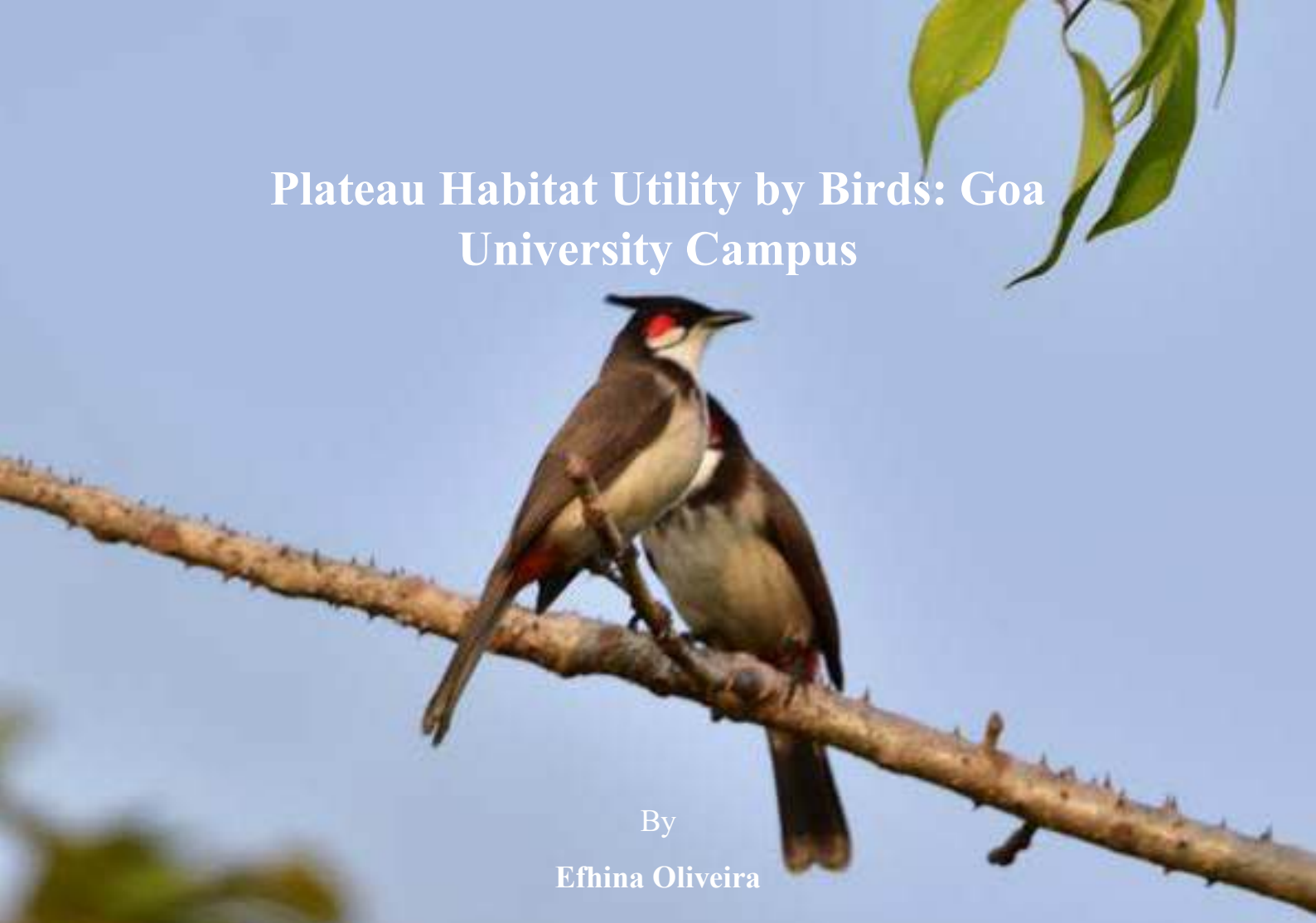
Plateau Habitat Utility by Birds: Goa University Campus



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Plateau Habitat Utility by Birds: Goa University Campus

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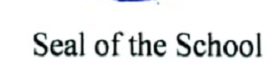

Seal of the School

DECLARATION BY STUDENT

I hereby declare that the data presented in this Dissertation report entitled, "**Plateau Habitat Utility by Birds: Goa University Campus"** is based on the results of investigations carried out by me in the Zoology Discipline at the School of Biological Sciences & Biotechnology, Goa University, under the Supervision of Dr. Minal Desai Shirodkar and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University or its authorities will be not be responsible for the correctness of observations / experimental or other findings given the dissertation.

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(Ms. Efhina Oliveira)

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Place: Goa University

COMPLETION CERTIFICATE

This is to certify that the dissertation report "**Plateau Habitat Utility by Birds: Goa University Campus"** is a bonafide work carried out by Ms. Efhina Oliveira under my mentorship in partial fulfilment of the requirements for the award of the requirement of ZOO-651 Dissertation (16 credit) in the Zoology Discipline at the School of Biological Sciences & Biotechnology, Goa University.

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CONTENTS

PREFACE

This thesis is submitted for the fulfilment of the requirement for the degree of Masters in Zoology and comprises research work carried out by the author under the supervision of Dr.Minal Desai Shirodkar, Assistant Professor, Zoology Discipline, School of Biotechnology, Goa University from 2023-2024.

Birds are some of the most prominent species of the Earth's biodiversity and being sensitive to environmental changes they act as key indicators for assessing the status of ecosystem health. The aim and objectives to investigate the bird diversity in different habitat types on Taleigao Plateau (Goa University Campus). To assess the utility of selected trees by birds on the plateau.

The change in vegetation composition could impact the quality and quantity of habitat for birds in terms of food, water and cover which can further affect the diversity, abundance and distribution of birds. Assessing the bird diversity of a habitat over time and space is one of the key issues for avian community ecologists. Richness, abundance and community composition of birds are often used by ecologists to understand the diversity of species in natural occurrence.

ACKNOWLEDGEMENT

I am extremely thankful to the almighty Lord who has blessed, guided and protected me throughout. I would like to acknowledge all the people who have helped and guided me without which this project would have not been possible.

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Ms. Efhina Oliveira

TABLES

FIGURES

ABBREVIATIONS USED

Entity	**Abbreviation**
Acacia Plantation	AP
Carnivore	C
Indigenous Plantation	IP
Insectivore	I
Least Concern	LC
Migratory	M
Near Threatened	NT
Open Area	OA
Omnivore	O
Phytophages	P
Shrub area	SA

ABSTRACT

A total of 79 bird species, spanning 13 orders and 41 families, were recorded during the study period. Notably, the presence of the Grey-headed Bulbul, an endemic species to the Western Ghats, underscores the ecological significance of the region. The Indigenous plantation emerged as the habitat with the highest bird species, followed by the Shrub area, Acacia plantation, and Open area, in descending order. The majority of recorded species (78) were classified as Least Concern, with only one species categorized as Near-Threatened, emphasizing the overall health of the avian community within the campus. Resident species predominated over migratory ones, with insectivores comprising the most dominant group, followed by phytophages, carnivores, and omnivores. House Crow, Scaly-breasted Munia, and Red-whiskered Bulbuls were identified as the dominant resident birds, while Rosy Starling and Chestnut-tailed Starling were notable among migratory species. The presence of the Grey-headed Bulbul as an endemic species highlights the campus's role in conserving regional biodiversity. Additionally, several bird species were found exclusively in certain habitats, underscoring the importance of habitat diversity. Certain species exhibited a broad habitat range, with several species common across multiple habitats, indicating their adaptability to varying environmental conditions. Overall, this study provides valuable insights into the utilization of plateau habitats by birds within the Goa University campus, emphasizing the need for continued conservation efforts to preserve this unique ecosystem and its avian inhabitants.

CHAPTER 1: INTRODUCTION

1.1 Background

Birds are chordate belonging to class Aves. Aves is the Latin name for birds-feathered winged, bipedal, warm-blooded, egg laying Vertebrate animal (Singh, R., et al. (2018). Aves are warm blooded animals and the body is covered with non-conducting feathers that helps in thermoregulation. Their rate of metabolism is higher than mammals and they lack sweat glands (VIDYANAGAR, V. (2019). Birds are widely distributed across the globe in comparison to other types of vertebrates. The size of birds varies from Bee Humming (5 cm) to Ostrich 2.5 m. Avifauna is classified based on their habitat, behaviour and feeding mechanism. Birds inhabit various regions from the polar regions to the equator across the earth, showcasing remarkable diversity influenced by their specific habitats and geographical circumstances. Birds play a significant role as an ecological element within the overall global biodiversity.

Birds are considered to be among the most significant components of the Earth's biodiversity and being sensitivity to environmental changes, play a crucial role as primary indicators for evaluating the overall health of an ecosystem. Assessing the bird diversity of a habitat over time and space is one of the key issues for avian community ecologists. (Aggarwal,2015). Ecologists frequently utilize various parameters such as species richness, abundance, and community composition to understand the diversity of species in their natural habitats. The structure of the avian community is influenced by alterations in the vegetation structure resulting from either natural occurrences or disturbances caused by human activities, when two disturbances happen at the same time or in rapid succession, they have the potential to create a compound disturbance.

The primary factor influencing the diversity of bird species is the destruction of their natural habitats, therefore large portion of bird species inadvertently migrates to urban environments. The change in vegetation composition could impact the quality and quantity of habitat for birds in terms of food, water and cover which can further affect the diversity, abundance and distribution of birds (Singh, R., et al. (2018). Many researchers have already documented the response that avian diversity shows to different vegetation composition structure and have also demonstrated that Avian diversity increases with an enhanced level of Vegetation (Aggarwal,2015).

Vegetation is a critical component of bird habitat (Dyson, K. (2020). Previous studies have also shown that changes in vegetation habitat composition can indirectly or directly alter bird composition and that increasing vegetation structural complexity and species diversity can effectively increase bird diversity (Xu, Weizhen, et al. (2022). In recent years, studies on the relationship between bird diversity and vegetation have mostly been conducted in natural environments (Xu, Weizhen, et al. (2022). The preservation of natural habitats throughout the country is the most important factor in the sustenance of avian populations. The rapid decrease in the natural forested area has pressured avian species into utilizing shrub and open-area habitats for their survival and reproduction. (Rajpar, M. N., & Zakaria, M. (2015). Shrub habitats consist of understory woody or sapling vegetation generally measuring less than 3 m in height (Hunter et al., 2001) that exhibits specific environmental features that are rich in food resources (such as berries and insects) and offer safe shelter and nesting sites for a diversity of bird species (Rajpar, M. N., & Zakaria, M. (2015). Birds inhabiting shrub habitats have received relatively little attention as compared to species that inhabit forests (Hunter et al., 2001; Peterjohn, 2006)

Birds and trees share a significant symbiotic relationship. It is recognized that plantations of tree species with extended lifespan contribute to system stability through the provision of habitat

complexity, which in turn enhances bird diversity. Various scientists claim that habitat Structure (physiognomy) and floristics (composition) of a particular location are the key Components affecting the assemblage of land birds (Kaur, N., & Kumar, M. (2018) Indigenous plantations are thought to support higher proportion of biodiversity than plantations of non-native trees (Kaur, N., & Kumar, M. (2018). In a study from Kenya Farwig et al. also supported this by investigating that plantations of indigenous trees support more bird diversity than those of exotic ones. The presence and variety of fruit resources within specific environments have an impact on the population size of frugivorous birds. In contrast, the quantity of prey resources like arthropods within wooded areas influences the diversity of insectivorous bird species.

Globally, environmental issues have resulted in a decrease in the population of widespread and common bird species. Recent research conducted by the University of New South Wales tried to determine the global population of birds, with estimates ranging between 50 billion and 430 billion. The International Ornithological Committee reports that the global avifauna comprises approximately 11,000 distinct species of birds, organized into 44 Orders, 253 Families, and 2,384 Genera. Currently, an estimated 159 species are extinct, 226 critically endangered, 461 endangered, 800 vulnerable, and 1,018 near threatened. (https://www.thayerbirding.com/how-many-birds-are-in-the-world/). According to Birdlife International, Colombia is home to a collective sum of 1,866 distinct avian species. South America is the continent with the most bird species: 3,557.

India is home to over 1,350+ species of birds including species which are endemic to the Western Ghats. The report of SoIB 2023 categorized a total of 942 species into three priority action groups. Within these groups, there are 178 species designated as High Priority, 323 as Moderate Priority, and 441 as Low Priority. The SoIB 2023 also report, a collective sum of 204 avian species have

exhibited a decrease over the course of the previous three decades and 217 bird species were identified to be either constant or on the rise within the most recent eight years. The Great Backyard Bird Count (GBBC) has documented a total of 340 different avian species in Kerala.

Goa is experiencing an increase in popularity because of its diverse floral and faunal landscapes, which are also making it a preferred destination for bird watching. In the year 1999, Heinz Lainer meticulously compiled the first comprehensive list of birds found in Goa, documenting a total of 382 species. According to the current bird checklist of Goa, there are 486 species in total, with 17 species being exclusive to the Western Ghats of India and 22 species being classified as threatened by the International Union for Conservation of Nature (IUCN). This can be attributed to the presence of various ecosystems, including coastal areas, mangroves, estuarine grasslands, wetlands, and the unique Western Ghats complex.

Plateaus are characteristic features of Goa (Alvares 2002). They are intermediate areas between the Western Ghats and the coastal plains and are known to harbor endemic plants of the Western Ghats (Joshi & Janarthanam 2004). The most prominent plateaus in Goa are Pernem, Mopa, Morgim, Assonora, Ponda, Kundaim, Betul, Sanvordem and Quepem Numerous flora species exhibit uniqueness within the lateritic plateau, displaying ephemeral characteristics. Studies have indicated that the lateritic plateaus located in the Western Ghats represent distinctive habitats, characterized by a wealth of endemic and endangered species. Plateaus are often considered as barren lands and hence they were the natural choice for setting up developmental projects (Alvares 2002; Desai & Shanbhag 2012). Plateaus serve as biodiversity hotspots that function as reservoirs for our water bodies, hosting a diverse range of flora, predominantly endemic, and fauna. Previous study revealed that the plateau is home to a diverse range of flora and fauna.

1.2 Aim and Objectives

To investigate the bird diversity in different habitat types on Taleigao Plateau (Goa University Campus). To assess the utility of selected trees by birds on the plateau.

1.3 Hypotheses

Plateau habitat is utilized by diverse birds.

1.4 Scope

Long-term monitoring of bird diversity on the Goa University campus should be continued. Future developmental plans on the campus should be devised considering the importance of the habitat to the biodiversity.

CHAPTER 2: LITERATURE REVIEW

Birds are habitat specific and some can occupy more than one habitat type, however because of land use changes, most of the birds have been displaced from their original habitats (Burgess et al., 2002).

The Study on diversity and abundance of birds with respect to different habitat types is important since this will provide an understanding on the avifauna diversity and abundance within natural and human occupied habitats. (Collina, Kambai, et al. (2021)

East Yunnan-Kweichow Plateau is rich in biodiversity in China. (Zhang, Haibo, et al. (2023) suggested that the distribution pattern of avian biodiversity was influenced by the collective impact of diverse habitat elements primarily associated with the availability of food resources and the heterogeneity of habitats.

Sarwar, M. (2019). Study was conducted to determine the number and species richness found in various agricultural environments situated on the plateau and suggested Habitat characteristics estimates of population Sizes of bird species (in the term of the number and Species richness) that are connected to various agricultural systems.

(Peris, S., & Montelongo, T. (2014). examined various relationships between the avian species and the size, level of isolation, and habitat features of the parks within a supra-Mediterranean European city situated on the western Spanish plateau. The study was assessing the abundance, diversity, and impact of different habitat types on the diversity of bird species.

254 species of birds were documented In the Great Indian Bustard Sanctuary, Solapur, Maharashtra, and its surrounding Deccan Plateau landscape, out of 254 bird species documented, 143 were residents, 22 locally migratory, 84 long distance migrants, four resident-local migratory.

Industrial developments have been overlaid on Great Indian Bustard Sanctuary. The study was conducted to understand the threats to the birds and the habitat. (Narwade, S. S., & Rahmani, A. R. (2020).

Chandra et al. (2015) and Dutta et al. (2017) published their paper on birds of the Bastar Plateau. The Bastar Plateau, in Chhattisgarh, the entire region faces various threats such as Iron ore mining, new Railway tracks and Power transmission line projects and two multipurpose hydel projects envisaged on river Indravati. 260 avian species, encompassing both resident and migratory classifications. Among these, ten species were classified as threatened, with two falling under the Critically Endangered category, two under Vulnerable, and six under Near Threatened, one of which was the Malabar Pied Hornbill. This research was conducted to assess the differences in avifauna status between the past and present. (Bharos, A. M. K., et al. (2023).

In Goa, the Plateaux occupy a major portion of the land area (Joshi & Janarthanam 2004). Plateaus in Goa are particularly subjected to significant anthropogenic pressure, as they accommodate the majority of educational institutions and industrial estates.In 1993, hanbhag & Gramopadhye made the initial attempt to analyze the avifauna on Taleigao Plateau. However, the study was unable to reach its ultimate conclusion, despite the documentation of 64 bird species in the region. The subsequent study conducted by Shyama and Gowthaman (1995) documented a total of 43 bird species within the same area, with 13 of these species being previously unrecorded. It appears that both studies relied on limited opportunistic surveys, likely conducted at varying times of the year.

Hence, a comprehensive one-year investigation was carried out on the bird species inhabiting the Taleigao Plateau in Goa due to the absence of research focusing on the faunal variety in these plateaux, which are presently under significant anthropogenic pressures. The Taleigao Plateau is home to 114 bird species, representing 37% of the bird diversity in the state. Plateau are often

considering as non-agriculture land due to the barren appearance and are attracted to various development projects. Birds are considered the key indicators of environmental health, in order to comprehend the impacts of anthropogenic activities. The study was undertaken to compare the old and the present avifauna status. The investigation revealed that 99 avian species were observed, among which 16 are known to migrate and 4 were discovered to be breeding.

CHAPTER 3: METHODOLOGY

3.1: Study area

The geographical location of Taleigao Plateau (15°27'15"N and 17°50' 00" E). Panjim is the capital city of Goa and the plateau is about 8Km away from Panjim. The plateau is an east west trending lateritic table land which covers an area of approximately 296ha and is surrounded by alluvial plains and sloping valleys of two rivers—Mandovi in the north and Zuari in the south. Most of plateau is occupied by many semi / Government establishments and residential tenements (Desai, M., & Shanbhag, A. B. (2012). The Goa University campus is the central zone houses spanning an area of 173ha with its ever-increasing infrastructural facilities. 4 habitats were chosen on same location from the study area. Taleigao is situated within the tropical zone and close proximity to Arabian due to this climate is warm and humid for most of the year, with Atmospheric temperatures ranging from 21 to 37°C.The humidity ranges from 60 to 95%. (Pandit, R., & Pai, I. K. (2017).

Habitat

Open area Habitat (15°27'19.5N" 73°50'05.1"E) is opposite to girl's hostel. comprising of herbs and shrubs. The site contains ephemeral pools in the rainy season for animals

Shrub area Habitat (15°27'21.8"N 73°50'00.9"E)- It is vegetation area behind the girl's hostel consisting shrubs.

Acacia plantation Habitat (15°27'20.7"N 73°50'28.1E")- it is opposite to Dr. Shyama Prasad Mukherjee Stadium. The area consists of exotic tress

Indigenous plantation Habitat (15°27'29.8"N 73°49'49.2"E)- It is behind the Goa University library an area of around 6300m consisting of native trees

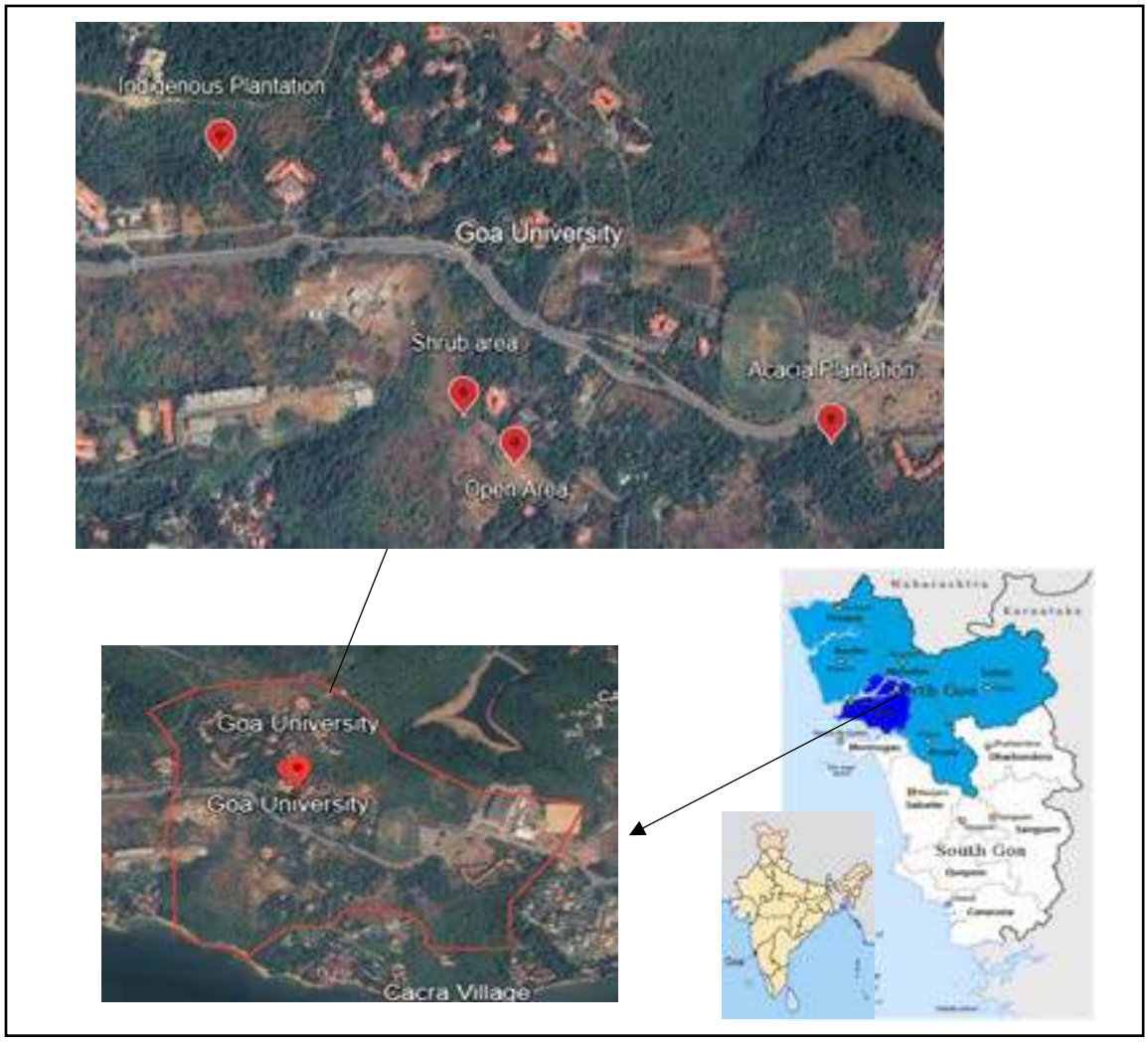
Vegetation

Vegetation on the campus is moist deciduous type mixed with evergreen species. Extensive patches of grasslands on the lateritic rocky outcrops are interspersed by trees and also large thickets of shrubs. (Desai, M., & Shanbhag, A. B. (2012)

Shrubs- *Microcos paniculata, Ziziphus rugosa, Chromolaena odora, Leea indica, Carissa carandas, Ixora coccinea, Ziziphus oenopolia, Abrus precatorius, Dalbergia horridahorrida, Lantana camara, Leucaena leucocephala, Calycopteris floribunda, Holarrhena pubescens, Memecylon umbellatum, Bridelia stipularis*.

Trees-*Acacia auriculiformis, Bombax ceiba, Pithecellobium dulce, Ficus benghalensis, Bridelia retusa, Peltophorum pterocarpum, Alstonia scholaris, Ziziphus mauritiana, Caryota urens, Mangifera indica, Terminalia bellirica, Anacardium occidentale, Trema orientale.*

Figure 3. 1. Map of Study Area



Study Sites

Figure3.2: Open Area

Figure3.3: Shrub Area

Figure3.4: Acacia Plantation

Figure3.5: Indigenous Plantation

3.2: Methods

The entire study area was classified into different land classes including, open area, shrub area, Acacia plantation and Indigenous plantation. Field data were obtained using the "Point Counts" (Bibbly et al,2001) which is a count from a fixed location. This method is suitable for studying highly visible, and/or vocal bird Species, in a wide variety of habitats. bird count was carried out during the morning from 7:00 to 10:00 am, when birds are found to be most active. Each study site was surveyed twice in a month from May 2023 to April 2024 covering all seasons. A total four habitat each habitat varied in length depending on the total area of the study site and its vegetation of the area. A distance of approximately 20 m was maintained between the two the two habitats. Bird species were observed using binoculars (Celestron 10×50) and photographs were taken with a digital camera (Nikon D5600). Birds were identified with the help of available literature, Birds of Indian Subcontinent (Grimmett et al.2011), Birds of Goa (Grewal B.& Sanvio Fonseca). All birds are listed along with their current IUCN Red list of Threatened Species (2023), food habit (Desai, M., & Shanbhag, A. B. 2012 & Rong, Abhik, et al. 2023), resident and migratory status (State of Indian Birds 2023)

The dominant trees such as *Bombax ceiba, Pithecellobium dulce, Ziziphus mauritiana, Trema orientalis* and shrubs such as *Ziziphus rugosa, Ziziphus oenoplia, Microcos paniculata* were taken to study the utility by birds for foraging from October to April

In addition, the bird's behaviour was classified among different vegetation habitats into the following three categories:

Perching: birds were observed in resting, singing, calling, preening, etc.

Moving: birds were observed moving or walking among different places, searching, chasing etc.

Feeding: birds were observed pecking for food or eating worms, plants, or other food resources.

Bird species which are in flight or identified by sounds were omitted from behaviour analysis because no direct vegetation layer information was collected in these cases.

3.3: Statistics

The data was analysed using GraphPad Prism. The variation in bird community with in different habitat as species was analysed by one-way Anova test.

Selected Trees and Shrubs

Figure3.6: ***Bombax ceiba***

Figure3.7: ***Pithecellobium dulce***

Figure3.8: ***Trema orientalis***

Figure3.9: ***Ziziphus mauritiana***

Figure3.10: *Ziziphus rugosa*

Figure3.11: *Ziziphus oenoplia*

Figure3.12: *Microcos paniculata*

CHAPTER4: ANALYSIS AND CONCLUSION

Figure4.1: Indian Peafowl

Figure4.2: Rock Pigeon

Figure4.3: Asian Koel

Figure4.4: Common Hawk-Cuckoo

Figure4.5: Red-wattled Lapwing

Figure4.6: Brahminy Kite

Figure4.7: Black Kite

Figure4.8: Shikra

Figure4.9: White-eyed Buzzard

Figure4.10: White-cheeked Barbet

Figure4.11: Coppersmith Barbet

Figure4.12: Asian green Bee-eater

Figure4.13: Blue-tailed Bee-eater

Figure4.14: Indian Roller

Figure4.15: Rose-ringed Parakeet

Figure4.16: Plum-headed Parakeet

Figure4.17: Indian golden Oriole

Figure4.18: Common Iora

Figure4.19: Black Drongo

Figure4.20: Ashy Drongo

Figure4.21: Brown shrike

Figure4.22: House Crow

Figure4.23: Purple Sunbird

Figure4.24: Purple-rumped Sunbird

Figure4.25: Baya Weaver

Figure4.26: White-rumped Munia

Figure4.27: Scaly-breasted Munia

Figure4.28: Paddyfield Pipit

Figure4.29: White-browed Wagtail

Figure4.30: Ashy Prinia

Figure4.31: Plain Prinia

Figure4.32: Blyth's reed Warbler

Figure4.33: Red-whiskered Bulbul

Figure4.34: White-browed Bulbul

Figure4.35: Rosy Starling

Figure4.36: Chestnut-tailed Starling

Figure4.37: Indian Robin

Figure4.38: Oriental magpie-Robin

Figure4.39: Tickell's blue Flycatcher

Table4.1: Checklist of birds of Taleigao Plateau

Sr No.	Order/ Family/ Species	Common name	OA	SA	AP	IP	IUCN	Status	Feeding guilds
	GALLIFORMES: Phasianidae								
1	*Pavo cristatus*	Indian Peafowl	+	+			LC	R	O
	COLUMBIFORMES: Columbidae								
2	*Columba livia*	Rock Pigeon	+	+		+	LC	R	P
3	*Streptopelia chinensis*	Spotted Dove		+		+	LC	R	P
	CAPRIMULGIFORMES: Apodidae								
4	*Apus affinis*	Little Swift	+				LC	R	I
	CUCULIFORMES: Cuculidae								
5	*Centropus sinensis*	Greater Coucal	+		+	+	LC	R	O
6	*Phaenicophaeus viridirostris*	Blue-faced Malkoha		+	+	+	LC	R	I
7	*Clamator jacobinus*	Jacobin Cuckoo		+			LC	M	I
8	*Eudynamys scolopaceus*	Asian Koel	+	+	+	+	LC	R	P
9	*Cacomantis passerines*	Grey-bellied Cuckoo		+			LC	M	I
10	*Hierococcyx varius*	Common Hawk-Cuckoo		+			LC	M	I

	GRUIFORMES: Rallidae								
11	*Amaurornis phoenicurus*	White-breasted Waterhen	+				LC	R	O
	PELECANIFORMES: Ardeidae								
12	*Ardeola grayii*	Indian Pond Heron	+		+		LC	R	C
13	*Bubulcus ibis*	Cattle Egret	+				LC	R	I
	CHARADRIIFORMES: Charadriidae								
14	*Vanellus indicus*	Red-wattled Lapwing	+	+		+	LC	R	I
	CHARADRIIFORMES: Scolopacidae								
15	*Actitis hypoleucos*	Common Sandpiper	+				LC	R	I
	ACCIPITRIFORMES: Accipitridae								
16	*Pernis ptilorhynchus*	Oriental Honey Buzzard			+		LC	M	C
17	*Haliastur indus*	Brahminy Kite	+			+	LC	R	C
18	*Milvus migrans*	Black Kite	+			+	LC	R	C
19	*Accipiter badius*	Shikra		+			LC	R	C
20	*Haliaeetus leucogaster*	White-bellied Sea Eagle		+			LC	R	C
21	*Butastur teesa*	White-eyed Buzzard		+		+	LC	M	C

	BUCEROTIFORMES: Bucerotidae								
22	*Ocyceros birostris*	Indian Grey Hornbill		+			LC	R	P
	BUCEROTIFORMES: Upupidae								
23	*Upupa epops*	Common Hoopoe	+				LC	M	I
	PICIFORMES: Picidae								
24	*Dinopium benghalense*	Black-rumped Flameback		+			LC	R	I
	PICIFORMES: Ramphastidae								
25	*Psilopogon viridis*	White-cheeked Barbet				+	LC	R	P
26	*Psilopogon haemacephalus*	Coppersmith Barbet				+	LC	R	P
	CORACIIFORMES: Meropidae								
27	*Merops orientalis*	Green Bee-eater	+			+	LC	R	I
28	*Merops philippinus*	Blue-tailed Bee-eater	+			+	LC	M	I
	CORACIIFORMES: Coraciidae								
29	*Coracias benghalensis*	Indian Roller	+				LC	R	C
	CORACIIFORMES: Alcedinidae								
30	*Halcyon smyrnensis*	White-throated Kingfisher	+	+	+		LC	R	C

	PSITTACIFORMES: Psittaculidae								
31	*Psittacula cyanocephala*	Plum-headed Parakeet		+	+	+	LC	R	P
32	*Psittacula krameria*	Rose-ringed Parakeet			+	+	LC	R	P
33	*Loriculus vernalis*	Vernal Hanging Parrot			+		LC	R	P
	PASSERIFORMES: Campephagidae								
34	*Pericrocotus flammeus*	Orange Minivet		+		+	LC	R	I
35	*Pericrocotus cinnamomeus*	Small Minivet		+	+	+	LC	R	I
	PASSERIFORMES: Oriolidae								
36	*Oriolus kundoo*	Indian Golden Oriole	+	+	+	+	LC	M	O
	PASSERIFORMES: Aegithinidae								
37	*Aegithina tiphia*	Common Iora		+	+	+	LC	R	I
	PASSERIFORMES: Dicruridae								
38	*Dicrurus macrocercus*	Black Drongo		+	+	+	LC	R	C
39	*Dicrurus leucophaeus*	Ashy Drongo		+	+	+	LC	M	C
40	*Dicrurus paradiseus*	Greater Racket-tailed Drongo				+	LC	R	I

	PASSERIFORMES: Laniidae								
41	*Lanius cristatus*	Brown Shrike	+	+		+	LC	M	C
42	*Lanius Schach*	Long-tailed Shrike		+			LC	M	C
	PASSERIFORMES: Corvidae								
43	*Dendrocitta vagabunda*	Rufous Treepie			+		LC	R	O
44	*Corvus splendens*	House Crow	+	+	+	+	LC	R	O
	PASSERIFORMES: Monarchidae								
45	*Terpsiphone paradisi*	Indian Paradise-flycatcher				+	LC	R	I
	PASSERIFORMES: Dicaeidae								
46	*Dicaeum concolor*	Plain Flowerpecker			+	+	LC	M	P
	PASSERIFORMES: Nectariniidae								
47	*Leptocoma zeylonica*	Purple-rumped Sunbird		+	+	+	LC	R	P
48	*Cinnyris asiaticus*	Purple Sunbird		+	+	+	LC	R	P
49	*Cinnyris lotenius*	Loten's Sunbird		+	+	+	LC	R	P
	PASSERIFORMES: Irenidae								
50	*Chloropsis jerdoni*	Jerdon's Leafbird				+	LC	R	O

	PASSERIFORMES: Ploceidae								
51	*Ploceus philippinus*	Baya Weaver	+			+	LC	R	P
	PASSERIFORMES: Estrildidae								
52	*Lonchura striata*	White-rumped Munia	+				LC	R	P
53	*Lonchura punctulate*	Scaly-breasted Munia	+	+		+	LC	R	P
	PASSERIFORMES: Motacillidae								
54	*Anthus rufulus*	Paddyfield Pipit	+				LC	R	I
55	*Motacilla maderaspatensis*	White-browed Wagtail	+				LC	R	I
	PASSERIFORMES: Cisticolidae								
56	*Prinia hodgsonii*	Grey-breasted Prinia		+	+	+	LC	R	I
57	*Prinia socialis*	Ashy Prinia		+	+	+	LC	R	I
58	*Prinia inornate*	Plain Prinia		+	+	+	LC	R	I
59	*Orthotomus sutorius*	Common Tailorbird		+	+	+	LC	R	I
	PASSERIFORMES: Acrocephalidae								
60	*Phylloscopus affinis*	Tickell's Leaf Warbler	+	+	+		LC	M	I
61	*Acrocephalus dumetorum*	Blyth's Reed Warbler			+	+	LC	M	I

	PASSERIFORMES: Hirundinidae								
62	*Cecropis daurica*	Red-rumped Swallow	+				LC	R	I
63	*Hirundo smithii*	Wire-tailed Swallow	+				LC	R	I
64	*Hirundo rustica*	Barn Swallow				+	LC	M	I
	PASSERIFORMES: Pycnonotidae								
65	*Pycnonotus jocosus*	Red-whiskered Bulbul	+	+	+	+	LC	R	O
66	*Pycnonotus cafer*	Red-vented Bulbul	+	+	+	+	LC	R	O
67	*Pycnonotus luteolus*	White-browed Bulbul	+	+	+	+	LC	R	P
68	*Brachypodius priocephalus*	Grey-headed Bulbul				+	NT	R	P
	PASSERIFORMES: Phylloscopidae								
69	*Phylloscopus trochiloides*	Greenish Warbler	+		+		LC	M	I
	PASSERIFORMES: Timaliidae								
70	*Dumetia hyperythra*	Tawny-bellied Babbler		+	+	+	LC	R	I
	PASSERIFORMES: Pellorneidae								
71	*Pellorneum ruficeps*	Puff-throated Babbler	+		+	+	LC	R	I

	PASSERIFORMES: Leiothrichidae								
72	*Turdoides striata*	Jungle Babbler	+		+		LC	R	P
	PASSERIFORMES: Sturnidae								
73	*Pastor roseus*	Rosy Starling		+	+	+	LC	M	I
74	*Sturnia malabarica*	Chestnut-tailed Starling		+	+	+	LC	M	I
75	*Acridotheres fuscus*	Jungle Myna	+			+	LC	R	O
	PASSERIFORMES: Muscicapidae								
76	*Saxicoloides fulicatus*	Indian Robin	+	+	+	+	LC	R	I
77	*Copsychus saularis*	Oriental Magpie Robin	+	+	+	+	LC	R	I
78	*Cyornis tickelliae*	Tickell's Blue Flycatcher		+	+	+	LC	R	I
	PASSERIFORMES: Turdidae								
79	*Geokichla citrina*	Orange-headed Thrush			+	+	LC	R	I

4.1: OBSERVATION

In the study period of 1 year, from May 2023 to April 2024, a total of 79 species were recorded belonging to 13 orders and 41 families in 4 different habitats (Table1). Grey-headed Bulbul endemic to Western Ghats was recorded. Maximum bird species were recorded in the Indigenous plantation (51), followed by Shrub area (43) Acacia plantation (39), and least is Open area (37). Out of 79 species, 78 species were Least Concerned and 1 is Near-Threatened. Based on residential status, 61 species were residents, 18 were migratory. During the study period insectivores where the dominant contributes 37 (47%) species followed by phytophages 19 species (24%), 13 (16%) were carnivores and least is omnivores 10(13%) species. House Crow, scally breasted munia, Red- whiskered Bulbuls were the dominant residents' birds observed. The dominant of migratory birds were Rosy Starling and Chestnut tailed Starling observed in the study. 1 bird recorded endemic is Grey- headed Bulbul. 8 species of birds were common in all 4 different habitats.11 bird species exclusively found in Open area, in Shrub area 8 bird species, 2 bird species exclusively found in Acacia plantation and 7 bird species found exclusively in Indigenous plantation. In case of Open Area and Shrub Area 15 species were common. In Shrub Area and Acacia Plantation 27 species were found common. Comparing the Acacia and Indigenous Plantation there are around 29 species were common in both habitats. In case of Indigenous Plantation and Open Area 18 species were common.

HABITAT

1.Open Area Habitat:

In Open Area 37 species were recorded. All 37 species were Least Concerned. Out of 37 species, 30 were resident's species and 7 were migratory species. Feeding habit of these birds consisted of 18 species with insectivorous diet, 7 with carnivorous diet, 7 with omnivorous diet and 5 with phytophagous diet. Rock Pigeon was the dominant in the study area. Maximum number of species 15 we're recorded in the month of March.

2. Shrub Area Habitat:

Shrub Area 43 species were recorded. All 43 species were Least Concerned. Out of 43 species, 34 were resident's species and 9 were migratory species. Feeding habit of these birds consisted of 19 species with insectivorous diet, 8 with carnivorous diet, 7 with omnivorous diet and 9 with phytophagous diet. House Crow was the dominant in the study area. Maximum number of species 15 we're recorded in the month of February.

3. Acacia Plantation Habitat:

In Acacia Plantation 39 species were recorded. All 39 species were Least Concerned. Out of 39 species, 30 were resident's species and 9 were migratory species. Feeding habit of these birds consisted of 18 species with insectivorous diet, 5with carnivorous diet, 6 with omnivorous diet and 10 with phytophagous diet. Red-whiskered Bulbul was the dominant in the study area. Maximum number of species 16 we're recorded in the month of January.

4. Indigenous Plantation Habitat:

In Indigenous Plantation 51 species were recorded. All 50 species were Least Concerned and one species was Near-Threatened Out of 51 species, 41 were resident's species and 10 were migratory species. Feeding habit of these birds consisted of 22 species with insectivorous diet, 7 with carnivorous diet, 7 with omnivorous diet and 15 with phytophagous diet. Indian Golden Oriole was the dominant in the study area. Maximum number of species 29 we're recorded in the month of January

Birds Feeding on Selected Trees

A total 8 bird species visited *Bombax ceiba.* (Table4.3) The observations indicated that avian species were attracted to the flowers of *Bombax ceiba* for the purpose of obtaining nectar and water, in addition to feeding on insects. Out of 8 bird species, 3 species were sucking nectar of *B. ceiba* flowers such as Red-whiskered Bulbul, Jungle Mynas, Indian golden Oriole and 5 bird species visited flowers for eating insects such as Chestnut-tailed Starling, Rosy Starling, among listed birds Rosy Starling and Chestnut-tailed Starling were dominant in number visited to flower of *B. ceiba*.

Pithecellobium dulce (Table4.3) a fruiting tree, the birds have to hang upside down and peck at it to open the pod. A total 7 birds visited *P. dulce*. All were observed feeding on fruit of *P. dulce* such as Asian Koel, House Crow, Indian golden Oriole, Red-whiskered Bulbul, White-browed Bulbul, Plum-headed Parakeet and Rose-ringed Parakeet. Asian Koel and White-browed bulbul were dominant in number visited to fruits of *P. Dulce*.

Some researchers have investigated the presence of frugivorous avian species on the plant species *Z. mauritiana* (Ramachandran, 2021). Total 4 bird species visited *Ziziphus mauritiana*. (tTable 4.3) 2 were observed feeding on fruit of *Z. mauritiana* such as, Red-whiskered Bulbul and Red-vented

Bulbul. 2 bird species visited flowers for sucking nectar such as Purple Sunbird, Purple-rumped Sunbird. Sunbirds was dominant in number visited to flower of *Z. mauritiana*.

Trema orientalis (Table4.3) a small tree. Total 7 bird species visited *Trema orientale*. 6 bird's species observed feeding on fruit of *T. Orientalis* such as Asian koel, House Crow, Red-whiskered bulbul, Jungle mynas, Rosy Starling and Chestnut-tailed starling. Bird species visited flowers for sucking nectar such as Purple-rumped sunbird. visited flowers for feeding on insects. House Crow and Red-whiskered bulbul were dominant feeding on fruits of *T. Orientalis*.

Birds Feeding on Selected Shrubs

In *Ziziphus rugosa*, (Table 4.4)6 bird species visited *Z.rugosa*. 6 bird's species observed feeding on fruit of Z.rugosa such as House Crow, Red-whiskered bulbul, Jungle mynas, Rosy Starling and Chestnut-tailed starling and Orange headed. Rosy Starlings was dominant feeding on fruits of *Z.rugosa*.

I *Ziziphus oenoplia*, (Table4.4) 4 bird species visited *Z.oenoplia*. 2 bird species observed feedind on fruits of *Z. oenoplia* such as Red whiskered Bulbul and White browed Bulbul.Bird species visited on flower for sucking nectar such as Purple Sunbird and Purple rumbed Sunbird. Red whiskered Bulbul was dominant feeding on fruits of *Z.oenoplia*

In *Microcos paniculata*, (Table 4.4) 3 bird species visited *M.paniculata*. 3 bird species observed feeding on fruits of *M. paniculata* such as Red whiskered Bulbul, Orange headed Thrush and white browed Bulbul. White browed Bulbul was dominant feeding on fruits of *M. paniculata*

Table4.2: Observation Tables showing variation in number of Species per Habitat

Sr No.	Month	OA	SA	AP	IP
1	May	7	11	10	13
2	June	9	13	11	15
3	July	12	18	16	20
4	August	12	15	20	26
5	September	14	18	24	21
6	October	10	13	16	20
7	November	11	20	15	25
8	December	13	19	16	23
9	January	15	23	28	35
10	February	14	19	16	25
11	March	15	17	13	23
12	April	10	14	17	20

One-way ANOVA was used to compare diversity of birds of four different habitat showed

F= 33.22

P= <0.0001

Statistically Significant

Figure4.40: Graph showing month variation of Birds in different habitat

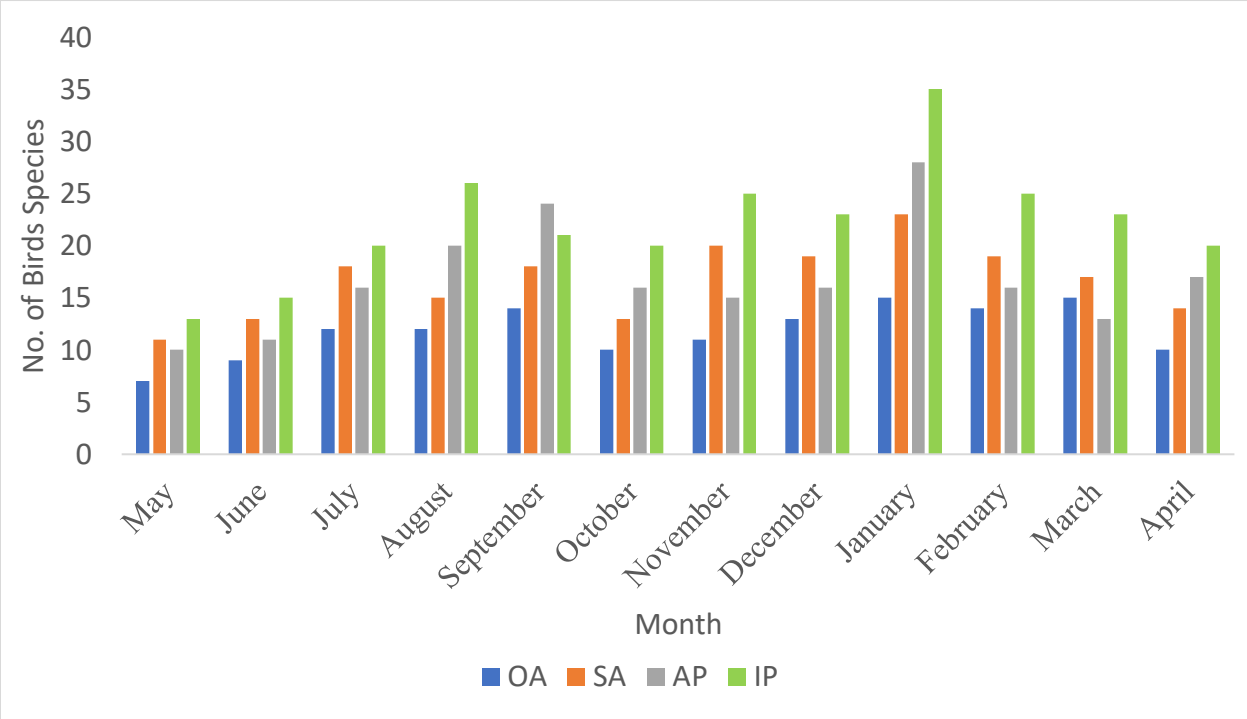


Figure4.41: Graph showing total number of birds in different habitat

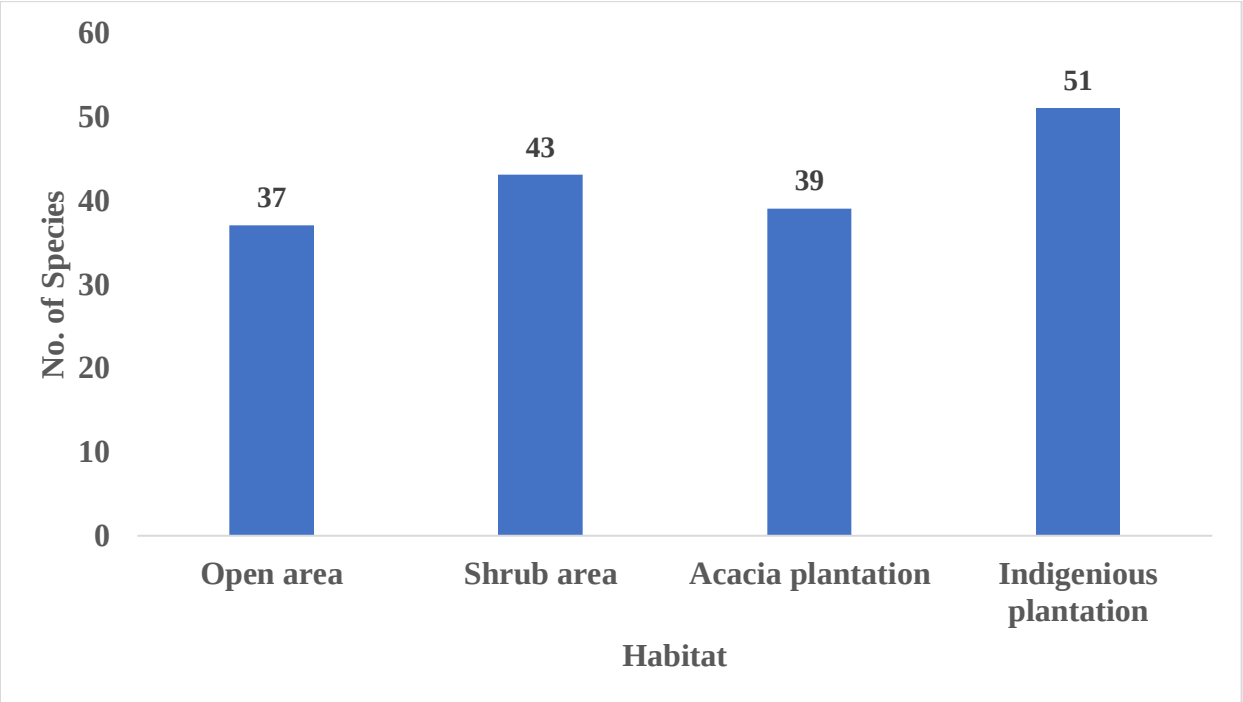


Figure4.42: Pie Chart Showing Residential Status of Birds

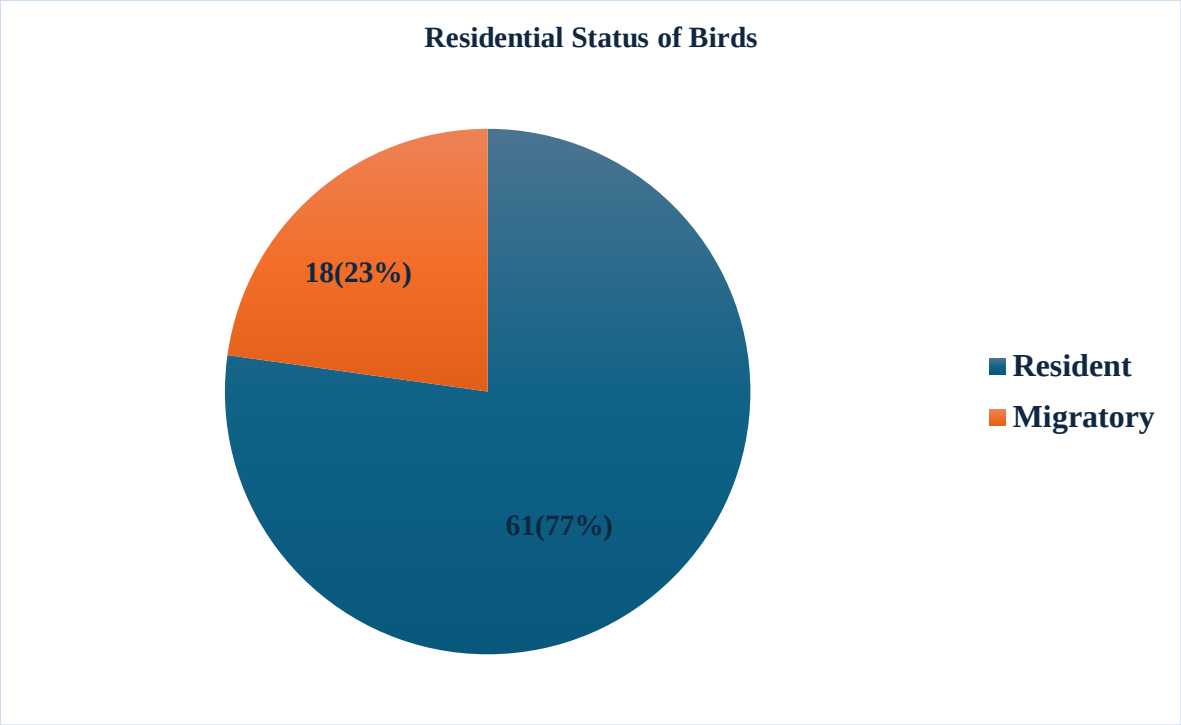


Figure4.43: Graph showing Residential Status Variation per Habitat

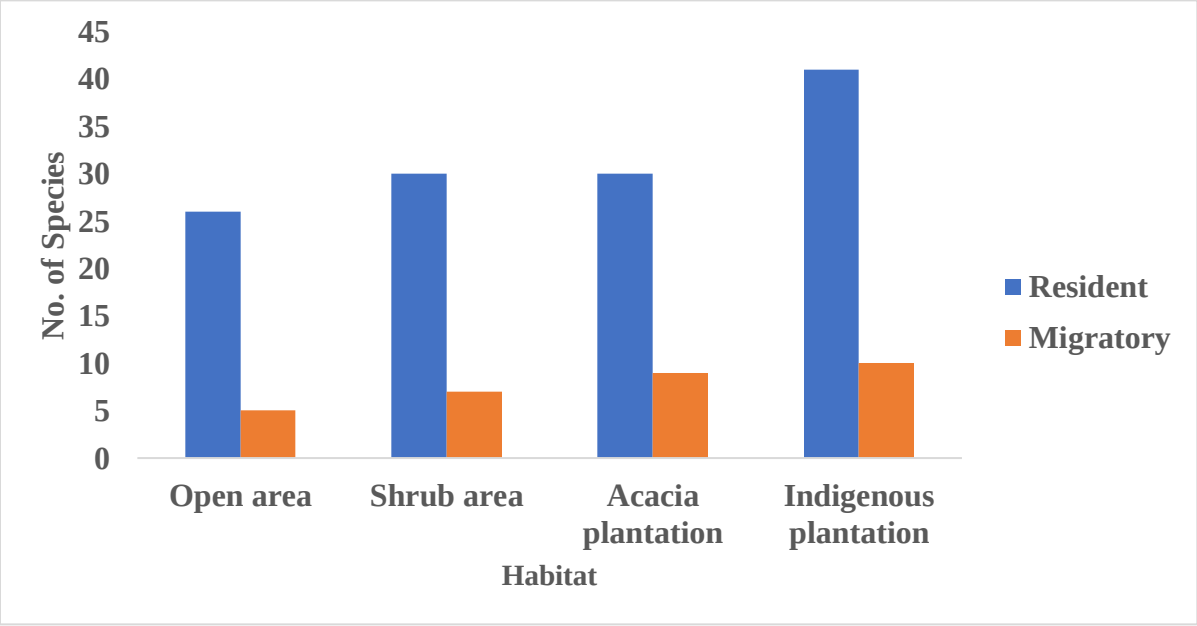


Figure4.44: Pie Chart showing Feeding Guilds of Birds

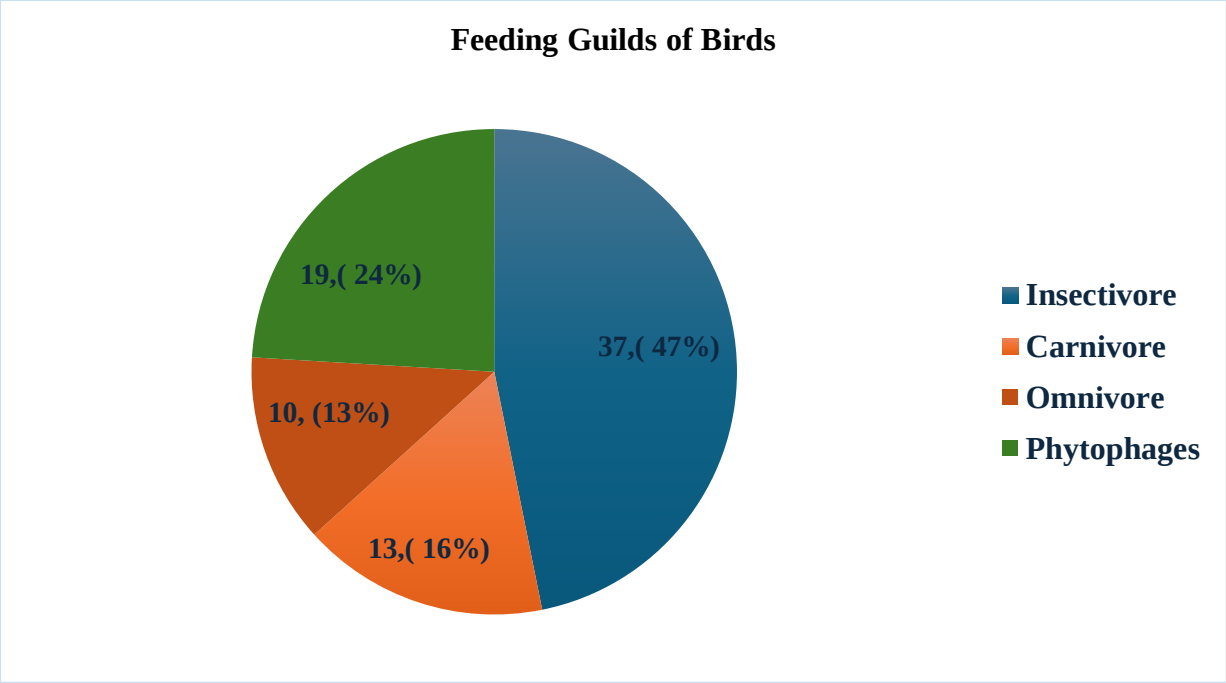


Figure4.45: Graph Showing Feeding Guild Variation per Habitat

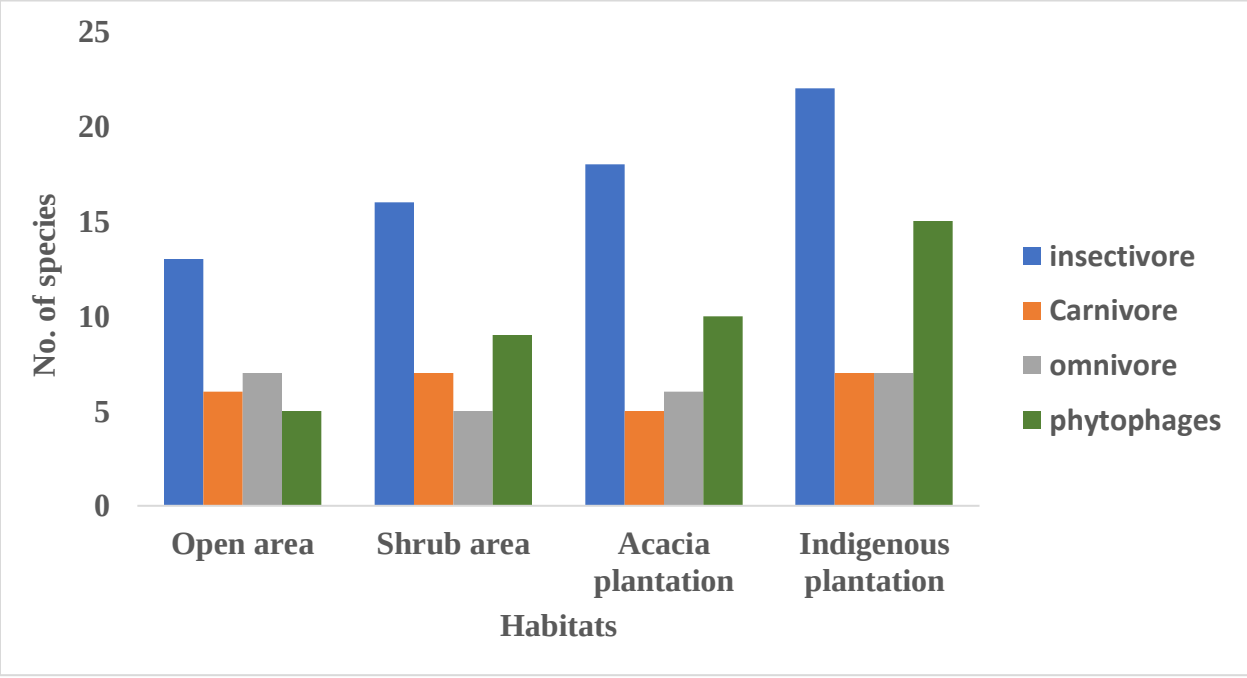


Figure4.46: Graph Showing Birds Visited Trees

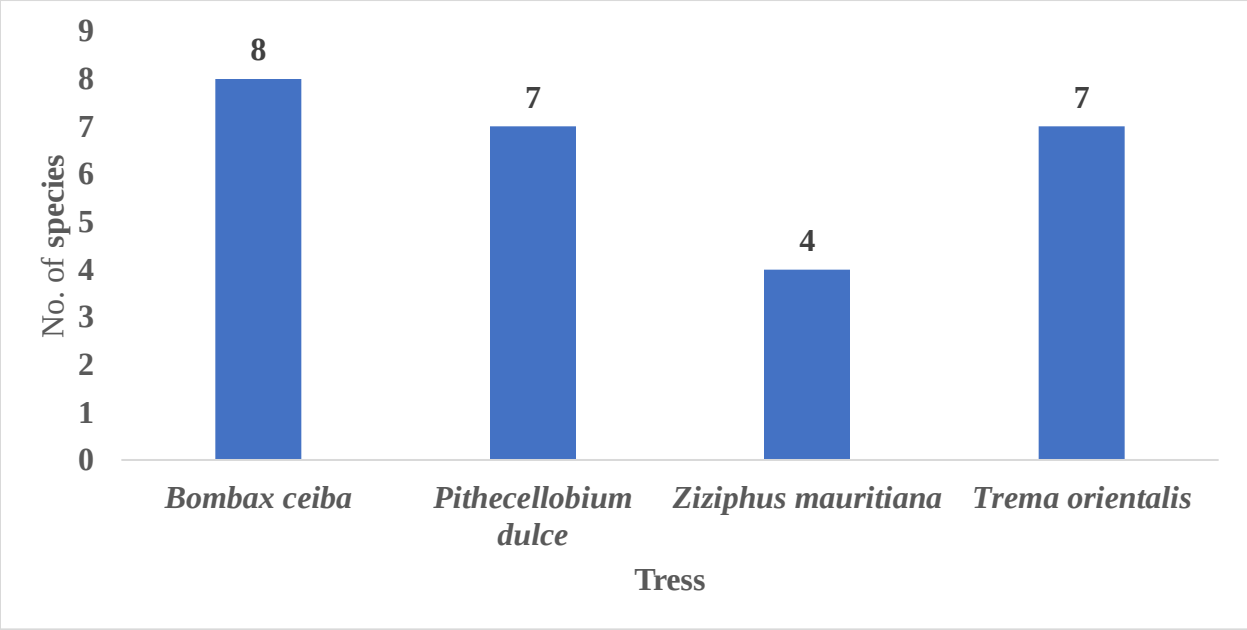


Figure4.47: Graph Showing Birds Visited Shrubs

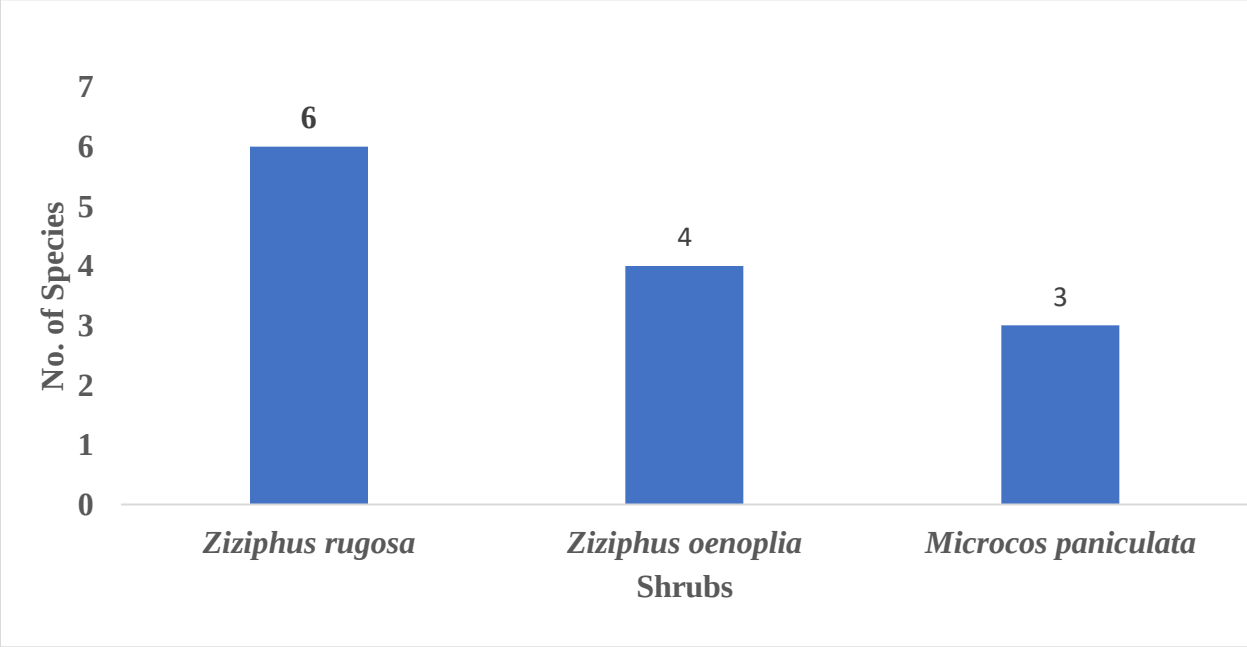


Table4.3: Number of Birds Visited Trees

Trees	**Number of Birds visited**
Bombax ceiba	Indian golden Oriole, House Crow, Black Drongo, Ashy Drongo, Chestnut-tailed Starling, Rosy Starling, Red-whiskered Bulbul, Jungle Myna
Pithecellobium dulce	Asian Koel, Indian golden Oriole, House Crow, Rose-ringed Parakeet, Plum-headed Parakeet, Red-whiskered Bulbul, White-browed Bulbul, House Crow
Ziziphus mauritiana	Red-whiskered Bulbul, Red-vented Bulbul, Purple Sunbird, Purple-rumped Sunbird
Trema orientale	House Crow, Chestnut-tailed Starling, Rosy Starling, Red-whiskered Bulbul, Jungle Myna, Asian Koel, Purple-rumped Sunbird

Table4.4: Number of Birds Visited Shrubs

Shrubs	**Number of Birds visited**
Ziziphus rugosa	House Crow, Chestnut-tailed Starling, Rosy Starling, Red-whiskered Bulbul, Jungle Myna, Orange-headed Thrush
Ziziphus oenopolia	Red-whiskered Bulbul, White-browed Bulbul, Purple Sunbird, Purple-rumped Sunbird
Microcos paniculata	Red-whiskered bulbul, Orange-headed Thrush, White-browed Bulbul

Figure4.48: Graph Showing Activities of Birds

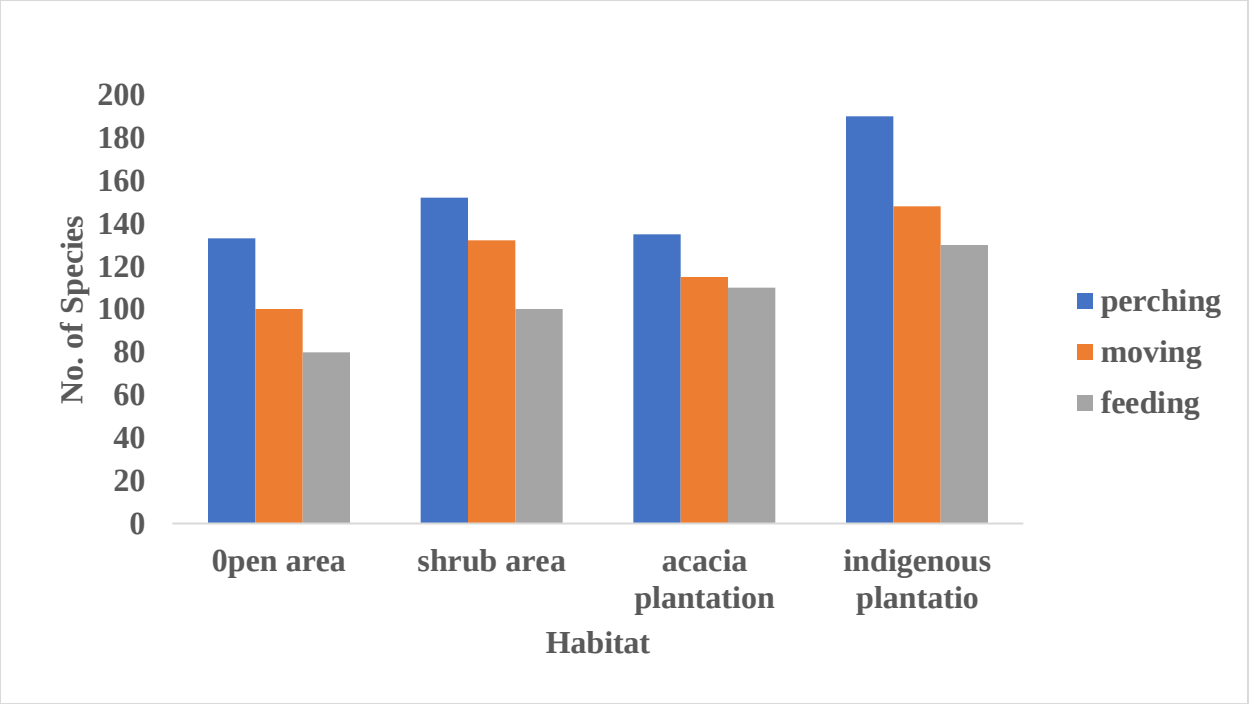
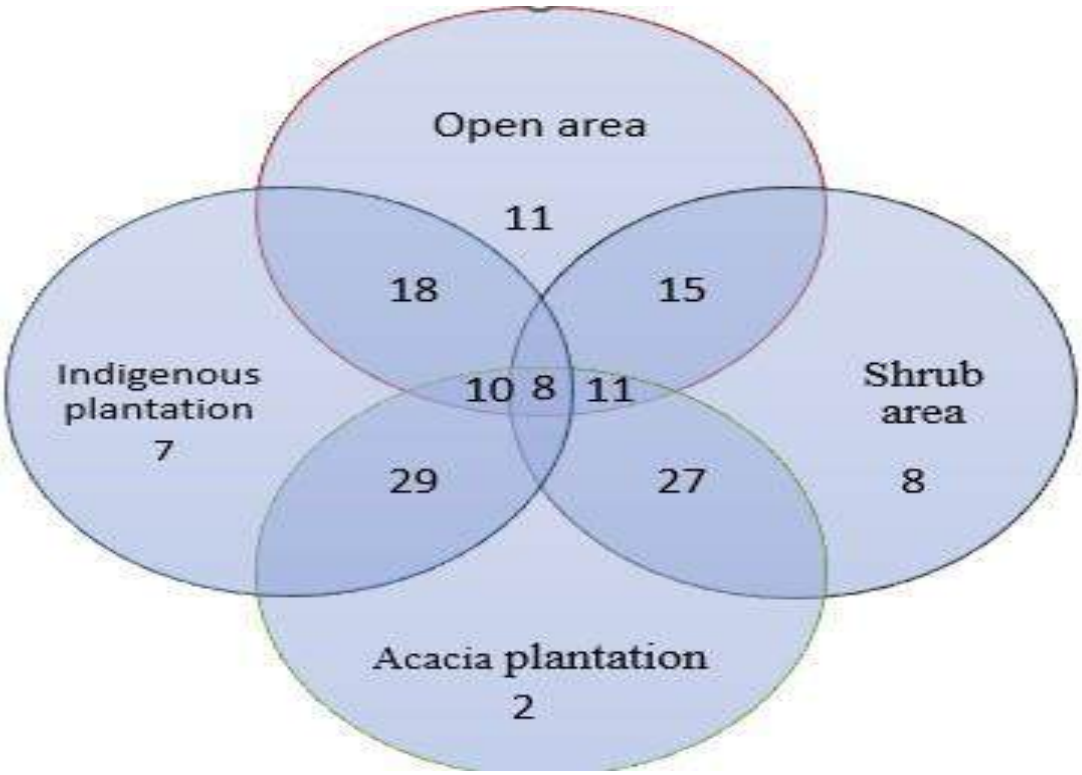


Figure4.49: Venn diagram



4.2: DISCUSSION

The observations on bird species in the Goa University campus provide valuable insights into the dynamics of bird habitat utilization, particularly in the Taleigao Plateau. The shift in dominant bird species from House Crow and Jungle Myna to House Crow, Scaly-breasted Munia, and Red-whiskered Bulbuls suggests a change in the ecological conditions of the plateau, possibly due to anthropogenic factors.

The increase in buildings on the plateau over the past decade might have led to habitat fragmentation, affecting the presence of certain bird species like Larks. This highlights the impact of urbanization on biodiversity, causing declines in specific bird populations.

Furthermore, the decrease in both resident and migratory bird species indicates a general decline in habitat quality, likely due to increased anthropogenic pressure. This emphasizes the importance of conservation efforts to mitigate human-induced impacts on the plateau ecosystem and preserve its biodiversity.

Indigenous plantation emerges as a crucial habitat, boasting the highest number of bird species due to the presence of native trees that provide stability to bird populations. Even open areas play a pivotal role, hosting 37 bird species, highlighting their importance in supporting avian diversity.

The migration pattern reveals a peak in bird population from November to March, coinciding with the migratory season. This underscores the seasonal influx of birds and the need to conserve habitats to support their migration.

Residential status analysis indicates that 61 bird species are residents, while 18 are migratory. The dominance of residential birds in Indigenous plantation underscores its role in providing suitable conditions for resident species.

The feeding guild variation across habitats shows the prevalence of insectivores, highlighting the abundance of insects facilitated by the presence of flora in the campus. This intricate ecosystem interaction underscores the importance of habitat diversity in supporting avian communities and ecological balance.

The plateau habitat within the Goa University campus serves as a vital ecosystem for various bird species, offering a diverse range of resources for feeding and nesting. Observations indicate that certain tree species, such as *Bombax ceiba Pithecellobium dulce, Ziziphus mauritiana,and Trema Orientalis* play significant roles in attracting birds due to their flowering and fruiting patterns. For instance, the flowering of B. ceiba in January attracts both migratory and resident birds, with Rosy Starlings and Chestnut-tailed Starlings being dominant visitors for nectar and insects. Similarly, Z. mauritiana's fruiting season from October to December attracts frugivorous birds.

The presence of native trees in the Indigenous Plantation area fosters a rich bird activity, as these trees provide essential resources for birds such as food and shelter. Conversely, open areas lack flora and consequently support fewer bird species. Additionally, the location of habitats, such as the Acacia plantation near the highway, influences bird activity, with noise pollution from vehicles impacting the presence of birds.

Understanding the flowering and fruiting seasons of different plant species is crucial in determining bird preferences and habitat utilization. This knowledge can inform conservation efforts, such as promoting the growth of native trees and minimizing disturbances in bird habitats, ultimately contributing to the preservation of avian biodiversity within the Goa University campus.

The dominance of bird activity in Indigenous Plantation areas underscores the importance of native flora in supporting bird populations. Native trees likely provide food sources, nesting sites, and

shelter for a variety of bird species, contributing to higher levels of bird activity compared to other areas.

Conversely, the relatively low bird activity in Open areas highlights the impact of habitat loss or degradation on avian populations. The absence of flora in open spaces may result in limited resources and nesting opportunities for birds, leading to reduced activity levels.

The findings regarding Acacia plantation areas near the highway demonstrate the influence of anthropogenic factors on bird habitat utility. The presence of vehicular noise near these habitats likely disrupts bird behavior and reduces their activity levels.

Overall, these observations emphasize the importance of preserving and restoring diverse habitats, particularly those with native vegetation, to support healthy bird populations within urban environments like the Goa University campus.

4.3: CONCLUSION

In conclusion, the study conducted at Goa University Campus highlights the significant influence of habitat characteristics on bird diversity. Indigenous plantation emerged as a crucial habitat supporting a diverse range of bird species due to its rich flora providing ample food sources. Conversely, areas near the main highway, such as the Acacia plantation, experienced lower bird diversity possibly due to increased vehicle noise. The Open areas are of utmost important for the bird's population as they provide better visibility for vigilance from their predators and free movement towards food procurement. The findings underscore the importance of long-term monitoring to assess bird population trends and understand the impacts of habitat alterations on avian communities. It emphasizes the need for conservation efforts to mitigate anthropogenic pressures and preserve diverse bird habitats for the future.

To preserve the biodiversity of the plateau habitat and support a wider range of bird species, it is essential to implement conservation measures such as habitat restoration, reducing anthropogenic disturbance, and promoting awareness about the importance of preserving natural habitats within urban environments. By addressing these challenges, the Goa University can continue to serve as a valuable refuge for birds and contributes to the overall biodiversity conservation efforts in the region.

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