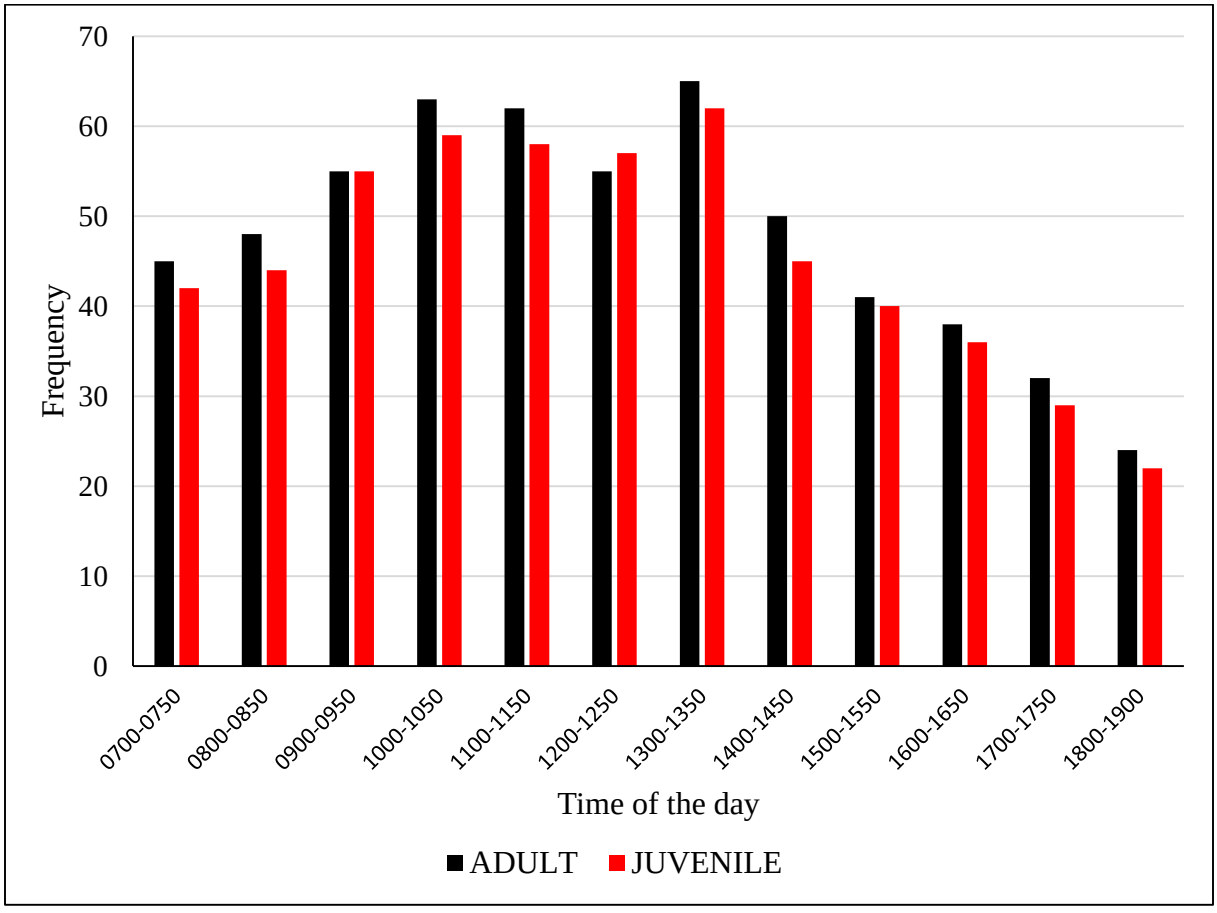


Figure 11: Variation in the frequency of scanning of the grey crowned crane with time of the day

3.3.3 Preening

By perching on buildings, termite mounds or trees, the bird preened elaborately (Plate 2). It was an important activity in plumage care performed by the bill. The grey crowned crane preened its neck first followed by the back, then the wings, breast, flank and tail. While preening, the bird fluffed its feathers. Preening was most frequent during perching hours (Figure 12).



Plate 2: Cranes standing on the top of a building during preening. *Source: Field data 2014*

The frequency of preening behaviour increased as the day proceeded and reached the peak rate between 1300 and 1350 hours. It then decreased up to 1750 hours. There was no preening between 1800 hours and 1900 hours. The least value was observed between 1700 and 1750 hours in the evening. Preening activity for both the adult and juvenile had a similar trend during the course of the day. The adult preened more than the juvenile (Figure 13).

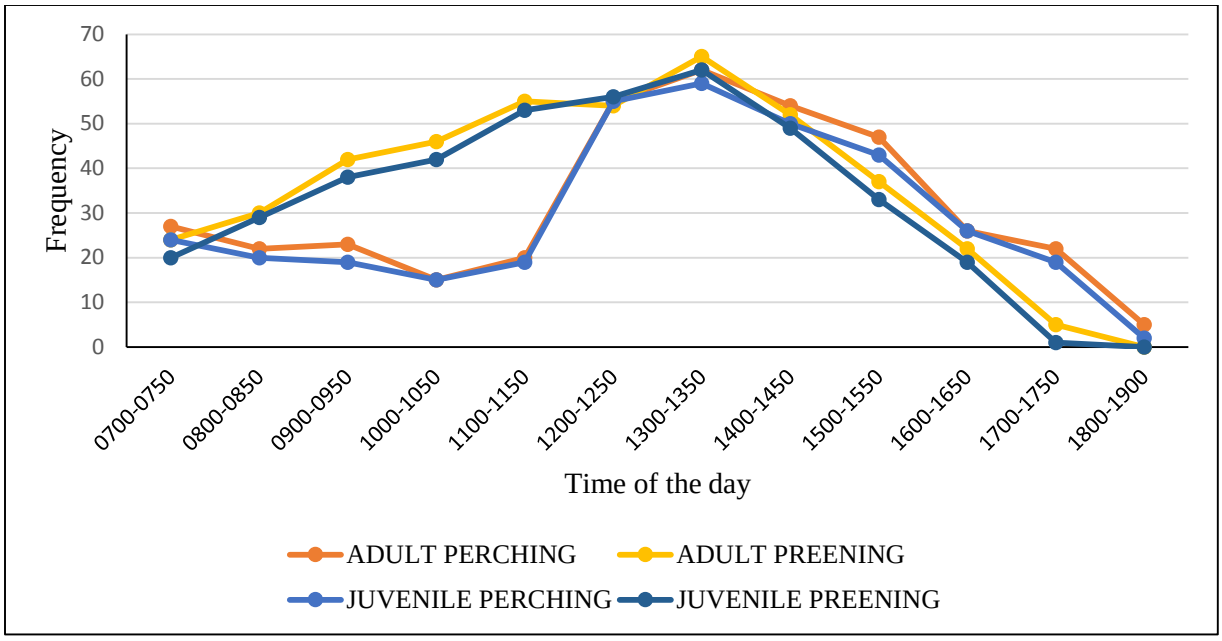


Figure 12: Relationship between perching and preening with time

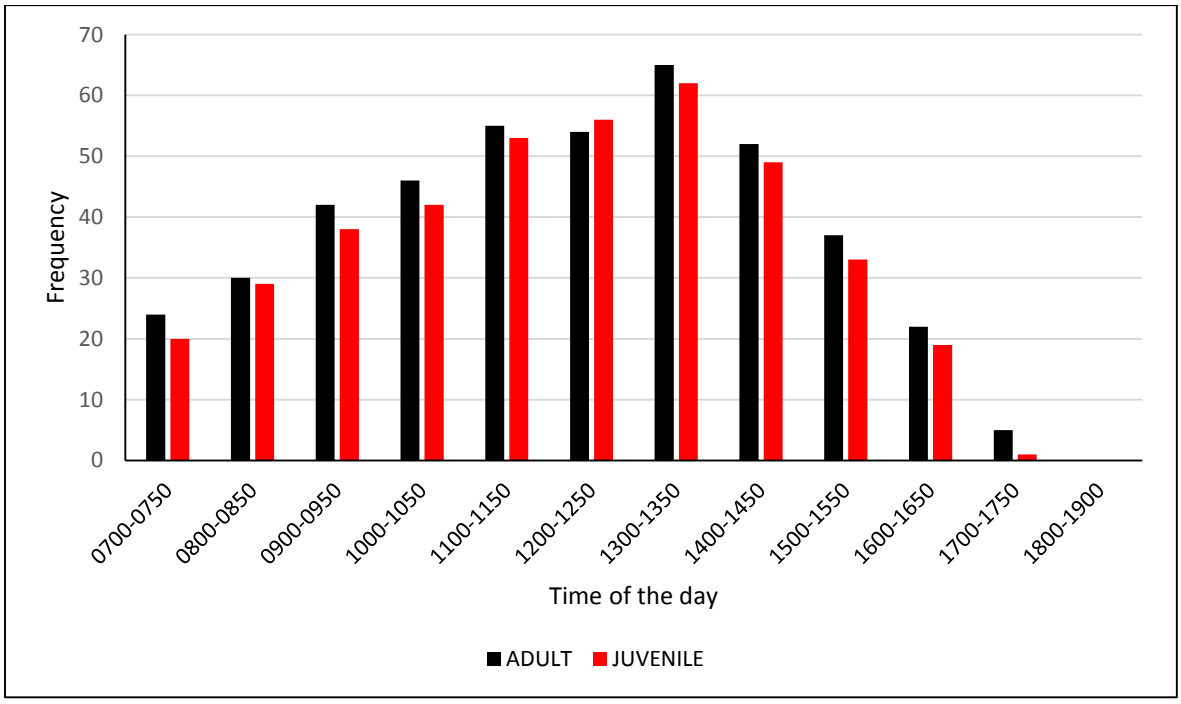


Figure 13: Variation of preening frequency of the grey crowned crane with time of the day

3.3.4 Perching

The bird perched upright on buildings, termite mounds, or trees with the long neck held in 'S' shape exhibiting the streamlined body (Plate 3.3). In most cases, perching synchronized with preening, dancing and calling.



Plate 3: Grey crowned cranes perching on top of a building

Perching was highest in the afternoon hours when feeding was low. Perching decreased slowly in the morning from 0700 to 1050 hours. It then increased throughout the afternoon until it gained a peak between 1300 to 1350 hours. Perching then decreased gradually up to 1900 hours. It was higher in adults than in juveniles (Figure 14).

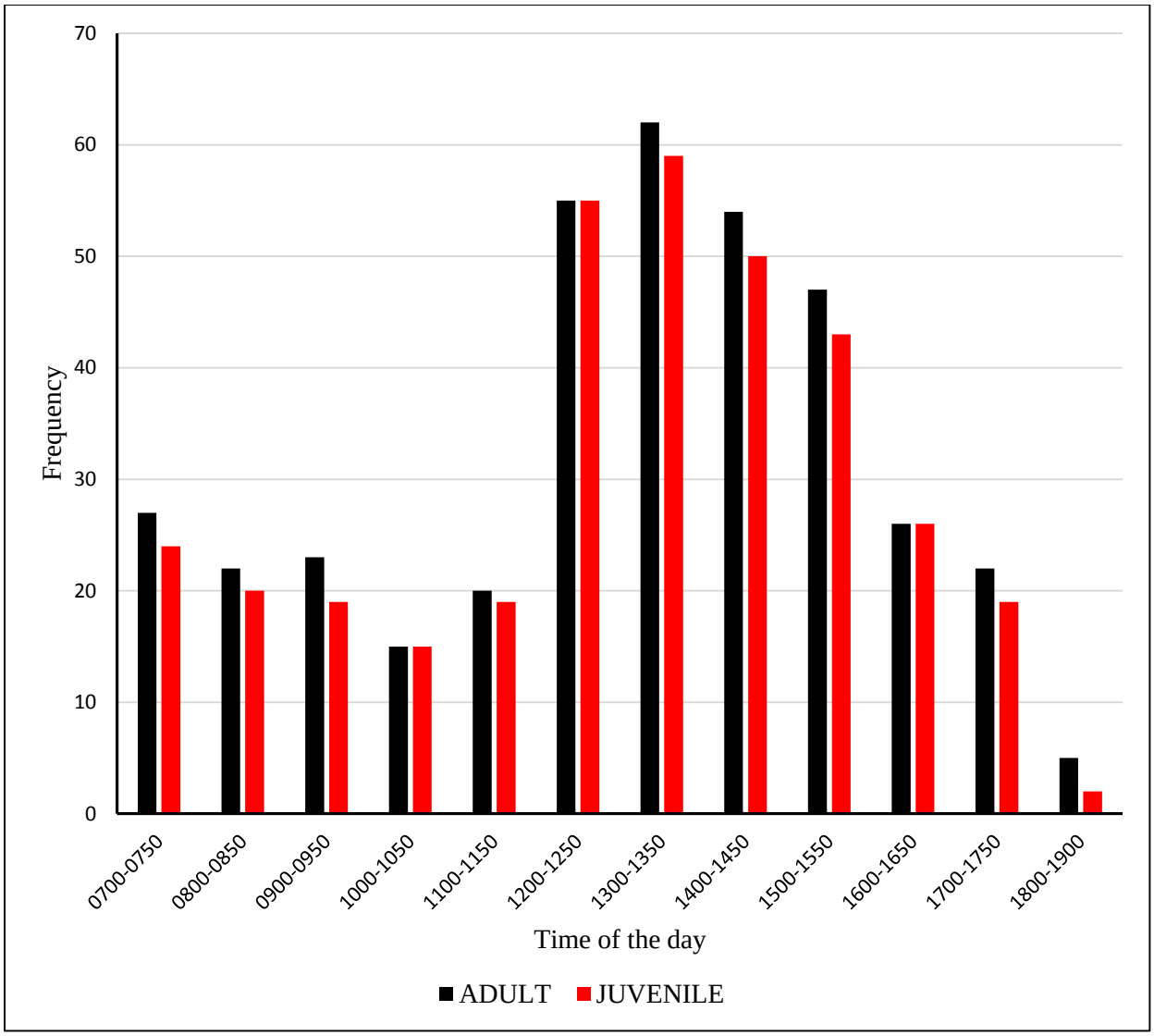


Figure 14: Variation in the frequency of perching of the grey crowned crane with time of the day

3.3.5 Flying

The peaks in flying were similar to the peaks in feeding in all the time blocks of the day. Very short flights were observed between other activities.

Generally, the adult was seen to fly more than the juvenile. Flying showed a bimodal pattern with peaks between 0700 to 1750 hours and 1800 to 1900 hours. The frequency of flying activity was lowest at mid-day. Between 0800 and 1700 hours, there were oscillations of increase and decrease in the flying activity (Figure 15).

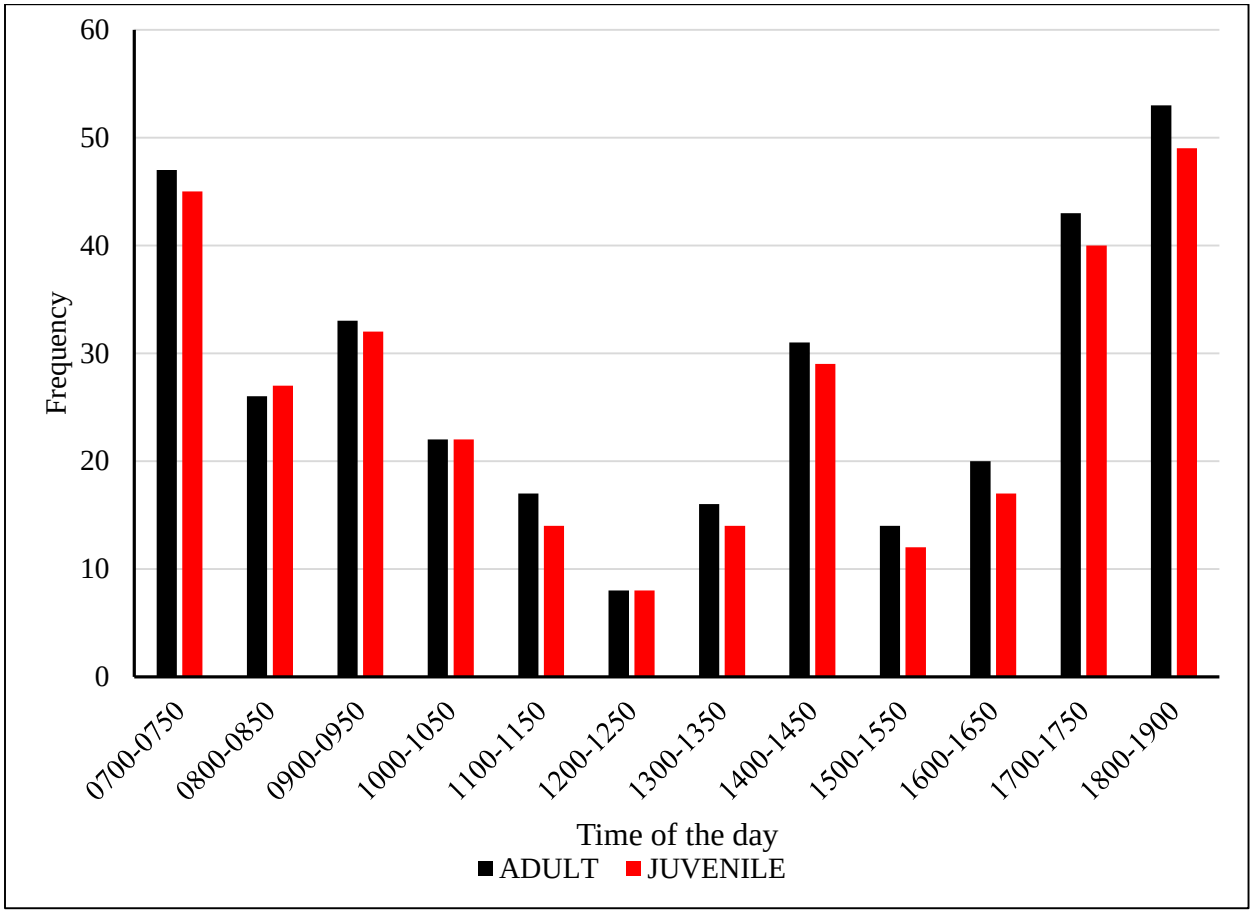


Figure 15: Variation in the frequency of flying by the grey crowned crane with time of the day

3.3.6 Walking

Walking frequency increased between 0700 and 0850 hours. It then decrease gradually up to 14500 hours. Walking was highest between 1500 hours and 1550 hours. From 1550 hours, there was a decrease in the frequency of walking up to 1900 hours. Walking was almost similar in both the adult and the juvenile (Figure 16).

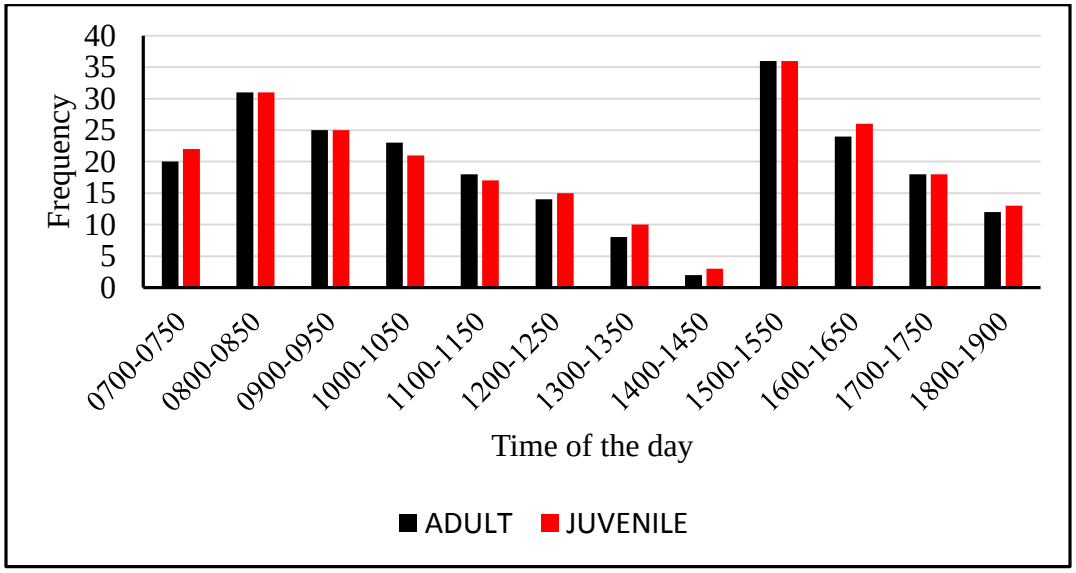


Figure 16: Variation in the walking frequency of the grey crowned crane with time of the day.

3.3.7 Dancing

The Grey Crowned Crane was seen to perform some beautiful displays during the perching time but these were not so prolonged and prominent during the study period. They danced, bowed, ran and jumped, while giving low booming calls involving the inflation of the gular sacs. These calls were given with the head lowered to shoulder level.

Between 0700 to 0750 hours, it was only the adult that danced. Juveniles were seen to copy the adults and also danced between 0800 and 1500 hours. The peak in dancing was between 1400 and 1450 hours when the birds were perching. Between 1500 and 1550 hours,

juveniles were again not seen to dance. There was a general increase in the frequency of dancing between 1600 and 1750 hours which was then followed by a decrease between 1800 and 1900 hours. Adults were seen to display more than the juveniles generally except between 1600 and 1650 hours (Figure 17).

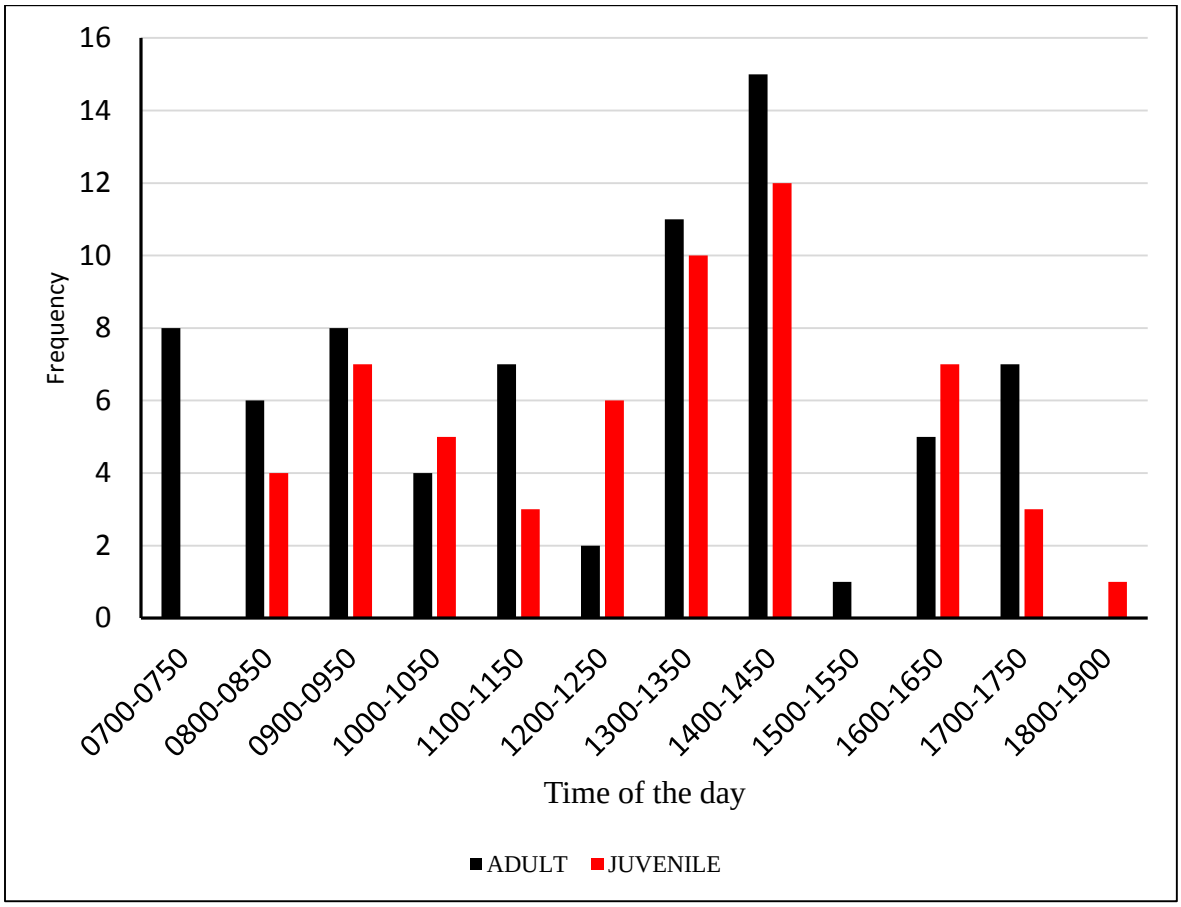


Figure 17: Variation in the dancing frequency of the grey crowned crane with time of the day

3.3.8 Calling

The grey crowned Cranes are highly vocal and have a large vocabulary of specialized calls. I listened to the calls and recorded the number of times these calls were made during different hours of the day in the study period. Calls were produced during the feeding hours, early in the morning and late in the evening mostly.

The frequency of calling was high in the morning between 0700 and 0750 hours. It then decreased gradually between 0900 and 1050 hours. There was then a steady increase between 1100 and 1900 hours. The highest frequency of calling was between 1700 to1750 hours for the juvenile and 1800 to 1900 hours for the adult. In general, adults made more calls than juveniles (Figure 18).

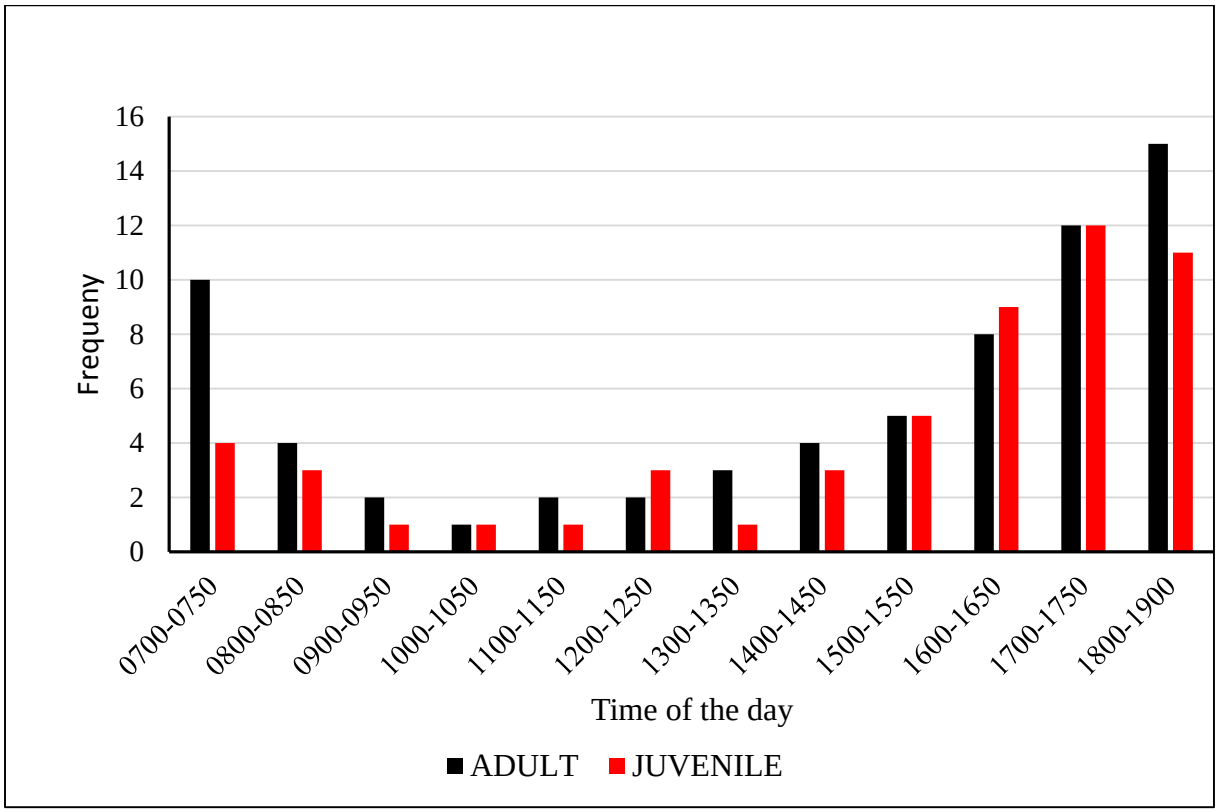


Figure 18: Variation in the frequency of calling of the grey crowned crane with time of the day

3.4. The association of the grey crowned crane with other animals.

The grey crowned cranes associated with different birds and other animals during the course of their activities. Association of the grey crowned crane was studied by observing and recording the animal they were associating with during each activity. The overall frequency of association was then recorded. Generally, the grey crowned crane associated more with animals during feeding (40%) followed by during preening (14%), perching (11%), walking (10%), scanning (10%), flying (8%), calling (6%) and dancing. The grey crowned crane associated less with other animals during dancing (1%) (Figure 19).

The Marabou stork was the most frequently observed animal associating with the grey crowned crane in all activities. The bird was observed perching together with the Marabou storks on the same building at a close distance and were also seen to forage together in harvested maize gardens. The pied crow was the second in the frequency of association, this was followed by the weaver bird, Hadada Ibis, human being, common bulbul, white cattle egret and lastly the sacred ibis (Figure 20).

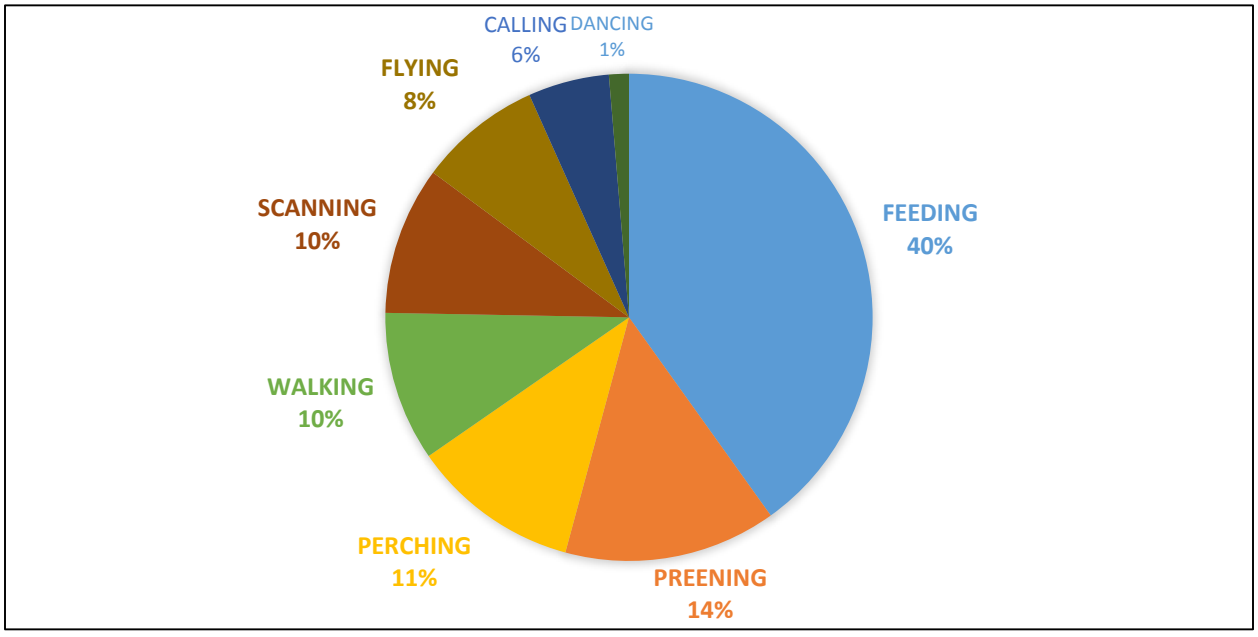


Figure 19: Percentage of association of the grey crowned crane and other animals during different activities

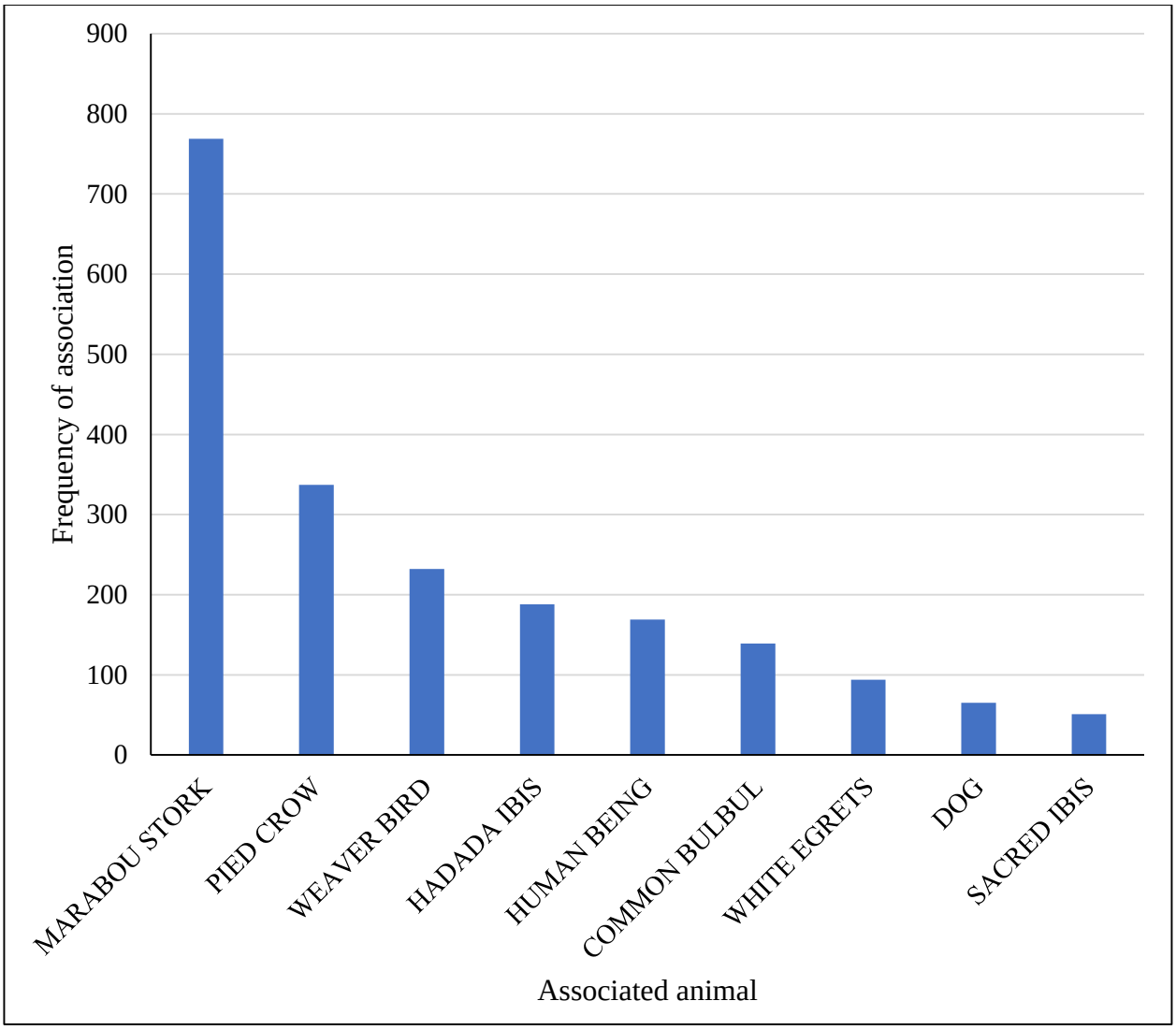


Figure 20: Overall frequency of observation the grey crowned cranes' association with other animals

4.5 Differences in the activity pattern of the adult and juvenile grey crowned crane.

There was a difference of 2.4% between the feeding of the adult and the juvenile, with the juveniles feeding more. The juveniles also walked more than the adults, while the adults preened, flew, danced, perched, called and scanned more than the juveniles (Figure 8).

4.6 Seasonal variations in the activity

Feeding, scanning, walking and flying showed seasonal variations feeding was more frequent in wet season for both the adults and juveniles. Scanning also increased from the dry season to the wet season but it was highest in the wet season. Flying was also more pronounced in the wet season than in the dry season. Dancing and calling were much lower in the wet season than in the dry season. Preening, perching and walking showed negligible variations between the wet and dry seasons (Figure 21).

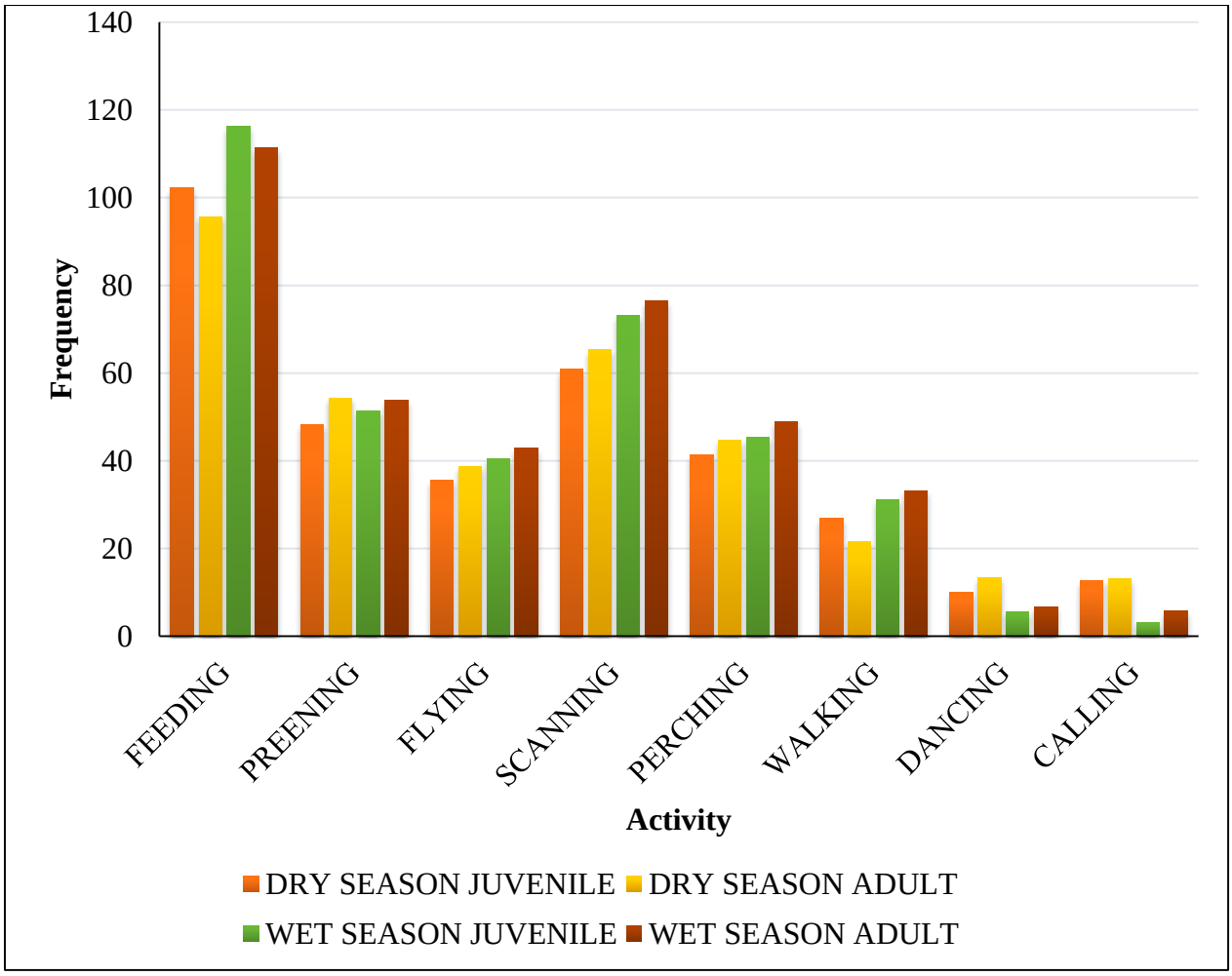


Figure 21: Average seasonal variations in the activities of the grey crowned cranes

CHAPTER FOUR

4.0. DISCUSSION OF RESULTS

4.1 Group dynamics

Smaller groups of 3-12 individuals were the most frequently observed possibly because the grey crowned cranes wanted to reduce on the competition for resources in large groups. Some of these groups also had juveniles, hence the groups were almost made of closely related birds. Pairs had the second highest frequency because grey crowned cranes are monogamous in their mating system and therefore are found to be in pairs of two. They normally form permanent monogamy. Birds which were found to be single might have lost their partners and were therefore lonely birds living a solitary life or some might have been the fully fledged juveniles awaiting partners.

The mean flock size increased towards evening, reaching a peak at 1700-1750 hours. During the morning cranes showed a higher locomotor activity, foraging in smaller flocks, at longer distances from each other, on grounds with higher food availability, in which cereal seeds were easily obtained from the surface. On the contrary, during the afternoon, birds showed lower locomotor activity, aggregated in larger flocks, foraged closer to each other and used more frequently sown grounds, which offered a lower but less variable food availability. This could be because birds want to reduce other possible non-foraging risks like predator and human interference and benefit from group defence in the afternoon.

One benefit of these evening flocks was a reduced individual vigilance time due to the large flock size, and thus an increased time head down, searching food. But this compensated only in part for the lower accessibility of buried seeds on sown grounds. Also, birds foraging in a group increase the chance of success in finding and exploiting the source of food (Pettingill, 1970).

There were generally fewer juveniles compared to adults during the study period. This could be because the research was conducted in the non-breeding season. However, there

is a general decrease in the clutch size of the grey crowned cranes in Uganda of even greater concern is the low breeding success. Muheebwa-Muhoozi (2001) reported a decline in breeding success of 0.42 birds fledged per clutch over a 25-year period (1974/1975 - 1999/2000).

4.2 Habitat preference of the grey crowned cranes in Mbarara municipality

Nyamitanga division was found to support the highest number of grey crowned cranes. This may be because of the many agricultural lands found in this division. During the study, the division had so many harvest maize, millet, sorghum and ground nuts gardens which provided a good food supply to the cranes.

The grey crowned cranes occupied varied habitats with the agricultural lands generally supporting highest activity (59%) followed by settlement areas (22%) and river banks (19%). According to Lack (1937), terrestrial animals seek their habitats rather than dispersing randomly and birds are no exception. The greater number of grey crowned cranes seen performing different activities in the agricultural lands might be due to relatively rich supply of food especially maize, millet and sorghum. The agricultural lands are dynamic habitats that are unpredictable in terms of food abundance and availability. Though there are human disturbances, but the food availability outweighs the human disturbance are neglected. Lack (1966) stated that food is frequently the most important density dependent factor for birds. Muhoozi-Muheebwa (2001) studied the population of grey crowned cranes and concluded that they preferred agricultural lands and avoided the urban habitats. The less time spent in river banks and settlement areas may be due to less food availability, avian predator pressure and human disturbance as a result humans crossing around the bridge, movement of people in homesteads and children swimming and praying around river Rwizi.

The settlement areas and river banks ranked second and third in the order of preference that might be due to greater availability of prey vegetation densities. In these habitats, large well branched trees, shrubs and buildings were recorded and they provided suitable

perching and preening sites to the grey crowned crane. Vegetative complexity has been shown to be strongly correlated with the structure of avian communities. Complex vegetation also aids in protection from predators. DeGraff & Wentworth (1986) reported a strong association between the measures of tree cover and insectivorous bird densities.

4.3 Activity patterns

Feeding was the most time consuming diurnal activity of the grey crowned cranes for both the adults and juveniles, this was followed by scanning, preening, perching, flying, walking, dancing and calling in that order. Time activity budget reflects a combination of factors including individual physical condition, social structure and environmental conditions (Paulus, 1988). The amount of time allocated to various behaviours is therefore critical in understanding the ecological needs of a species. Most organisms allocate their time for different behavioural activities and optimal time budgeting is influenced by circadian and seasonal rhythms.

4.3.1 Feeding

A bimodal peak in the feeding pattern one during morning (0700-0950 hours) and another during evening (1500-1900 hours) was observed. Other birds are known to exhibit feeding maxima early in the morning and late in the evening (Frederick & Klaas, 1982; Paulus 1984; Gauthier et al., 1988; Natarajan, 1991; Evers, 1994; Ramachandran, 1998; Rodway, 1998). Because of the increased temperatures at midday, the grey crowned cranes fed more in the early morning to minimize the effect of increased temperatures. Schartz & Zimmerman (1971) stated that amount of time spent in feeding does reflect the effect of temperature, time of day, microhabitats and prey availability. More feeding activity of the grey crowned crane in the late evening may reflect their need to obtain energy for overnight energetic requirements.

These double-peak patterns of feeding effort have probably evolved as an adaptation to compensate for the prolonged fasting imposed by cold nights and is now endogenous in many bird species (Beer, 1961; Aschoff, 1966; 1967; Meier & Russo, 1985). Like in other

species, hungry cranes filled their empty crops as soon as possible in early morning, and in late evening they refilled them to anticipate fasting during the night. In fact, the double-peaked average pattern observed resulted from most cranes stopping to feed on cereal fields at midday for some time, which they devoted to drinking, bathing and preening. Frequently they had to fly a considerable distance to reach one of the few drinking sites available in the study area. After landing, cranes foraged intensively to compensate for the time they had spent flying, increasing the average evening feeding peak.

The feeding frequency differed among the three habitats studied. Highest feeding activities were seen in the agricultural lands, followed by riverbanks and settlement areas this because agricultural lands provided enough food supply in terms of maize, sorghum and ground nuts, while river banks provided watering grounds after feeding.

Juveniles were observed to feed more than adults (31.2 and 28.8 respectively). This could be because juveniles need much energy for growth as compared to the adults.

4.3.1.1 Diet

Biologically, the grey crowned cranes are omnivorous. Therefore, in the study site, the grey crowned cranes were observed to feed on a variety of food. Food resources are generally abundant during the dry season (February) and grey crowned crane fed on a variety of insects (grasshoppers, ants and beetles), maize, millet, ground nuts and many other foods because it was a harvesting season. The consumption of certain food types more than the others could be explained in terms of availability of food rather than food preference. Grey crowned cranes were seen to feed more on maize than other foods because maize could have been more abundant than other foods.

4.3.2 Scanning

Scanning was the second frequent diurnal activity for grey crowned crane. In the study area they generally perched on buildings and trees when searching for food. Within the time blocks, scanning activity was greater in late morning (0950-1250 hours) and midday (1300-

1550 hours) and differed between time blocks. The availability of insect prey was lowest during above period and they spent additional time in searching (scanning) for prey and feeding was also comparatively lesser in the above time blocks. Scanning was highest in settlement areas because there is low food availability in these areas and therefore scanning had to be high in order to find food.

Among habitats, scanning was lowest in agricultural lands, moderate in river banks and highest in settlement areas and is directly correlated with the vegetation structure, food availability and predator pressure. There is also a lot of human disturbance in settlement areas and river banks and there birds had to be so vigilant against predators

4.3.3 Preening

Preening, varied between time blocks (high in midday and low in late evening). Time spent on preening was highest in, settlement areas, river banks and least in agricultural lands. The wings, breast and back were the body parts most often preened by grey crowned crane, followed by the tail, neck, rump and feet. The most frequent comfort activities were bill scratching, feather shaking and wing flapping. Time spent on this kind of body maintenance activities were recorded in several bird species (Fischer, 1981; Khera & Kalsi, 1986; Natarajan, 1991) and therefore, cranes were also found to perform such maintenance activities.

Preening was done to clean the feathers, to remove any debris or ecto-parasites larking under the surface of feathers or to rearrange the feather barbules.

4.3.4 Perching

Perching differed between time of the day and habitats. Perching activity varied between times of the day and was always at its peak at midday. Earlier, many researchers also found perching to be a major midday activity of birds (Verbeek, 1972; Quinlan & Baldassarre, 1984; Losito *et al*., 1990; Lee, 1997; Martinez, 2000). Tamisier (1976) suggested that an increase in perching during midday was a mechanism to minimize the heat load on a bird

at high environmental temperatures. Sleeping was the major diurnal perching activity for grey crowned crane and generally resting on dense trees and building tops. Birds also perched more at midday because other activities were at a standstill.

4.3.5 Flying

The grey crowned cranes spent the other diurnal time in flying activities. Grey crowned crane flying activity differed at all the time of the day but not in habitats. In general the peaks in flying were similar to the peaks in feeding in all time blocks and habitats because birds had to fly in order to pursue their food. The observed high flying frequencies in the morning and in the evening hours could be due to changing of feeding sites by the birds.

Low frequencies of flying observed at midday could be because the birds were perching since during this time, perching was high. It could also be explained in terms of increased temperature which would not enable these birds to fly, since birds need to minimise energy expenditure at such elevated temperatures. Flying is an energy consuming activity, yet there was no feeding at this time to provide such energy.

4.3.6 Walking

Walking frequencies were high between 0700 and 1850 hours and between 1500 and 1550 hours because birds had a high feeding activity in these periods and therefore had to walk to search for food on the ground.

4.3.7 Dancing.

The grey crowned cranes had the highest dancing frequency at midday during perching hours. Physical displays are important means of communication among social species like grey crowned cranes. Dances are also important in mate selection.

4.3.8 Calling

Calls were high in the morning and the evening and lowest at midday. Calling in the morning could be to notify other birds about the presence of food and warn others about the approaching enemies. The adults engaged in calling more than the juveniles. Croaking sound was produced by adults during parental care when intruders were present. Other calls included alarm calls and "flight intention" calls, both of which are maintained into adulthood. Calls are also important in individual recognition.

Calls were produced when intruders were present. Normally the adults were very silent and became noisy only in the presence of intruders and juveniles.

4.4 Association with other animals

No organism in the environment exists in isolation, it must depend on others in one or more ways. Grey crowned cranes were seen to associate with different animals and they associated most with the marabou storks and least associated with the sacred ibis. The marabou stork was found to associate more with the grey crowned crane because they feed on the same food and use the same perching places, the bird also associated with the weaver birds and pied crow because they were found to feed on the same resource (cereals) during the study period. The least association of the grey crowned crane with the sacred ibis could be because they do not have many similar resources to share.

4.5 Differences in the activity pattern of the adult and juvenile grey crowned crane.

The juveniles were seen to feed more because they need enough energy for growth and development as compared to the adults which just need energy for maintenance activities and survival. This agrees with earlier studies by Alonso (1984) on the activity pattern the wintering common cranes, *Grus grus.* The juvenile cranes walked more than the adults in pursuit for food. The adults were observed to preen, fly, dance, call and scan more than the juveniles possibly because they need more maintenance activities. Calling was done more by the adults because they had to notify their juveniles of the approaching enemies. Scanning was done more by the adults to increase on the vigilance while dancing was done more by the adults for courtship purposes in order to seduce their mates.

4.6 Seasonal variations

There was a high feeding frequency in the wet season possibly because birds need enough energy to compensate for the heat lost during the cold days and also to generate enough heat to maintain a constant body temperature. In addition, due to the limited food availability in the wet season, feeding must be done more frequently in order to get enough food to satisfy their energy needs as compared to the dry season where there is enough food availability because of the presence of the harvested cereal gardens. On the other hand, due to the heat stress in the dry season, there was a low feeding activity as birds remained in relatively colder places during the hot afternoons, since they got enough food during the morning and evening hours. Feeding was also most frequent in the wet season possibly because the grey crowned cranes breed in the wet season and therefore have to accumulate energy to lay eggs and incubate them. Flying frequency was also high in the wet season because the grey crowned cranes flew more in the wet season in search for food since the peaks in feeding were similar to those in flying. Preening was high in the wet season as it was done to clean the feathers after it had rained and also straighten the feather barbules.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study revealed that grey crowned cranes were observed in singletons, pairs and groups with the biggest group being of 61 individuals. The most frequently observed group was a group of 3-12 birds.

Results of this study show that the increasing degree of satiation with advancing daytime relaxed the dispersal trend of the birds, which foraged progressively closer to the other and formed larger flocks on grounds with lower but more constant food availability.

The grey crowned cranes were observed to occupy a wide range of habitats (agricultural lands, settlement areas and river banks) with the agricultural lands being the most frequently occupied habitats in the peri-urban area by the grey crowned cranes

Feeding was the most time consuming activity of the grey crowned crane and the juveniles were observed to feed more than the adults. The feeding frequency was higher in the wet season than in the dry season. The grey crowned cranes were observed feeding on different food types with maize being the most frequently fed on food during the study period. Calling was the least time consuming activity of the grey crowned cranes during the study.

During the non-breeding season, birds must perform few activities in order to survive, the most important being feeding, drinking, avoiding predators and preening. However, since these activities are usually incompatible, each individual has to make several decisions about timing, duration and sequence of these activities, to maximize fitness (Sibly & McFarland, 1976, McCleery, 1978, Caraco, 1980, McNamara *et at.*, 1987). Time allocation decisions are related with the hunger state of the individual through a feedback process, and therefore change throughout the day constituting the animal's daily routine.

The study also revealed that the grey crowned cranes associated with different animals during the different activities but it was observed association more with the marabou stork and least with the sacred ibis.

Nyamitanga division was found to support the highest number of grey crowned cranes. This may be because of the many agricultural lands found in this division which provide abundant foraging grounds for the cranes.

5.2 Recommendations

Basing on the findings presented in this dissertation, the project recommends the following:

Grey Crowned Cranes are responsible for crop damage in the study area. A further research should be carried out to quantify the damage caused by these grey crowned cranes in the agricultural lands were they feed.

Grey crowned cranes can be conserved well in the peri-urban region by adopting conservation techniques which include those that produce abundant understory vegetation that can act as potential breeding cover, foraging habitats and home ranges for the grey crowned cranes.

Residents in the municipality should be encouraged and sensitised to plant trees in their backyards which offer perching and artificial nesting sites for the grey crowned cranes in Mbarara municipality.

Although grey crowned cranes destroy crops in the agricultural lands where they feed, farmers should be sensitised on how well to control the damages caused by the grey crowned cranes and also be told about the importance of conserving the grey crowned crane as it is an important bird to our country.

I recommend further research on the nesting and breeding ecology of the grey crowned cranes in Mbarara municipality.

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APPENDICES

Appendix 1: Grouped frequency distribution table for the group dynamics of the grey crowned cranes showing the relative group sizes

GROUP SIZE	**FREQUENCY (f)**
1(singleton)	5
2 (pair)	10
3-12	11
13-22	2
23-32	3
33-42	2
43-52	5
53-62	2
	∑f=40

Appendix 2: Numbers of grey crowned cranes in each division of Mbarara municipality

DIVISION	**PAIRS**	**PAIR+ JUV**	**PAIR+ 2 JUV**	**PAIR+3JUV**	**FLOCKS**
NYAMITANGA	10	7	4	5	61,48,53,35,24,25
KAMUKUZI	6	5	3	0	50,46,38,44,30
KAKOBA	4	3	1	0	7,8,18,24,45,10

Appendix 3: Average group sizes with respect to time of the day

Time of the day	Average group size
0700-0750	2
0800-0850	5
0900-0950	8
1000-1050	15
1100-1150	13
1200-1250	19
1300-1350	21
1400-1450	25
1500-1550	35
1600-1650	51
1700-1750	60
1800-1900	49

Appendix 4: Average seasonal variations in the activity pattern of the grey crowned crane

SEASON	DRY SEASON		WET SEASON	
ACTIVITY	JUVENILE	ADULT	JUVENILE	ADULT
FEEDING	102.33	95.67	116.2	111.4
PREENING	48.33	54.33	51.4	53.8
FLYING	35.67	38.67	40.4	42.8
SCANNING	61	65.33	73.2	76.4
PERCHING	41.33	44.67	45.4	48.8
WALKING	27	21.67	31.2	33.2
DANCING	10	13.33	5.6	6.8
CALLING	12.67	13	3.2	5.8
TOTAL	338.33	346.67	366.6	379

Appendix 5: Frequencies of observation of the different activities by the grey crowned crane according to habitat

ACTIVITY	HABITAT		
	AGRICULTURAL LANDS	**RIVER BANKS**	**SETTLEMENT AREAS**
FEEDING	460	256	150
PREENING	121	102	144
FLYING	123	103	94
SCANNING	115	154	295
PERCHING	101	99	165
WALKING	95	87	52
DANCING	49	40	43
CALLING	25	21	15
TOTAL	**1951**	**862**	**958**