

## Diurnal activity patterns of five distinct bird species in agricultural landscapes of Central Rajasthan during their non-breeding period in India

Rounak Choudhary<sup>1\*</sup>, Vivek Sharma<sup>1</sup>, Praveen Mathur<sup>1</sup>

<sup>1</sup>Department of Environmental Science, Maharshi Dayanand Saraswati University, Ajmer, Rajasthan, India

\*Corresponding author: rounakchoudhary17@gmail.com

Received: September 25, 2022

Accepted: December 12, 2022

**Abstract:** *The daily time activity budget explains how any species distribute their daily time for regular activities. The most typical behaviors observed in birds include foraging, feeding, roosting, flying, singing, building a nest, incubating eggs, and raising young. The temporal budgets of five bird species from three distinct feeding guilds were examined. The research area in central Rajasthan, India an ecotone of Arid and Semi-arid zones. Five bird species were examined for their behavior during the research period, with each bird being observed at least 40 (N=200) times during their non-breeding phase. The study includes the Red Collard Dove, White Eared Bulbul, Black Winged Kit, Long Tailed Shrike, and Yellow Throated Sparrow. The examination was carried out using the Scan sampling method. The data was aggregated using the un-weighted pair group method with arithmetic mean (UPGMA), and the Bray-Curtis method was used to evaluate species similarities based on time allocation in the same environment. The rates of transition between behaviors were investigated in order to understand which activity the animal does following a certain activity. Likelihood values vary from 0 to 1 were used where 0 indicated that the bird is unlikely to undertake the activity after completing any specific activity and 1 indicated that the bird has the highest probability to perform the activity after finishing any specific activity. In the behavioral research, the Yellow-throated Sparrow, Red Collard Dove, and White Eared Bulbul had the highest similarity because they devote about comparable time to similar behaviors. The results showed that the Long-Tailed Shrike and the Black-Winged Kite have very similar habits and time allocation for different tasks. When flying, the Black Winged Kite has a 0.900 chance of entering screening, and the lowest observed likelihood of flying following other behaviors such as preening is 0.100. Long-tailed Shrikes were more likely to switch from roosting to other behaviors like calling and preening, and from other activities to screening the area for food. The White-Eared Bulbul eats on insects and grains, while Red Collared Doves fly more after scanning. The Long-tailed Shrike and the Black-Winged Kite spend more time examining agricultural fields. The Red Collard Dove is among the potential pests for farmers in the study area. Long-tailed Shrike needs time to hunt, kill, and consume prey that is nearly half their body size.*

**Keywords:** Agro-Ecosystems, Behavior, Birds, Nagaur, Parbatsar, Time budget



This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

### 1. Introduction

The diurnal time activity budget is a quantitative description of how any species allocate its daily time for routine tasks (Baldassarre & Bolen, 1994). The allocation of time to various activities differs between species and habitats. Foraging, feeding, roosting, walking, flying, singing, constructing a nest, incubating eggs, and rearing young are the most common behaviors observed in birds. Understanding the behavior of any species in their habitat and how the biotic and abiotic environment affects their daily activities is aided by time budgeting (Paulus, 1988). Observing and comprehending the daily behaviors of bird aid in

establishing their life cycle, ecological adaption, and similarities with other species (Hamilton et al. 2002). The evaluation of the time spent and employed by birds in their habitat aids in understanding the niche of birds and, as a result, aids in habitat conservation (Hepworth & Hamilton, 2001).

The feeding guild has a direct impact on bird behavior (Prajapati and Prajapati 2013). We assessed the temporal budgets of five bird species from three different feeding guilds, namely carnivorous, granivorous, and frugivorous, as well as a few that are occasionally insectivorous, that

live in the agricultural fields of central Rajasthan. Some birds, such as *Lanius schach* and *Elanus caeruleus*, maintain their feeding zone for undisturbed feeding (Schemske, 1975).

The use of time to conduct any activity is determined by the individual's age and gender, the season and time of day (Martinez, 2000), the kind of habitat, and habitat usage (Eberhardt et al; 1989, Caraco, 1979). The purpose of this study is to investigate how birds from various feeding guilds divide their available time between behaviors. Especially during their non-breeding period, when the birds focus on themselves rather than being involved in different breeding tasks such as displays, collecting nest materials and creating nests, caring for eggs and nestlings, and others.

## 2. Materials and Methods

### 2.1. Description of the study area

The research was carried out in the agricultural areas of Parbatsar (26°52'36.0"N 74°44'56.7"E), Nagaur district, central Rajasthan, India (Figure 1). The study region receives around 33 mm of precipitation per year and has an average yearly

temperature of 30 °C. The area is dominated by agricultural fields and exhibits Arid and Semi-arid biogeographic zone characteristics. It is mostly composed of Dry mixed deciduous thorn woodland with some bushy plants and trees like *Anogeissus pendula*, *Capparis deciduas*, *Acacia nilotica*, *Acacia senegal*, *Salvadora persica*, and other species dominate the study area's plains. During the monsoon season, the land is cultivated. Some of the most significant seasonal crops are pearl millet, cluster bean, sesame, green gramme, moth bean, groundnut, wheat, cumin, cotton, and mustard.

### 2.2. Bird species studied

Throughout the year, the central Rajasthan region is home to more than 191 bird species (Choudhary et.al; 2020). The following five species were chosen (Table 1 & Figure 2) since they maintain their territory in the study area throughout the year and the study area is also their breeding ground, making it easy to study them and have a decent population here, and they all belong to four different feeding guilds, allowing us to collect a diverse dataset.

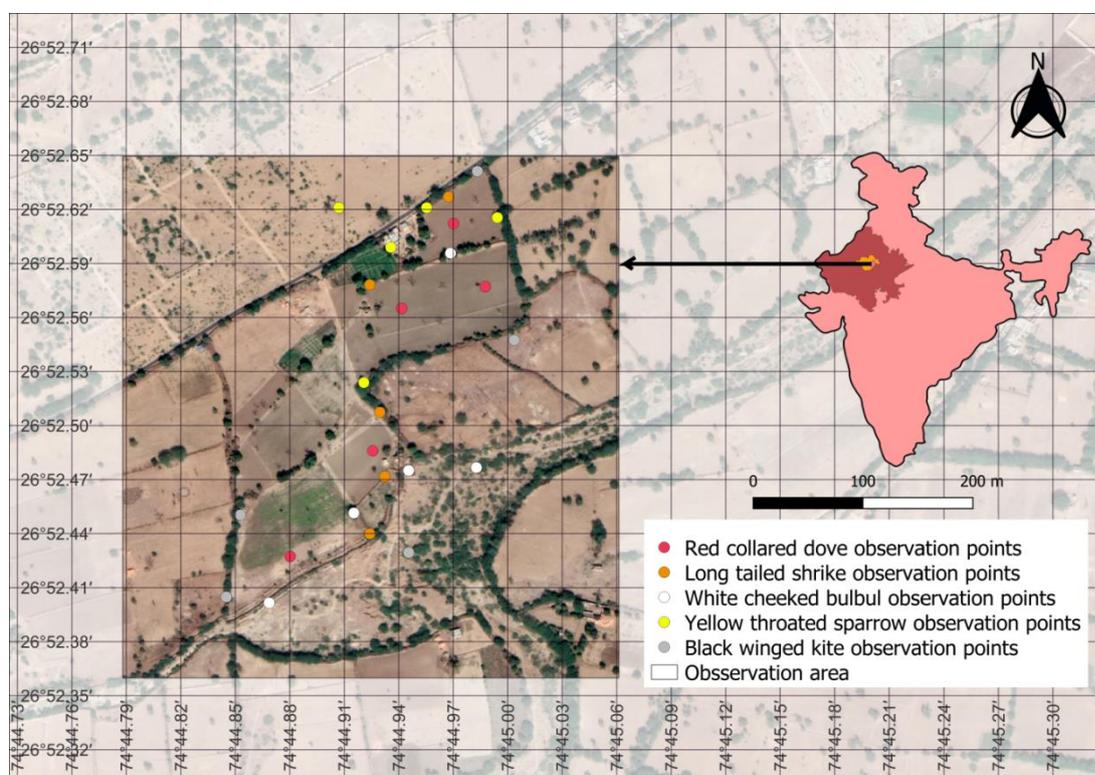


Figure 1: Map of study area

**Table 1: Description of studied bird species**

Common Name	Black-winged Kite	Long-tailed Shrike	Red-collared Dove	White-eared Bulbul	Yellow-throated Sparrow
Scientific name	<i>Elanus caeruleus</i>	<i>Lanius schach</i>	<i>Streptopelia tranquebarica</i>	<i>Pycnonotus leucotis</i>	<i>Gymnoris xanthocollis</i>
Breeding period	August to January	February to July	Throughout the Year	February to May	April to June
Food	Insects and Small Mammals	Insects, Lizards and Small Mammals	Grains and Seeds	Fruits and Insects	Grains and Insects
Major feeding guild	Carnivorous	Carnivorous	Grainivorous	Fruigivorous	Insectivorous



**Figure 2: Photographs of studied birds from agriculture fields (left to right: Black-winged Kite (BWK); Long-tailed Shrike (LTS); Red-collared Dove (RCD); White-eared Bulbul (YEB); Yellow-throated Sparrow (YTS))**

### 2.3. Bird Survey and Behavioral Data collection

The research was carried out from September 2020 to August 2022, particularly during the non-breeding season of the selected birds. During the study period, five bird species were observed for their behavior, with each bird being observed at least 40 (N=200) times during their non-breeding period. At every observation, the birds were observed for at least 6 hours (7:00 am – 10:am in the morning and 4:00 pm to 7:00 pm in the evening). Black Winged Kit (*Elanus caeruleus*) was observed during February 2021 to July 2022, Long Tailed Shrike (*Lanius schach*) was observed from August 2021 to January 2022, White Eared Bulbul (*Pycnonotus leucoti*) and Yellow Throated Sparrow (*Gymnoris xanthocollis*) were observed from July 2021 to January 2022 and August 2020 to March 2022 respectively, and Red Collard Dove (*Streptopelia tranquebarica*) was observed throughout the year when there was no nesting involved as the bird breeds throughout year in the study area.

The scan sampling method (Altmann, 1974) was employed to conduct the research. For each

observation, a single observation point was chosen and the nearest individual was taken as the observation unit. A single individual was perhaps observed throughout the day, and if the individual went out of sight, the nearby individual was observed. The birds were spotted using an Olympus Binocular 10\*50 X and a Nikon P1000 camera and a stopwatch and the mean  $\pm$  SD of observations are presented in the result.

The analysis was done using PAST software (Hammer et al., 2001), the un-weighted pair group method with arithmetic mean (UPGMA) was used to aggregate data, and the Bray-Curtis method was employed to calculate species similarities based on time allocation in the same habitat. The rates of transition between behaviors were examined in order to determine which activity the animal does after a certain activity. A plot matrix was used to visualize the most favored behaviors of species in agricultural landscapes in form of a heatmap. The frequency of transition between behaviors was calculated by dividing the total number of switches between two particular behaviors (scanning to feeding, feeding to flying, flying to roosting, etc.)

by the total number of switches between behavior during the total observed time period that indicates how likely a bird species is to do a behavior after performing another. The values of probability range from 0 to 1, with 0 indicating no probability and the bird is unlikely to perform the activity after performing any particular activity and 1 suggesting that the bird has the highest probability to perform the activity after completing any particular activity. The visualization of data was done using R software and its circle package (Gu et. al. 2014) for making chord diagrams.

During observations, the following activities were taken into account:

**Scanning:** Perched on trees or at high elevations, and structures in agricultural fields actively scan their surroundings.

**Feeding:** Entails capturing prey, breaking it apart, and ingesting it in the case of carnivorous animals. Capturing and ingesting insects in the case of insectivorous animals, and consuming fruits and grains in the case of insectivorous and granivorous animals.

**Flying:** Being in the air, usually in pursuit of prey or going from one location to another.

**Roosting:** Sleeping perched in shrubs or trees, head retracted and eyes closed.

**Other activities:** Preening, wing flapping, bill cleaning, bill scratching, and body shaking, calls and songs.

### 3. Results and Discussion

#### 3.1. Daily time expenditure

In this study, scanning was observed as the most important daytime activity in Black Winged Kite ( $56.25 \pm 2.4\%$ ) and Long Tailed Shrike ( $48.21 \pm 3\%$ ), and both species belonged to the same feeding guild, i.e., Carnivorous. The scanning period includes the black kite hovering over the prey. The Black-Winged Kite spent  $21.87 \pm 1.7\%$  of its time flying through agricultural areas and  $14.6 \pm 3.6\%$  roosting. Feeding accounted for only  $4.7 \pm 2.5\%$  of the Black-winged Kite's total time, with the species devoting only  $2.58 \pm 2.3\%$  of its time to other activities. Scanning and feeding are the two most time-consuming behaviors of the Long Tailed Shrike, accounting for  $48.21 \pm 3\%$ , and  $20.38 \pm 2.1\%$  of the time, respectively. Roosting takes up

$12.3 \pm 1.6\%$  of total time, whereas flying and other activities take up nearly the same amount of time ( $9.85 \pm 2.1\%$  and  $9.26 \pm 2.2\%$ , respectively). In the case of the Red Collared Dove, the majority of time is spent flying and roosting ( $24.73 \pm 2.9\%$  and  $24.23 \pm 3.8\%$ , respectively), followed by feeding ( $17.53 \pm 2.5\%$ ), scanning ( $16.72 \pm 3.2\%$ ), and all other activities ( $16.79 \pm 2.9\%$ ). The Red Collared Dove is one of the possible pests for the farmers in the research region because they feed in big groups, although they spend most of their time roosting and flying. The White Eared Bulbul spends most of its time roosting ( $30.43 \pm 2.7\%$ ) and flying ( $25.62 \pm 2.9\%$ ), scanning and feeding take up  $25 \pm 2.5\%$  of the overall time and another  $18.35 \pm 3.8\%$  of the time is spent on other pursuits. Yellow-Throated Sparrows spend more than half of their time hidden in bushes, with roosting accounting for  $56.17 \pm 2.7\%$  of total time, followed by flying ( $22.8 \pm 2.2\%$ ), making it a difficult species to spot in central Rajasthan's agricultural areas. Scanning and feeding take up only  $3.95 \pm 1.5\%$  and  $2 \pm 1.2\%$  of Yellow-throated Sparrows' total time, respectively. An ethnography study comparing the time allocation to different activities by different birds (Figure 3) and a heatmap of species and their most favored behavioral activity in agricultural areas (Figure 4) are presented below.

Our findings indicate that all birds spend a significant portion of their daytime engaged in four key activities, which are scanning, feeding, flying, and roosting. This is due to probably due to the abundance of types and food sources throughout the year. Because of the larger body mass of the Black Winged Kite, it is easier for them to kill and eat prey such as Hare, Mouse, Squirrels, and Lizards (Amat 1979, Tarboton 1978), whereas the Long-Tailed Shrike takes preferentially longer time for attacking, capturing, and eating the prey due to its small body mass.

Roosting is a key activity in birds, particularly in insectivorous and granivorous birds, as a technique to reduce the heat burden on a bird under high environmental temperatures (Verbeek 1972, Lee 1997, Martinez 2000). Tamisier and Dehorter (1999) suggest that scanning and feeding, usually referred to as foraging and roosting, allow birds to conserve as much energy as they need throughout both breeding and non-breeding phases, same was observed in this study as collectively all 3 behaviors account for more than 50% in time

allocation of selected birds and the study area is represented as a suitable foraging and roosting habitat for these birds.

Flying symbolizes an escape, evasion, or change of location in order to avoid being predated by predators (Bensizerara 2014) and flying is one of

the most energy-intensive bird activities (Casey, 1992). In this study, on average the birds allot a quarter of their total time for flying ranging from 9% to 25%, and mostly because of moving from one area to another, as the predator and disturbance pressure is very low in the study area, the major disturbances are caused by human activities.

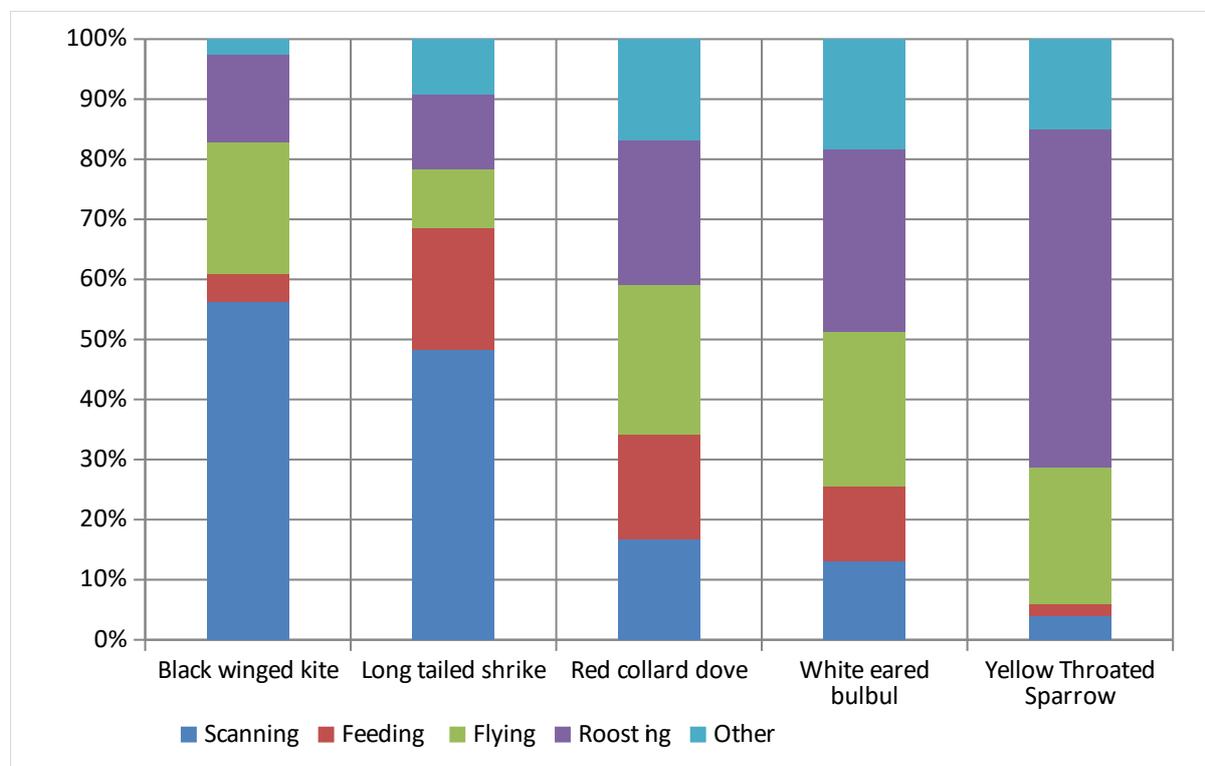


Figure 3: Ethograph of observed bird activities

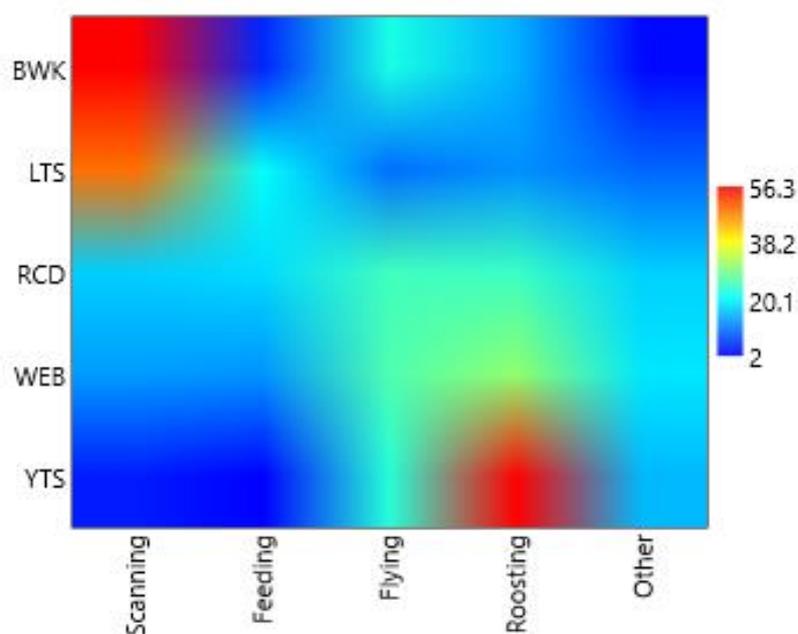


Figure 4: Plot Matrix showing species and their highly preferred activities, x-axis denoting the activities and y-axis denoting the species, the legend represents the percentage of time given to the activities ranging from 2%-56.3% of total time

Figure 5 shows that Yellow-throated sparrow, Red Collard Dove, and White Eared Bulbul are much more similar on the basis of time allotted for roosting, Moreover, Red Collard Dove and White Eared Bulbul exhibit the highest similarity in the behavioral study as they allot almost equal time to similar activities. The Long-Tailed Shrike and the Black-Winged Kite also exhibit great similarities in their behaviors and similar time allocation to different activities as they belong same feeding guild, and they roost and scan in the same areas as well.

which is associated with accessibility of food in the fields. The body size has little bearing on feeding time, but in the instance of the Long-Tailed Shrike, which feeds on food that is roughly half its body size, they need time to capture, kill, and devour the prey. Because of the hot arid conditions of the day, roosting generally occupies a larger share of the time of selected birds to limit the waste of water and energy. Flying across the fields takes around a quarter of the time for the observed species, but in the case of the Long-Tailed Shrike, the time is only about 10% since they maintain tiny territories for feeding, roosting, and other activities.

According to the results, it is deduced that the birds of central Rajasthan do not require more time,

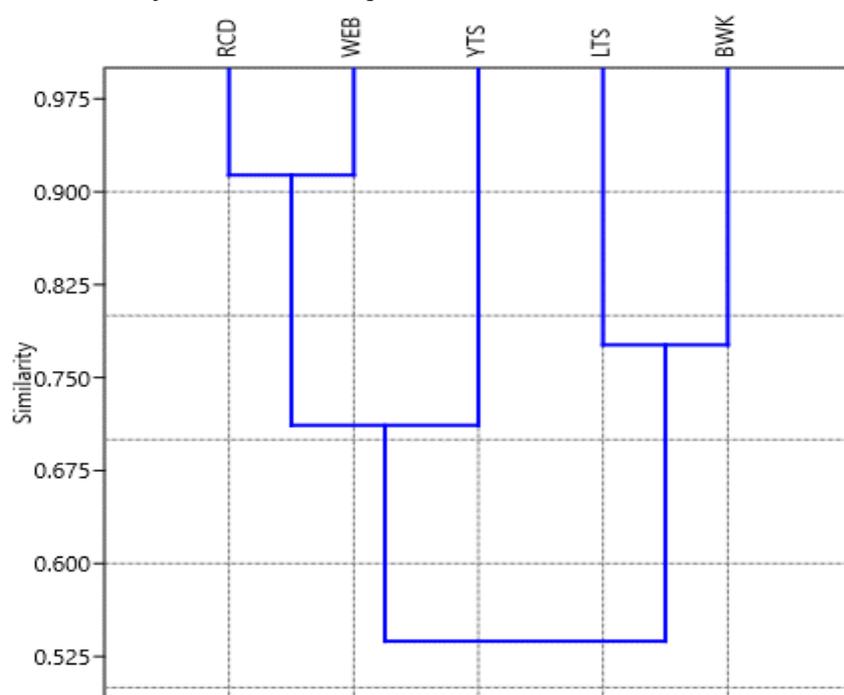


Figure 5: Similarities between species by Bray-Curtis Method

**3.2. Frequencies of transition between observed behaviors**

The results of frequencies of transitions between behaviors are shown as chord diagram in Figure 6 to Figure 10. The nodes at edge of circle represent particular behaviors and the bands represent transitions between the behaviors. The more the width of a band, the more is the probability of performing a particular behavior after another. The Black Winged Kite (Figure 6) has a probability of 0.900 of entering screening when flying. And the lowest measured chance of flying after other actions such as preening is 0.100. The frequency of eating after screening is only 0.450, and the bird usually returns to scanning after feeding at 0.850

since the prey is rather little in comparison to its body size, and the bird needs to finish its energy requirements. Long-tailed Shrike (Figure 7) had a higher likelihood of transitioning from roosting to other behaviours such as calling and preening, and from other activities to screening the habitat for food, with values of 0.800 for both. After scanning, the chance of feeding is 0.700. When compared to Black Winged Kite and Long Tailed Shrike, Red Collared Doves (Figure 8) have a higher likelihood of feeding after scanning, which is 0.900, because their dietary items are often static. The likelihood of flight after feeding is 0.950 in Red Collared Doves because they roost for a longer amount of time. The White-eared Bulbul (Figure 9), which

feeds on fruits and berries, has a higher likelihood of feeding after scanning, which is 0.950, as does the Yellow-Throated Sparrow (Figure 10), which feeds on insects and grains. With an observed value of 0.800, the White Eared Bulbul favors calling

after roosting; the bird rarely returns to scanning after feeding. However, in the instance of the Yellow-throated Sparrow, the bird has a 0.100 chance of returning after feasting on insects.

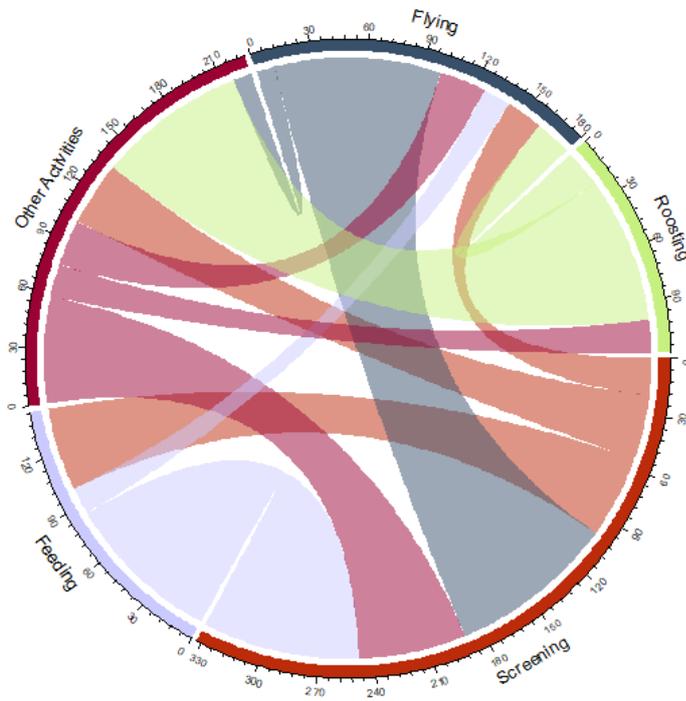


Figure 6: Transition between behaviors in Black Winged Kite

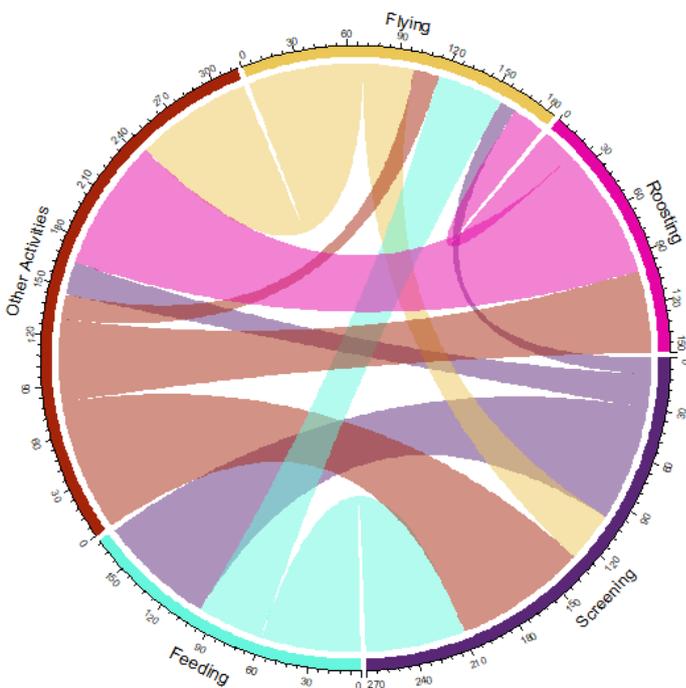


Figure 7: Transition between behaviors in Long Tailed Shrike

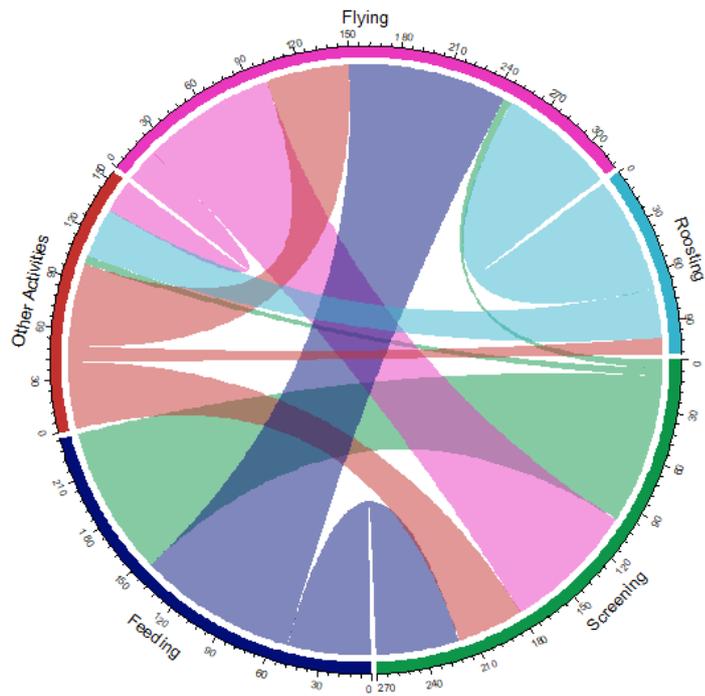


Figure 8: Transition between behaviors in Red Collard Dove

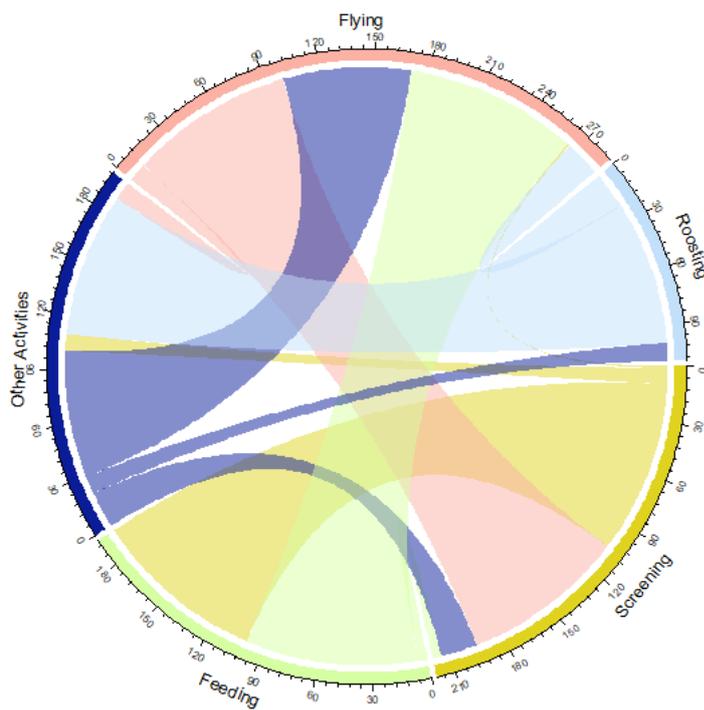
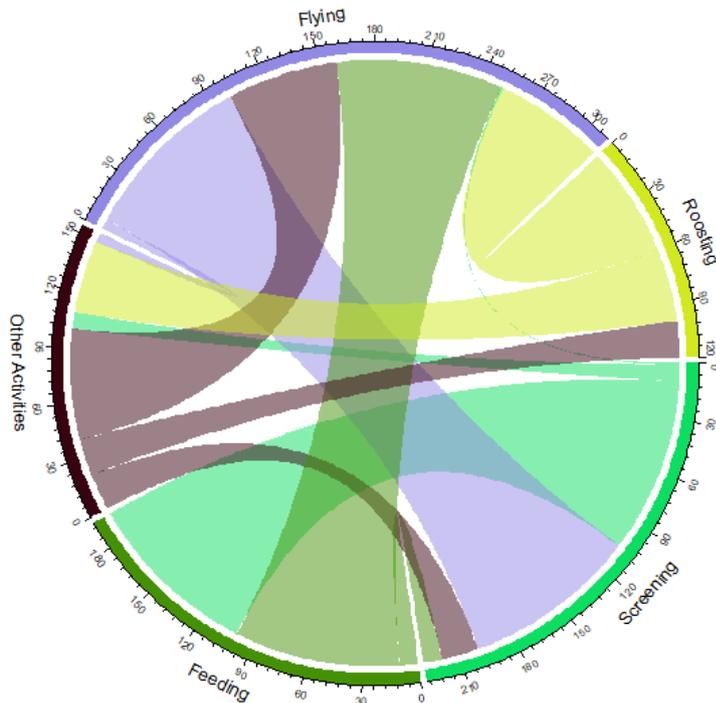


Figure 9: Transition between behaviors in White Eared Bulbul



**Figure 10: Transition between behaviors in Yellow Throated Sparrow**

#### 4. Conclusion

According to the findings of this study, the two carnivorous birds, the Black Winged Kite and the Long-tailed Shrike, spend more time scanning in agricultural fields because the fields provide a suitable refuge for the prey population. The Black Winged Kite, as a raptorial bird, has longer flights between landscapes, whereas the Long-Tailed Shrike has comparatively shorter flights. Based on observations, these birds are particularly prone to disturbances, causing them to displace frequently. The White Eared Bulbul spends most of its time roosting in agricultural fields; feeding often occurs between early morning and late afternoon, and it shares the least amount of time for feeding. Yellow-throated Sparrows hide in bushes or thorny trees since they have the smallest body size compared to all other observed species. Their dietary items are mostly insects and grains, and thus they spend the least amount of time feeding. Because there are fewer predators and less human disturbance in the study region, the Red collard dove spends more than half of its time being a constant threat to crops.

#### Conflict of Interest

The Authors declare that there is no conflict of interest in publishing the manuscript in this journal.

#### Acknowledgment

We would like to acknowledge the Rajasthan State Biodiversity Board (RSBB), the Department of Science and Technology (DST) and Government of Rajasthan for funding and their collaborative efforts under the RSBB-DST Scholarship.

#### References

- Altmann, J. (1974). Observational study of behaviour: sampling methods. *Behaviour*, 49: 227-267.
- Amat, J. A. (1979). Notas sobre la ecología alimenticia del Elanio Azul (*Elanus caeruleus*). *Donana Acta Vert.*, vol. 6, pp. 124-128.
- Baldassarre, G.A. and Bolen, E.G. (1994). *Waterfowl Ecology and Management*. John Wiley and Sons, Inc, New York, 49: 342.
- Bensizerara, D. (2014). *Ecologie des oiseaux de Sabkhat Djendli*. Doctoral Thesis. University of Biskra, Algeria.
- Caraco, T. (1979). Time budgeting and group size: A test of theory. *Ecology*, 60: 618-627.
- Casey, T. M. (1992). Energetics of locomotion. *Advances in Comparative and Environmental Physiology*, vol. 11, pp. 251-275 [M. Alexander, editor]. Berlin: Springer Verlag.

- Choudhary, R., Mathur P., and Sharma V. (2020). Avifaunal composition of various microhabitats of southern Nagaur (Parbatsar, Kuchaman, Nawa and Makrana), Rajasthan. *International Journal of Research - granthaalayah*, 8(11), 112-128.
- Eberhardt, L.E., Gregory G.B., Robert G.A., and William, H.R., (1989). Activity budgets of Canada geese during brood rearing. *Auk*, 106: 218–224.
- Gu, Z., Gu, L., Eils, R., Schlesner, M., and Brors, B. (2014). circlize implements and enhances circular visualization in R. *Bioinformatics*, **30**, 2811-2812.
- Hamilton A.J., Taylor I.R., Hepworth G. (2002). Activity budgets of waterfowl (Anatidae) on a wastestabilization pond. *Emu - Austral Ornithology*, 102: 171–179.
- Hammer, O., Harper, D., and Ryan, P. 2001. PAST: paleontological statistics software package for education and data analysis. *Palaeontologia Electronica*, 4: 1–9.
- Hepworth, G. and Hemilton, A. J. (2001). Scan sampling and waterfowl activity budget studies: design and analysis considerations. *Behaviour*, 138(11): 1391-1405
- Lee, S. (1997). A time budget study of wintering mallards on the Southern High Plains of Texas, USA. *Korean Journal of Biological Science*, 1: 571-576.
- Martinez, C. (2000). Daily activity pattern of Great bustards, *Otis tarda*. *Ardeola*, 47(1): 57–68.
- Paulus, S.L. (1988). Time activity budgets of non-breeding Anatidae: a review. *Waterfowl in winter*. Minnesota: University of Minnesota Press. 135–152.
- Prajapati, S.H. and Prajapati, R.P. (2013). Classified guilds in avian community with respect to food and feeding behaviour. *Indian Journal of Scientific Research and Technology*, 1: 1 – 7
- Schemske, D.W. (1975). Time budget and foraging site preference of the Cinnamon Hummingbird in Costa Rica. *The Condor*, 77: 216- 217.
- Tamisier, A., Dehorter, O. (1999). Camargue, Canards et Foulques; Fonctionnement d'un prestigieux quartier d'hiver. Nîmes: Centre Ornithologique du Gard; 369.
- Tarboton, W. R. (1978). Hunting and the energy budget of the Blackshouldered Kite. *The Condor*, 80: 88-91.
- Verbeek, N.A.M. (1972). Daily and annual time budget of the Yellow-billed Magpie. *The Auk*, 89: 567-582.